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CHAPTER 6.0

ENGINEERED SAFETY FEATURES

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*Refer to Section 1.6 and Table 1.6-3. Controlled drawings were removed from the USAR at Revision 17 and are considered incorporated by reference.

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*Refer to Section 1.6 and Table 1.6-3. Controlled drawings were removed from the USAR at Revision 17 and are considered incorporated by reference.

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NRC QUESTIONS PERTAINING TO CHAPTER 6.0

Section	Question Number	Section	Question Number
6.4	450.00		
6.4	450.01		
6.4	450.02		
6.4	450.03		
6.4	450.04		
6.4	450.05		
6.4	450.06		
6.5.2	450.07		

CHAPTER 6.0

ENGINEERED SAFETY FEATURES

Engineered safety features (ESF) are those safety-related systems and components designed to directly mitigate the consequences of a design basis accident by:

a. Protecting the fuel cladding

b. Ensuring the containment integrity

c. Limiting fission product releases to the environment within the guideline values of 10 CFR, Part 100

The limiting design basis accidents which are discussed and analyzed in Chapter 15.0 and Section 6.3 are:

a. Loss-of-coolant accident (LOCA)

b. Main steam line break (MSLB)

c. Steam generator tube rupture

d. Fuel handling accident

(Items a and b are also discussed in Section 6.2)

The engineered safety features consist of the following systems:

a. Containment (Section 6.2.1)

b. Containment heat removal (Section 6.2.2)

c. Containment isolation (Sections 6.2.4 and 6.2.6)

d. Containment combustible gas control (Section 6.2.5)

e. Emergency core cooling (Section 6.3)

f. Fission product removal and control systems (Section 6.5)

g. Emergency HVAC and filtration (Section 9.4)

h. Control room habitability (Section 6.4)

i. Auxiliary feedwater (Section 10.4.9)

The containment is provided to contain radioactivity following a LOCA.

The containment spray system, in conjunction with the containment fan coolers and the emergency core cooling system, was designed to remove sufficient heat from the containment atmosphere following a LOCA or main steam line break inside the containment to rapidly reduce the containment pressure and temperature and maintain them at acceptably low levels.

The containment spray system was also designed to minimize the iodine and particulate fission product inventories in the containment atmosphere resulting from a postulated LOCA.

Containment isolation is provided to minimize leakage from the containment. Steam line and feedwater line isolation is provided to minimize the heat removal from the reactor coolant system and prevents excessive blowdown of a steam generator following a postulated main steam line rupture. Steam line isolation also prevent excessive radioactivity release following a steam generator tube rupture. The containment purge isolation capability is provided to reduce the radioiodine released following a fuel handling accident inside the containment.

The emergency core cooling system (ECCS), consisting of accumulator tanks, safety injection pumps, RHR pumps, and centrifugal charging pumps, is provided for emergency core cooling to limit fuel damage following a LOCA or main steam line break.

An emergency exhaust system is provided to reduce the radioiodine released following a fuel handling accident outside the containment and to filter ECCS leakage outside the containment following a LOCA.

The auxiliary feedwater system provides an adequate amount of feedwater into the steam generators to prevent a pressure transient which could cause a loss of reactor coolant through the pressurizer relief valves and a possible uncovering of the reactor core following a main steam line break or loss of the main feedwater system.

Other safety-related systems are identified in Section 3.2. Because of the importance of safety-related systems to the health and safety of the general public, special precautions are taken to ensure high quality in the components and in the system design and to ensure reliable and dependable operation.

6.1 ENGINEERED SAFETY FEATURE MATERIALS

This section provides a discussion of the materials used in the fabrication of engineered safety feature components and of the material interactions that could potentially impair the operation of the ESF.

6.1.1 METALLIC MATERIALS

6.1.1.1 Materials Selection and Fabrication

Information on the selection and fabrication of the materials in the engineered safety features of the plant, such as the emergency core cooling systems, the containment heat removal systems, the containment combustible gas control system, and the containment spray system, is provided below. Materials for use in the ESF are selected for their compatibility with the reactor coolant system and containment spray solutions, as required by Section III of the ASME Boiler and Pressure Vessel Code, Articles NC-2160 and NC-3120.

6.1.1.1.1 Specifications for Principal Pressure-Retaining Materials

All pressure-retaining material in the engineered safety feature systems' components complies with the corresponding material specification permitted by ASME Section III, Division 1.

The material specifications for pressure-retaining material in each component of the engineered safety feature systems will meet the requirements of Article NC-2000 of ASME Section III, Class 2, for quality group B and Article ND-2000 of ASME Section III, Class 3, for quality group C components. Containment penetration materials will meet the requirements of Article NE-2300 of ASME Section III, Division I. Table 6.1-1 includes the specifications for the principal pressure-retaining components.

6.1.1.1.2 Engineered Safety Feature Materials of Construction

The engineered safety feature materials that would be exposed to the emergency core cooling water and containment sprays following a LOCA are indicated in Table 6.1-1. These materials are chosen to be compatible with the core cooling and spray solutions. Additional information concerning metallic materials' compatibility with post-LOCA conditions is provided in Reference 1.

In order to keep materials within the containment that are subject to corrosion to a minimum, the following restrictions are placed on the use of zinc, aluminum, and mercury in the containment:

a. Aluminum is severely attacked by the alkaline containment spray solution. This reaction may result in the loss of structural integrity and the generation of gaseous hydrogen. The use of aluminum in the containment is minimized.

b. Boric acid reacts with zinc, oxidizing it and liberating hydrogen gas. The use of zinc (galvanized materials and paint) in the containment is minimized to reduce the generation of hydrogen.

c. The use of mercury and mercuric compounds is minimized inside the containment because of its corrosive effects on stainless steel, NiCrFe alloy 600, and alloys containing copper. The amount of mercury associated with plant lighting and control switches, etc., is negligible.

Table 6.2.5-3 is a list of the amounts of aluminum and zinc which are in the containment and which could potentially be exposed to a corrosive environment. These materials are listed by the system or component in which they are used, and an estimate of their expected corrosion rate is given. Aluminum or zinc is not used in any safety-related item where exposure to the spray solution is possible.

For other materials which could come in contact with containment sprays, tests have been performed and are detailed in Reference 2. These tests have shown that no significant amount of corrosion products is produced from these materials.

Many coatings which are in common industrial use may deteriorate in the post-accident environment and contribute substantial quantities of foreign solids and residue to the containment sump. Consequently, protective coatings used inside the containment in significant quantities are demonstrated to withstand the design basis accident conditions and are designed to meet the criteria given in ANSI N101.2 (1972), "Protective Coatings (Paints) for Light Water Nuclear Reactor Containment Facilities," and are in compliance with Regulatory Guide 1.54, "Quality Assurance Requirements for Protective Coatings Applied to Water-Cooled Nuclear Power Plants," as indicated in Table 6.1-2. Some small items may be painted or coated using common industrial practice but the paint/coating is not in sufficient quantity to cause any clogging problems for the sump strainer. Any precipitation of appreciable size that occurs either settles out prior to reaching the sump strainer or is trapped by the sump filter strainer. The strainer opening size 0.045 inch is smaller than the line piping, the RHR heat exchanger tubes, the spray nozzles, and clearances in the reactor core. Therefore, particles which could potentially cause blockage are filtered out. Refer to Section 6.2.2.1 for a discussion of the sump design and consideration given to strainer clogging. For each containment component, a complete list of the surface coatings, the dry film thickness, and the surface area covered is presented in Table 6.1-3.

6.1.1.1.3 Integrity of Safety-Related Components

The following information is provided to demonstrate that the integrity of the safety-related components is maintained during all stages of component manufacturing:

a. Regulatory Guide 1.44, Control of the Use of Sensitized Stainless Steel, is complied with to the extent specified in Table 6.1-4 for the purpose of avoiding significant sensitization and stress corrosion cracking in austenitic stainless steel components of the engineered safety features.

b. Cleaning and contamination protection of austenitic stainless steel components of the engineered safety features complies with Regulatory Guide 1.44, Control of the Use of Sensitized Stainless Steel, as described in Table 6.1-4. Regulatory Guide 1.37, Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants, is complied with to the extent specified in Table 6.1-5.

c. Cold worked austenitic stainless steel material with 0.2-percent offset yield strengths greater than 90,000 psi are not used in components that are part of the engineered safety features.

d. The selection, procurement, testing, storage, and installation of all nonmetallic thermal insulation assure that the leachable concentrations of chloride, fluoride, sodium, and silicate are in accordance with Regulatory Guide 1.36, Nonmetallic Thermal Insulation for Austenitic Stainless Steel. Compliance with Regulatory Guide 1.36 is discussed in Table 6.1-6.

e. With regard to the preheat temperature used for welding low alloy steels, the recommendations of Regulatory Guide 1.50, Control of Preheat Temperatures for Welding of Low Alloy Steel, were followed, as discussed in Table 6.1-7.

f. The recommendations of Regulatory Guide 1.71, Welder Qualification for Areas of Limited Accessibility, are followed as discussed in Table 6.1-8.

g. In order to determine the RT_{NDT} for the steam and feedwater system materials, the guidelines in NRC Branch Technical Position MTEB 5-2 Section 1.1, Article 4 were followed.

   The applied test methods and acceptance criteria for all materials used in the steam and feedwater systems, with the exception of the steam generators, comply completely with ASME Code Section III, Article NC-2310 of the Winter 1974 Addenda for fracture toughness of ferritic materials used in Class 2 components. The applied test methods and acceptance criteria for all Class 2 steam generator materials comply with the requirements of ASME Code Section III 1971 Edition through Summer 1973 Addenda.

6.1.1.1.4 Control of Stainless Steel Welding

Regulatory Guide 1.31, Control of Stainless Steel Welding, as supplemented by Branch Technical Position MTEB 5-1, is complied with to the extent specified in Table 6.1-9 for the purpose of avoiding fissuring in austenitic stainless steel welds that are part of the engineered safety features.

6.1.1.2 Composition, Compatibility, and Stability of Containment and Core Spray Coolants

The information given below is provided on the composition, compatibility, and stability of the core cooling water and the containment sprays on the engineered safety features.

6.1.1.2.1 Control of pH During a Loss-of-Coolant Accident

A description of the method of establishing containment spray and recirculation sump pH following a LOCA is included in Sections 6.2.2 and 6.5. The resultant basic pH range of 8.5-9.0 is not conducive to stress-corrosion cracking in austenitic stainless steels. Hydrogen evolution is discussed in Section 6.2.5, Combustible Gas Control in Containment.

6.1.1.2.2 Engineered Safety Feature Coolant Storage

The borated water supply for the containment sprays and emergency core cooling system is drawn from the refueling water storage tank. As described in Section 6.3, the refueling water storage tank is fabricated of stainless steel and is not subject to significant corrosive attack by the tank's contents. Spray additive (NaOH) for the containment spray system is stored in a stainless steel tank to prevent corrosive attack by the 30 weight percent (nominal) sodium hydroxide solution.

The accumulator tanks which store borated water for the accumulator safety injection system are made of carbon steel and are clad with stainless steel to ensure that they are resistant to corrosion.

6.1.2 ORGANIC MATERIALS

Use of organic material inside the containment is kept to a minimum.

The amount of lubricants inside the containment which is subject to being released to the containment is listed in Table 6.1-10. The lubricants, such as those needed for the reactor coolant pumps and hydraulic snubbers, are, however, totally enclosed and not open to the containment atmosphere.

Table 6.1-3 is a coating schedule for the containment which indicates the type of paint and compliance with Regulatory Guide 1.54.

Protective coatings covered by Regulatory Guide 1.54 which are applied to surfaces within the containment have been tested to demonstrate that they will remain intact during postulated LOCA conditions. The tests are performed by an independent laboratory and show that no significant decomposition, radiolytic or pyrolytic failures will occur during a DBA.

Where the surface area and application type do not dictate special coatings, the coatings are evaluated by generic-type and formulation information. Paint chip formation is controlled by limiting the thickness of nonqualified coatings to a point where there is insufficient tensile strength in a removed film to form a chip.

6.1.3 POST-ACCIDENT CHEMISTRY

Following a main steam line break or design basis LOCA, sodium hydroxide and boric acid solutions will be present in the containment sumps. Figure 6.5-5 represents the time-history of the pH of the aqueous phase in the containment sump. Table 6.5-5 indicates the quantities of sodium hydroxide and boric acid that will be present in the containment after an accident. The pH control reduces the probability of chloride stress corrosion cracking on stainless steel and attack on aluminum fittings.

6.1.4 REFERENCES

1. Whyte, D. D. and Picone, L. F., "Behavior of Austenitic Stainless Steel in Post Hypothetical Loss-of-Coolant Environment," WCAP-7798-L (Proprietary), November 1971 and WCAP-7803 (Non-Proprietary), December 1971.

2. Picone, L. F., "Evaluation of Protective Coatings for use in Reactor Containment," WCAP-7198-L (Proprietary), April 1968 and WCAP-7825 (Non-Proprietary), December 1971.

3 Caplan, J. S., "The Application of Preheat Temperatures after Welding Pressure Vessel Steels," WCAP-8577 (Non-Proprietary), September 1975.

TABLE 6.1-1
ESF MATERIALS OF CONSTRUCTION

Item	Applicable Section	Externally Exposed to Containment Environment	Internally Exposed to Containment DBA Environment	Design Code	Specification	Protective Coating
Safety Injection Systems-Includes Residual Heat Removal and CVCS Systems						
Refueling water storage tank	6.3	No	No	III-2	SA 240, Type 304; SA 312, Type 304; SA 1182, F304; SA 479, Type 304	N/A
Accumulator	6.3	Yes	No	III-2	SA 533 with SS Clad	Chemically cured epoxy or modified phenolic epoxy
High head safety injection pump	6.3	No	Yes	III-2		
Casing					SA 351, Grade CF8 or CF8M, SA 182, F 304 or F 316	N/A
Impeller					A 296 CA40	N/A
Shaft					A 276 410	N/A
Residual heat removal pump	5.4.7/6.3	No	Yes	III-2		
Casing					SA 182, F304	N/A
Impeller					A 296 CA 40	N/A
Shaft					A 276 410	N/A

TABLE 6.1-1 (Sheet 2)
ESF MATERIALS OF CONSTRUCTION

Item	Applicable Section	Externally Exposed to Containment Environment	Internally Exposed to Containment DBA Environment	Design Code	Specification	Protective Coating
Residual heat removal heat exchanger	5.4.7/6.3	No	Yes	III-2		
Shell					SA 240 and SA 312, Type 304	N/A
Tubes					SA 213, Type 304; SA 249, Type 304	N/A
Tube Sheets					SA 182, F 304; SA 240, Type 304; SA 516, Grade 70 with SS Cladding	N/A
Recirculation valve encapsulation	6.3	No	No	III-2	SA 240, Type 304; SA 312, Type 304; SA 182, F 304; SA 285 Grade C	Carbozinc 11 for carbon steel skirt
Boron injection tank	6.3	No	Yes	III-2	SA 351, Grade CF8A; SA 240, Type 304	N/A
Centrifugal charging pump	9.3.4	No	Yes	III-1	SA 182, F 304	N/A
Containment Spray System						
Containment spray pump	6.2.2	No	Yes	III-2		
Casing					SA 182, F 304	N/A
Impeller					A 487, CB 6MM	N/A

TABLE 6.1-1 (Sheet 3)
ESF MATERIALS OF CONSTRUCTION

Item	Applicable Section	Externally Exposed to Containment Environment	Internally Exposed to Containment DBA Environment	Design Code	Specification	Protective Coating
Shaft					A 276, Type 410, Condition T	N/A
Containment spray additive tank	6.2.2	No	No	III-2	SA 240, Type 304	N/A
Containment spray additive eductor	6.2.2	No	Yes	III-2		
Body					SA 182, Type 304 (Body)	N/A
Insert					SA 564, Type 630 (Insert)	N/A
Containment spray header and nozzles	6.2.2	Yes	Yes	III-2		
Header					SA 312, Type 304 or SA 376, Type 304	N/A
Nozzles					SA 351, Type 304	N/A
Containment recirculation sump strainer	6.2.2	Yes	Yes	III-2	Type 304 SS	N/A
Recirculation valve encapsulation	6.2.2	No	No	III-2	SA 240, Type 304; SA 312, Type 304; SA 182, F 304; SA 285, Grade C	Carbozinc 11 for carbon steel skirt

TABLE 6.1-1 (Sheet 4)
ESF MATERIALS OF CONSTRUCTION

Item	Applicable Section	Externally Exposed to Containment Environment	Internally Exposed to Containment DBA Environment	Design Code	Specification	Protective Coating
Auxiliary Feedwater System						
Motor-driven auxiliary feedwater pump	10.4.9	No	No	III-3		
Casing					SA 217, WC9	Mfrs. Std.
Impeller					A 296, CA6NM	N/A
Shaft					A 276, Type 410, Condition T	N/A
Turbine-driven auxiliary feedwater pump	10.4.9	No	No	III-3		
Casing					SA 217, WC9	Mfrs. Std.
Impeller					A 297, CA6NM	N/A
Shaft					A 276, Type 410, Condition T	N/A
Auxiliary feedwater pump turbine	10.4.9	No	No	MS		
Casing					A 216, WCB	Mfrs. Std.
Rotor					AISI 4140	N/A

TABLE 6.1-1 (Sheet 5)
ESF MATERIALS OF CONSTRUCTION

Item	Applicable Section	Externally Exposed to Containment Environment	Internally Exposed to Containment DBA Environment	Design Code	Specification	Protective Coating
Main Feedwater System						
Portion of system piping and instrumentation	10.4.7	Yes	No	III-2	SA 333, Grade 6	Carbozinc 11
Isolation valve	10.4.7	No	No	III-2	SA 216, WCB	N/A
Main Steam System						
Portion of system piping and instrumentation	10.3	Yes	No	III-2	SA 155, KCF-70	Carbozinc 11
Isolation valve	10.3	No	No	III-2	SA 216, WCB	N/A
Containment and Piping Penetrations						
Containment piping penetration	6.2.4	Yes	Yes/No	III-2	SA 155, KCF-70 CL SA 333, Grade 6	Carbozinc 11
Containment penetration isolation valves	6.2.4	Yes	Yes/No	III-2	See ASME III Class 2 Valves	N/A
Containment penetration piping between isolation valves	6.2.4	Yes	Yes/No	III-2	See ASME III Class 2 Piping	Carbozinc 11 or N/A
Containment liner	6.2.4	Yes	N/A	III, Div 2 (Prop) Sec. 3,000	SA 285, Grade A	Carbozinc 11

TABLE 6.1-1 (Sheet 6)
ESF MATERIALS OF CONSTRUCTION

Item	Applicable Section	Externally Exposed to Containment Environment	Internally Exposed to Containment DBA Environment	Design Code	Specification	Protective Coating
Containment Cooling System						
Containment cooler fan Housing cone and bell	6.2.2/9.4	Yes	Yes	N/A	A 283	Modified phenolic epoxy
Containment cooler coils	6.2.2/9.4	Yes	No	III-3	SB 111, Alloy 706; B 152, Alloy 110; SB 466, Alloy 706; A 526	N/A
Containment cooler housing	6.2.2/9.4	Yes	Yes	N/A	A 500 B, A 570, Grade D	Modified phenolic epoxy
Containment cooler fan motor	6.2.2/9.4	Yes	No	NEMA	Carbon steel, copper	Modified phenolic epoxy
Hydrogen mixing fan	6.2.2/9.4	Yes	Yes	N/A	Carbon Steel	Modified phenolic epoxy
Hydrogen mixing fan motor	6.2.2/9.4	Yes	No	NEMA	Carbon steel, copper	Mfrs. Std.
Containment Hydrogen Control System						
Electric recombiner	6.2.5	Yes	Yes	NEMA	A 240, Type 304	N/A

TABLE 6.1-1 (Sheet 7)
ESF MATERIALS OF CONSTRUCTION

Item	Applicable Section	Externally Exposed to Containment Environment	Internally Exposed to Containment DBA Environment	Design Code	Specification	Protective Coating
Hydrogen analyzer	6.2.5	No	Yes	N/A		
Tubing (including coolers)					SA 213, Type 304 or 316	N/A
Fittings					SA 479, Type 316, SA 182, Type 316	N/A
<u>Piping and valves</u>						
ASME III Class 1	3.9.3			III-1		
Piping		Yes	Yes		SA 312, Type 304, seamless	N/A
Valves		Yes	Yes		SA 182, F 316 SA 351, Grade CP8 or CF8M	N/A
ASME III Class 2	3.9.3			III-2		
Piping		Yes	Yes		SA 312, Type 304, seamless or welded	N/A
					SA 155, KC-70, C1.1, welded	Carbozinc 11
					SA 155, KCP-70	
					SA 106, Grades B and C, seamless	Carbozinc 11
					SA 333, Grade 6, seamless or welded	Carbozinc 11

TABLE 6.1-1 (Sheet 8)
ESF MATERIALS OF CONSTRUCTION

Item	Applicable Section	Externally Exposed to Containment Environment	Internally Exposed to Containment DBA Environment	Design Code	Specification	Protective Coating
Valves		Yes	Yes		SA 182, F 316	N/A
					SA 351, Grade CP8 or CF8M	N/A
					SA 216, WCB	
ASME III Class 3	3.9.3			III-3		
Piping		Yes	No		SA 312, Type 304, seamless or welded	N/A
					SA 155, KC-70, C1.1, welded	Carbozinc 11
					SA 106, Grade B, seamless	Carbozinc 11
Valves		Yes	No		SA 182, F 316	N/A
					SA 351, Grade CF8 or CF8M	
					SA 216, WCB	Carbozinc 11

TABLE 6.1-2

DESIGN COMPARISON TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.54 REVISION 0, DATED JUNE 1973, TITLED "QUALITY ASSURANCE REQUIREMENTS FOR PROTECTIVE COATINGS APPLIED TO WATER-COOLED NUCLEAR POWER PLANTS"

Regulatory Guide 1.54 Position	Position on Non-NSSS Components Inside Containment	Position on NSSS Components Inside Containment
1. ANSI N101.4-1972 should be used in conjunction with ANSI N45.2-1971, "Quality Assurance Program Requirements for Nuclear Power Plants."	1. Complies.	1, 2, 3 and 4. NSSS equipment located in the containment building is separated into four categories to identify the applicability of this regulatory guide to various types of equipment. These categories of equipment are as follows: a. Category 1 - Large equipment b. Category 2 - Intermediate equipment c. Category 3 - Small equipment d. Category 4 - Insulated/stainless steel equipment A discussion of each equipment category follows:
2. Subdivision 2.7 of ANSI N101-4-1972 states that when references are made to other standards, these references shall imply the most recent or current editions of the referenced standards. The specific applicability or acceptability of referenced standards will be covered separately in other regulatory guides, where appropriate.	2. Complies.	
3. Subdivision 1.1.2 of ANSI N101.4-1972 states that quality assurance, as covered by this standard, comprises all those planned and systematic actions necessary to provide specified documentation and adequate confidence that shop or field coating work for nuclear	3. Complies, except that for certain applications within the containment, where the coating is not necessary for the protection of the component, a quality assurance	a. Category 1 - Large Equipment The Category 1 equipment consists of the following: (1) Reactor coolant system supports (2) Reactor coolant pumps (motor and motor stand)

TABLE 6.1-2 (Sheet 2)

DESIGN COMPARISON TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.54 REVISION 0, DATED JUNE 1973, TITLED "QUALITY ASSURANCE REQUIREMENTS FOR PROTECTIVE COATINGS APPLIED TO WATER-COOLED NUCLEAR POWER PLANTS"

Regulatory Guide 1.54 Position	Position on Non-NSSS Components Inside Containment	Position on NSSS Components Inside Containment
facilities will perform satisfactorily in service. This statement should not be interpreted as implying that the end product of quality assurance actions is the production of specified documentation. The term "quality assurance," as used in ANSI N101.4-1972, should be considered to comprise all those planned and systematic actions necessary to provide adequate confidence that shop or field coating work for nuclear facilities will perform satisfactorily in service. In this connection, it is emphasized that records and documents listed in Subdivisions 7.4 through 7.8 and included in the standard, are suggested forms only. Alternate documentation consistent with the requirements of Appendix B to 10 CFR Part 50 is also considered acceptable.	program was not applied. In those applications, the coating was reviewed to assure that there were no long-term detrimental effects.	(3) Accumulator tanks (4) Refueling machine Since this equipment has a large surface area and was procured from only a few vendors, it was possible to implement tight controls over these items. Stringent requirements were specified for protective coatings on this equipment through the use of a painting specification in the procurement documents. This specification defined requirements for: (1) Preparation of vendor procedures (2) Use of specific coatings systems which are qualified to ANSI N101.2 (3) Surface preparation (4) Application of the coating systems in accordance with the paint manufacturer's instructions

TABLE 6.1-2 (Sheet 3)

DESIGN COMPARISON TO REGULATORY POSITIONS OF
REGULATORY GUIDE 1.54 REVISION 0, DATED JUNE 1973,
TITLED "QUALITY ASSURANCE REQUIREMENTS FOR
PROTECTIVE COATINGS APPLIED TO WATER-COOLED NUCLEAR POWER PLANTS"

Regulatory Guide 1.54 Position	Position on Non-NSSS Components Inside Containment	Position on NSSS Components Inside Containment
4. Sections 3 and 4 of ANSI N101.4-1972 delineate quality assurance requirements for coating materials and surface preparation of substrates. Cleaning materials used with stainless steel would not be compounded from or treated with chemical compounds containing elements that could contribute to corrosion, intergranular cracking, or stress corrosion cracking. Examples of such chemical compounds are those containing chlorides, fluorides, lead, zinc, copper, sulfur, or mercury where such elements are leachable or where they could be released by breakdown of the chemical compounds under expected environmental conditions (e.g., by radiation). This limitation is not intended to prohibit the use of trichlorotrifluoroethane, Military Specification the following:	4. Complies	(5) Inspections and nondestructive examinations (6) Exclusive of certain materials (7) Identification of all nonconformances (8) Certifications of compliance The vendor's procedures were subject to review by engineering personnel, and the vendor's implementation of the specification requirements was monitored during quality assurance surveillance activities. This system of controls provides assurance that the protective coatings will properly adhere to the base metal during prolonged exposure to a post-accident environment present within the containment building. b. Category 2 - Intermediate Equipment The Category 2 equipment consists of

TABLE 6.1-2 (Sheet 4)

DESIGN COMPARISON TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.54 REVISION 0, DATED JUNE 1973, TITLED "QUALITY ASSURANCE REQUIREMENTS FOR PROTECTIVE COATINGS APPLIED TO WATER-COOLED NUCLEAR POWER PLANTS"

Regulatory Guide 1.54 Position	Position on Non-NSSS Components Inside Containment	Position on NSSS Components Inside Containment
MIL-C-81302b, for cleaning or degreasing of austenitic stainless steel provided adequate removal is assured.		(1) Seismic platform and tie rods (2) Reactor internals lifting rig (3) Head lifting rig (4) Electrical cabinets Since these items were procured from a large number of vendors, and individually have very small surface areas, it was not practical to enforce the complete set of stringent requirements which are applied to Category 1 items. Another painting specification was used in these procurement documents. This specification defined to the vendors the requirements for: (1) Use of specific coating systems which are qualified to ANSI N101.2 (2) Surface preparation (3) Application of the coating systems in accordance with the paint manufacturer's instructions

WOLF CREEK
TABLE 6.1-2 (Sheet 5)

DESIGN COMPARISON TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.54 REVISION 0, DATED JUNE 1973, TITLED "QUALITY ASSURANCE REQUIREMENTS FOR PROTECTIVE COATINGS APPLIED TO WATER-COOLED NUCLEAR POWER PLANTS"

Regulatory Guide 1.54 Position	Position on Non-NSSS Components Inside Containment	Position on NSSS Components Inside Containment
		The vendor's compliance with the requirements was also checked during quality assurance surveillance activities in the vendor's plant. These measures of control provide a high degree of assurance that the protective coatings will adhere properly to the base metal and withstand the postulated accident environment within the containment building. c. Category 3 - Small Equipment Category 3 equipment consists of the following: (1) Transmitters (2) Alarm horns (3) Small instruments (4) Valves (5) Heat exchanger supports These items were procured from several different vendors and were painted by the vendor in accordance with conventional industry practices. Because the total exposed surface area is very small, Westinghouse did not specify further requirements.

WOLF CREEK
TABLE 6.1-2 (Sheet 6)

DESIGN COMPARISON TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.54 REVISION 0, DATED JUNE 1973, TITLED "QUALITY ASSURANCE REQUIREMENTS FOR PROTECTIVE COATINGS APPLIED TO WATER-COOLED NUCLEAR POWER PLANTS"

Regulatory Guide 1.54 Position	Position on Non-NSSS Components Inside Containment	Position on NSSS Components Inside Containment
		d. Category 4 - Insulated or Stainless Steel Equipment Category 4 equipment consists of the following: (1) Steam generators - covered with wrapped insulation (2) Pressurizer - covered with wrapped insulation (3) Reactor pressure vessel - covered with rigid reflective insulation (4) Reactor cooling piping - stainless steel (5) Reactor coolant pump casings - stainless steel Since Category 4 equipment is insulated or is stainless steel, no painted surface areas are exposed within the containment. Therefore, this regulatory guide is not applicable for Category 4 equipment.

TABLE 6.1-3

CONTAINMENT COMPONENTS - COATING SCHEDULE

Category	Item/Type/ Description	R.G. 1.54 Q coating	MFRS. STD. COAT	Uncoated			Generic Type (1)	Estimated Total Film Thickness (mils)	Shop Applied	Field Applied	Estimated Area (Square Feet)
				Stainless	Galvanized	Insulation					
Carbon steel liner-plate	Containment-dome	X					Inorganic zinc	2-4	X	Touch-up	31,000 (4)
	Containment-walls (8)	X					Inorganic zinc	2-4	X	Touch-up	59,000 (4)
Structural steel	Heavy support steel	X					Inorganic zinc	2-4	X	Touch-up	182,300 (4)
	Miscellaneous steel	X					Inorganic zinc	2-4	X	Touch-up	16,500 (5)
	Gratings				X						43,700
Elevator	Metal siding				X						8,500
Tanks and pools	Accumulator tanks	X					Epoxy	4-5	X	Touch-up	5,200
	Refueling pool			X							N/A
	Reactor coolant drain tank			X							N/A
Carbon steel pipe, hangers, valves, and supports	Pipe			X		X					N/A
	Pipe	X					Inorganic zinc	2-4	X	Touch-up	9,100
	Pipe supports	X					Inorganic zinc	2-4	X	Touch-up	25,500
	Valves and valve actuators		X				Alkyd/red oxide	2.5-4	X	Touch-up	3,500
Mechanical Equipment (including driver)	Polar crane	X					Inorganic zinc	4-7	X		36,700
	Pumps (RCPs)	X					Epoxy	2-4	X	Touch-up	3,000
	Fans and fan housings (carbon steel)	X					Epoxy	7.5-11	X		1,200
			X				Epoxy	7.5-11	X		400
	HVAC ducting				X						14,000 (6)
	HVAC ducting			X							N/A
	Steam generators					X					15,200
	Hydrogen recombiners			X							N/A
	Containment coolers	X					Epoxy	6-10	X		5,400
	Containment coolers				X						1,100
	Heat exchangers	X					Epoxy	2-4	X	Touch-up	300
	Internals lifting device	X					Epoxy	8-12		X	2,000
	Containment Tool Room Cabinets		X				Enamel	1-2	X		850

TABLE 6.1-3 (Sheet 2)

Category	Item/Type/ Description	R.G. 1.54 Q coating	MFRS. STD. COAT	Uncoated			Generic Type (1)	Estimated Total Film Thickness (mils)	Shop Applied	Field Applied	Estimated Area (Square Feet)
				Stainless	Galvanized	Insulation					
Electrical	Motor control centers	X					Alkyd/red oxide	1-2.5	X		500
	Terminal boxes				X						600
	Control panels	X					Epoxy	1.75-3	X		1,000
	Raceways, conduit, cable trays, and supports				X						38,400 (6)
	Cable Rack Assemblies		X				Thermoset Acrylic	0.5-0.8	X		123(7)
Concrete and masonry	Floor, cove, and wainscot	X					Epoxy (2)	12		X	12,900 (3)

NOTES:

(1) Generic coating systems acceptable for containment use were selected from suppliers who are prequalified to Bechtel standards and test criteria. Other coating systems may be shown to be acceptable based on individual analyses.

(2) Concrete, if painted, was painted with epoxy surfacer or epoxy coating system.

(3) The wainscot extends 12 inches above the floor and was painted the same as described in Note 2, then top coated with 8 to 10 mils of epoxy-based paint.

(4) Top coated with epoxy at the Wolf Creek Plant. Touch-up of the top coat is a client option.

(5) Includes approximately 900 square feet of nonconforming coating on the maintenance truss which is protected by screen cover.

(6) Estimated area includes a limited amount of unqualified touch-up coating.

(7) Unqualified coating of cable rack assemblies added as part of simplified head modification.

(8) Containment Normal Sumps and Incore Instrumentation Sump are coated with non-qualified EPOXY coating.

TABLE 6.1-4

DESIGN COMPARISON TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.44, REVISION 0, DATED MAY 1973, TITLED "CONTROL OF THE USE OF SENSITIZED STAINLESS STEEL"

Regulatory Guide 1.44 Position	Position on Non-NSSS Components	Position on NSSS Components
Unstabilized, austenitic stainless steel of the AISI Type 3XXX series used for components that are part of (1) the reactor coolant pressure boundary, (2) systems required for reactor shutdown, (3) systems required for emergency core cooling, and (4) reactor vessel internals that are relied upon to permit adequate core cooling for any mode of normal operation or under credible postulated accident conditions should meet the following:		
1. Material should be suitable protected against containments capable of causing stress corrosion cracking during fabrication, shipment, storage, construction, testing, and operation of components and systems.	1. Complies.	1. Complies, as discussed in Section 5.2.3.4.1.
2. Material from which components and systems are to be fabricated should be solution heat treated to produce a nonsensitized condition in the material.	2. Complies.	2. Complies, as discussed in Section 5.2.3.4.2.
3. Nonsensitization of the material should be verified using ASTM A 262-70, "Reccommended Practices for Detecting Attack in Stainless Steel," Practices A or E, or another method that can be demonstrated to show nonsensitization is austenitic stainless steel. Test specimens should be selected from material subject to each different heat treatment practice and from each heat.	3. All austenitic stainless steels were furnished in the solution annealed and water-quenched condition. Since susceptibility to stress corrosion cracking in this condition is minimal, testing was not performed.	3 Complies, as discussed in Section 5.2.3.4.3.

TABLE 6.1-4 (Sheet 2)

Regulatory Guide 1.44 Position	Position on Non-NSSS Components	Position on NSSS Components
4. Material subject to sensitizing temperature in the range of 800ø to 1500øF, subsequent to solution heat treating in accordance with Subparagraph C.2. above and testing in accordance with Subparagraph C.3. above, should be L Grade material; that is, it should not have a carbon content greater than 0.03 percent. Exceptions are:	4. During fabrication and installation, austenitic stainless steels were not permitted to be exposed to temperatures in the range of 800ø-1500øF. except for welding. Welding practices were controlled to minimize sensitization, as discussed in Position 5 below.	4. Complies, as discussed in Section 5.2.3.4.4.
a. Material exposed to rector coolant which has a controlled concentration of less than 0.10 ppm dissolved oxygen at all temperatures above 200øF during normal operation, or		
b. Material in the form of castings or weld metal with a ferrite content of at least 5 percent; or		
c. Piping in the solution annealed condition whose exposure to temperatures in the range of 800ø to 1500øF has been limited to welding operations, provided it is of sufficiently small diameter so that in the event of a credible postulated failure of the piping during normal reactor operation, the reactor can be shut down and cooled down in an orderly manner, assuming makeup is provided by the reactor coolant makeup system only.		
5. Material subjected to sensitizing temperatures in the range of 800ø to 1500øF during heat treating or processing other than welding, subsequent to solution heat treating in accordance with	5. Heat treatment of austenitic stainless steel in the temperature range 800ø to 1500ø F was not permitted. Hot bending of austenitic stainless steel piping was performed.	5. Complies, as discussed Section 5.2.3.4.5.

TABLE 6.1-4 (Sheet 3)

Regulatory Guide 1.44 Position	Position on Non-NSSS Components	Position on NSSS Components
Subparagraph C.2. above, and testing in accordance with Subparagraph C.3. above, should be retested in accordance with Subparagraph C.3. above, to demonstrate that it is not susceptible to intergranular attack, except that retest is not required for: a. Cast metal or weld metal with a ferrite content of 5 percent or more: or b. Material with a carbon content of 0.03 percent or less that is subjected to temperatures in the range of 800ø to 1500øF for less than 1 hour or c. Material exposed to special processing, provided the processing is properly controlled to develop a uniform product and provided that adequate documentation exists of service experience and/or test data to demonstrate that the processing will not result in increased susceptibility to intergranular stress corrosion. Specimens for the above retest should be taken from each heat of material and should be subjected to a thermal treatment that is representative of the anticipated thermal conditions that the production material will undergo.	at the solution annealing temperature, followed by an immediate water quenching. If hot bending was performed at some temperature other than the solution annealing temperature, the pipes were re-solution annealed and water quenched. Since sensitization was avoided, testing to determine susceptibility to intergranular attack is not performed.	
6. Welding practices and, if necessary, material composition should be controlled to avoid excessive sensitization	6. Welding practices were controlled to minimize sensitization in the heat-affected zone of	6. Complies, as discussed in Section 5.2.3.4.4. and 5.2.3.4.5.

TABLE 6.1-4 (Sheet 4)

Regulatory Guide 1.44 Position	Position on Non-NSSS Components	Position on NSSS Components
of base metal heat-affected zones of weldments. An intergranular corrosion test, such as specified in Subparagraph C.3 above, should be performed for each welding procedure to be used for 0.03 percent.	unstabilized austenitic stainless steels, as described below. a. Weld Heat Input Heat input during welding was controlled by limiting the size of electrodes for the shielded metal arc and gas tungsten arc processes and the bead thickness for submerged arc welding. Other welding processes were not permitted. b. Interpass Temperatures.. Interpass temperatures during welding were controlled so as not to exceed 350øF. c. Ferrite Content Stainless steel welding materials were furnished with a ferrite content in the range of 8 to 25 percent for type 308 and 308L welding materials and 5 to 15 percent for type 316, 316L, 309, and 309L welding materials. Additional discussion regarding compliance to Regulatory Guide 1.31 is provided in Table 6.1-9. d. Postweld Heat Treatment Postweld heat treatment at temperatures in excess of 350øF was not permitted unless a full-solution anneal and water quench was performed. The above welding practices were sufficient to ensure that unacceptable sensitization of the base metal heat affected does not occur; therefore, the intergranular corrosion testing was not performed.	

TABLE 6.1-5

DESIGN COMPARISON TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.37, REVISION 0, DATED MARCH 1973, TITLED "QUALITY ASSURANCE REQUIREMENTS FOR CLEANING OF FLUID SYSTEMS AND ASSOCIATED COMPONENTS OF WATER-COOLED NUCLEAR POWER PLANTS"

Regulatory Guide 1.37 Position	WCGS Position
The requirements and recommendations for on-site cleaning of materials and components, cleanness control, and preoperational cleaning and layup of water-cooled nuclear power plant fluid systems that are included in ANSI N45.2.1-1973, "Cleaning of Fluid Systems and Associated Components During Construction Phase of Nuclear Power Plants," are generally acceptable and provide an adequate basis for complying with the pertinent quality assurance requirements of Appendix B to 10 CFR Part 50, subject to the following:	
1. Subdivision 1.5 of ANSI N45.2.1, 1973 states that other documents required to be included as a part of the standard are either identified at the point of reference or described in Section 10 of the standard. The specific applicability or acceptability of these listed documents has been or will be covered separately in other regulatory guides or in Commission regulations, where appropriate.	1. Complies.
2. Although subdivision 1.2 of ANSI N45.2.1-1973 states that the requirements promulgated apply during the construction phase of a nuclear power plant, many of the requirements and recommendations contained in the standard are also appropriate to cleaning of fluid systems and associated components during the operation phase of a nuclear power plant and they should be used when applicable. In this regard, however, it should be particularly noted that decontamination and cleanup of radioactively contaminated systems and components are not addressed by ANSI N45.2.1-1973. These operations will be considered separately in future regulatory guides.	

TABLE 6.1-5 (Sheet 2)

Regulatory Guide 1.37 Position	WCGS Position
3. Subdivision 3.2 of ANSI N45.2.1-1973 states that the selection of the water quality for a specific application shall be made by the organization responsible for the cleaning operations unless otherwise specified in the purchase document. The water quality for final flushes of fluid systems and associated components should be at least equivalent to the quality of the operating system water.	3. Complies.
4. Section 5 of ANSI N45.2.1-1973 states, in part, that low sulfur, low fluorine, and/or low chlorine compounds may be used on austenitic stainless steels and that low sulfur and low lead compounds may be used on nickel-base alloys. Chemical compounds that could contribute to intergranular cracking or stress-corrosion cracking should not be used with austenitic stainless steel and nickel-base alloys. Examples of such chemical compounds are those containing chlorides, fluorides, lead, zinc, copper, sulfur, or mercury where such elements are leachable or where they could be released by breakdown of the compounds under expected environmental conditions (e.g., by radiation). This limitation is not intended to prohibit the use of trichlorotrifluoroethane which meets the requirements of Military Specification Mil-C-81302b for cleaning or degreasing of austenitic stainless steel provided the precautions of subdivision 7.3(4) of ANSI N45.2.1-1973 are observed.	4. Complies.
5. Section 5 of ANSI N45.2.1-1973 states, in part, that operations such as grinding and welding which generate particulate matter should be controlled. Adequate control of tools used in abrasive work operations such as grinding, sanding, chipping, or wire brushing should be provided. Specifically, tools which contain materials that could contribute to intergranular cracking or stress-corrosion cracking or which, because of previous usage may have become contaminated with such materials, should not be used on surfaces of corrosion-resistant alloys.	5. Complies.

TABLE 6.1-5 (Sheet 3)

Regulatory Guide 1.37 Position	WCGS Position
Examples of such materials are listed in Regulatory Position 4.	
6. Subdivision 1.4 of ANSI N45.2.1-1973 suggests the use of ASTM A 262-68 or ASTM A 393-63 for detection of intergranular precipitation of chromium carbides in corrosion-resistant alloys. ASTM A 393-63 has been withdrawn by ASTM and is no longer considered a valid test.	6. Complies.

TABLE 6.1-6

DESIGN COMPARISON TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.36, REVISION 0, DATED FEBRUARY 1973, TITLED "NONMETALLIC THERMAL INSULATION FOR AUSTENITIC STAINLESS STEEL"

Regulatory Guide 1.36 Position	WCGS Position
The levels of leachable contaminants in nonmetallic insulation materials that come into contact with austenitic stainless steels of the American Iron & Steel Institute (AISI) Type 3XX series used in fluid systems important to safety should be carefully controlled so that stress-corrosion cracking is not promoted. In particular, the leachable chlorides and fluorides should be held to the lowest practicable levels. Insulation for the above application should meet the following conditions:	
1. All insulating materials should be manufactured, processed, packaged, shipped, stored, and installed in a manner that will limit, to the maximum extent practical, chloride and fluoride contamination from external sources.	1. Complies.
2. Qualification Test: Each type of insulating material should be qualified by the manufacturer or supplier for use by:	2. Complies.
a. An appropriate test to reasonably assure that the insulation formulation does not induce stress corrosion. Two acceptable tests are:	
(1) ASTM C 692-71, "Standard Method for Evaluating Stress Corrosion Effect of Wicking-Type Thermal Insulations on Stainless Steel" (Dana Test). The material should be rejected if more than one of five specimens crack; and	
(2) RDT M12-lT, "Test Requirements for Thermal Insulating Materials for Use on Austenitic Stainless Steel," Section 5 (Knolls Atomic Power Laboratory (KAPL) Test). The material should be rejected if more than one of four specimens crack.	

TABLE 6.1-6 (Sheet 2)

Regulatory Guide 1.36 Position	WCGS Position
b. Chemical analysis to determine the ion concentrations of leachable chloride, fluoride, sodium, and silicate. Insulating material that is not demonstrated by the analysis to be within the acceptable region of Figure 1 of this guide should be rejected. This analysis should also be used as a comparison basis for the production test specified in C.3 below.	
3. Production Test: A representative sample from each production lot of insulation material to be used adjacent to, or in contact with, austenitic stainless steels used in fluid systems important to safety should be chemically analyzed to determine leachable chloride, fluoride, sodium, and silicate ion concentrations as in C.2.a above. The lot should be accepted only if:	3. Complies, except that the representative sample will be chemically analyzed as in C.2.b above.
a. The analysis shows the material to be within the acceptable region of Figure 1; and	
b. Neither the sum of chloride plus fluoride ion concentrations nor the sum of sodium plus silicate ion concentrations determined by this analysis deviates by more than 50 percent from the values determined on the sample used to qualify the insulation in C.2 above.	
4. Requalification: When a change is made in the type, nature, or quality of the ingredients, the formulation, or the manufacturing process, the insulation material should be requalified by repeating the tests described in C.2 above.	4. Complies.

TABLE 6.1-7

DESIGN COMPARISON TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.50 REVISION 0, DATED MAY 1973, TITLED, "CONTROL OF PREHEAT TEMPERATURES FOR WELDING OF LOW-ALLOY STEEL"

Regulatory Guide 1.50 Position	Position on Non-NSSS Components	Position on NSSS Components
Weld fabrication for low alloy steel components should comply with the fabrication requirements specified in Section III and Section IX of the ASME B&PV Code supplemented by the following:		Westinghouse considers this Regulatory Guide applicable only to ASME III, Class 1 components.
1. The procedure qualification should require that: a. A minimum preheat and a maximum interpass temperature be specified.	1. Paragraph 1.a was complied with when impact testing, in accordance with ASME Boiler and Pressure Vessel Code, Section III, Subarticle 2300, was required. When Impact testing was not required, specification of a maximum interpass temperature in the welding procedures was not necessary in order to assure that the other required mechanical properties of the weld are met.	1.a. Complies, for Class 1 components.
b. The welding procedures be qualified at the minimum preheat temperature.	1.b. Complies	1.b. For Class 1 components, welding procedures are qualified within the preheat temperature ranges required by Section IX of the ASME Boiler and Pressure Vessel Code.
2. For production welds, the preheat temperature should be maintained until a postweld heat treatment has been performed.	2. Compiles for pressure vessels with nominal thicknesses greater than 1 inch. Maintenance of preheat beyond completion of welding until postweld heat treatment	2. Compliance is discussed In Section 6.1.4, Reference 3.

TABLE 6.1-7 (Sheet 2)

Regulatory Guide 1.50 Position	Position on Non-NSSS Components	Position on NSSS Components
	(PWHT) was not required for thinner sections, since experience has indicated that delayed cracking in the weld or heat affected zone (HAZ) is not a problem.	
3. Production welding should be monitored to verify that the limits on preheat and interpass temperatures are maintained.	3. Current usage of low alloy steel in piping, pumps, and valves is minimal and is normally limited to Class 3 construction. When low alloy steel piping, pumps, and valves were used, preheat was maintained until welding is complete, but not until postweld heat treatment (PWHT) was performed, since the conditions which cause delayed cracking in the weld or heat affected zone (HAZ) were not present.	3. Complies, for Class 1 components.
4. In the event that regulatory positions C.1, C.2, and C.3, above, are not met, the weld is subject to rejection. However, the soundness of the weld may be verified by an acceptable examination procedure.	4. Complies.	4. Complies, for Class 1 components.

TABLE 6.1-8

DESIGN COMPARISON TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.71 REVISION 0, DATED DECEMBER 1973, TITLED, WELDER QUALIFICATION FOR AREAS OF LIMITED ACCESSIBILITY"

Regulatory Guide 1.71 Position	Position on Non-NSSS Components	Position on NSSS Components
Weld fabrication and repair for wrought low-alloy or other materials such as static and centrifugal castings and bimetallic joints should comply with the fabrication requirements specified in Section III and Section IX supplemented by the following:		
1. The performance qualification should require testing of the welder under simulated access conditions when physical conditions restrict the welder's access to a production weld to less than 30 to 35 cm (12 to 14 inches) in any direction from the joint.	1. Performance qualifications for personnel who weld under conditions of limited access were maintained in accordance with the applicable requirements of ASME Sections III and IX. Additionally, responsible site supervisors were required to assign only the most highly skilled welders to limited-access welding. Of course, welding conducted in areas of limited access was subjected to the required nondestructive testing, and no waiver or relaxation of examination methods or acceptance criteria because of the limited access was permitted.	1. Performance qualification for requalification) of welder for areas of limited accessibility was not required. Experience shows that current shop practices produce high quality welds. In addition, the performance of nondestructive examinations provides further assurance of acceptable weld quality. Limited accessibility qualification for requalification) in excess of ASME Code, Section III or IX requirements was an unduly restrictive requirement for component fabrication, where the welder 8 physical position relative to the welds is controlled.
2. Requalification is required: a. When significantly different restricted accessability conditions occur, or	2. Requalification was required: when any of the essential variables of ASME Section IX are changed, or when any authorized inspector questions the ability	2. See response to I above.

TABLE 6.1-8 (Sheet 2)

Regulatory Guide 1.71 Position	Position on Non-NSSS Components	Position on NSSS Components
b. When any of the essential welding variables listed in Section IX are changed.	of the welder to perform satisfactorily the requirements of ASME Section III or IX.	
3. Production welding should be monitored and adherence to welding qualification requirements should be certified.	3. Production welding was monitored and welding qualifications were certified in accordance with (1) and (2) above.	3. See response to 1 above.

TABLE 6.1-9

DESIGN COMPARISON TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.31, REVISION 3, DATED APRIL 1978, TITLED, "CONTROL OF FERRITE CONTENT ON STAINLESS STEEL WELD METAL"

Requirements of this regulatory guide are applied to production weld (full penetration pressure boundary welds) which could be subject to microfissures due to low delta ferrite content of the deposited weld metal, in austenitic stainless steel ASME Section III, Class 1 and 2 components, and core support structures.

Regulatory Guide 1.31 Position	Position on Non-NSSS Components	Position on NSSS Components
1. Verification of Delta Ferrite Content of Filler Materials	1. Portions of the non-NSSS components conform to the requirements of Revision 3 of this regulatory guide.	1. Field welding of NSSS components Is done in accordance with Revision 3 of this regulatory guide.
Prior to production usage, the delta ferrite content of test weld deposits from each lot and each heat of weld filler metal procured for the welding of austenitic stainless steel core support structures and Class 1 and 2 components should be verified for each process to be used In production.	The remainder of the non-NSSS components, fabricated prior to the implementation of Revision 3 of this regulatory guide, conform to the requirements specified In the PSAR position on the NRC interim position on Revision 1 of this regulatory guide.	Section 5.2.3.4.6 describes the extent of compliance to the NRC interim position on Revision 1 of this regulatory guide of the NSSS supplied and fabricated components.
It is not necessary to make delta ferrite determination for SFA-5.4 type 16-8-2 weld metal or for filler metal used for weld metal cladding. Delta ferrite determinations for consumable Inserts, electrodes, rod or wire filler metal used with the gas tungsten arc welding process, and deposits made with the plasma arc welding process may be predicted from their chemical composition using an applicable constitutional diagram to demonstrate compliance. Delta ferrite verification should be made for all other processes by tests using magnetic measuring devices on undiluted weld deposits. For submerged arc welding processes, the verification tests for each wire and flux combination may	The requirements of the PSAR include magnetic testing of randomly selected production welds made from wire whose delta ferrite content was determined from constitution diagrams. Revision 3 requirements include the requirement to determine the delta ferrite content of the weld wire by magnetic tests on undiluted test pads. Production weld testing is not required by Revision 3 of this regulatory guide	

TABLE 6.1-9 (Sheet 2)

Regulatory Guide 1.31 Position	Position on Non-NSSS Components	Position on NSSS Components
be made on a production weld or simulated production weld. All other delta ferrite weld filler verification tests should be made on weld pads that contain undiluted layers of weld metal.		
2. Ferrite Measurement Appendix A to this guide contains extracts from a future edition of the American Welding Society's AWS A5.4, "Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Covered Welding Electrodes," which describes a procedure for pad preparation and ferrite measurement. The NRC staff considers this procedure acceptable for use with covered electrodes.	2. Compiles where magnetic testing was performed to verify the weld filler material as described in 1. above.	2. See Section 5.2.3.4.6
3. Instrumentation The weld pad should be examined for ferrite content by a magnetic measuring Instrument which has been calibrated against a Magnegage In accordance with American Welding Society Specifications AWS A4.2-74, "Procedures for Calibrating Magnetic Instruments to Measure the Delta Ferrite Content of Austenitic Stainless Steel Weld Metal." The	3. Compiles where magnetic testing was performed to verify the weld filler material as described in 1. above. When production weld testing was performed to support chemical composition similar Instrumentation requirements were met.	3. See Section 5.2.3.4.6

TABLE.E 6.1-9 (Sheet 3)

Regulatory Guide 1.31 Position	Position on Non-NSSS Components	Position on NSSS Components
Magnegage should have been previously calibrated in accordance with AWS A4.2-74 using primary standards as defined therein.		
4. Acceptability of Test Results	4. Complies.	4. See Section 5.2.3.4.6
Weld pad test results showing an average Ferrite Number From 5 to 20 Indicate that the filler metal is acceptable for production welding of Class 1 and 2 austenitic stainless steel components and core support structures.		
The upper limit of 20 may be waived for (a) welds that do not receive postweld stress relief heat treatment or welds for which such postweld stress relief treatment is conducted at temperatures less than 900 F, (b) welds that are given a solution annealing heat treatment, and (c) welds that employ consumable inserts.		
5. Quality Assurance	5. Complies.	5. See Section 5.2.3.4.6
She applicable provisions of 10 CFR Part 50, Appendix P, should be used in verifying compliance with requirements for delta ferrite as described herein.		

TABLE 6.1-10

TABLE OF LUBRICANTS INSIDE CONTAINMENT

Equipment	Lubricant Type	Quantity(4)
Reactor coolant pumps(1)	Oil	265 gal
Polar crane(2)	Wire rope lube	24 lb
	Gear lube	10 lb
	Graphite lube sticks	8 lb
Miscellaneous hoists and cranes(2)	Wire rope lube	1 lb
Miscellaneous fans(3)	Oil/grease	Neg
Miscellaneous pumps(3)	Oil/grease	Neg
Steam generator hydraulic snubbers(3)	Hydraulic fluid	Neg

NOTES:

(1) Assumes lube oil from one RC pump spills into sump.

(2) Assumes 10 percent will be washed off by containment spray.

(3) Motors, bearings, and snubbers are enclosed.

(4) Quantity subject to be released into the containment.

6.2 CONTAINMENT SYSTEMS

The containment systems include the containment, the containment heat removal systems, the containment isolation system, and the containment combustible gas control system.

The design basis accident (DBA) is defined as the most severe of a spectrum of hypothetical loss-of-coolant accidents (LOCA). The ability of the containment systems to mitigate the consequences of a DBA depends upon the high reliability of these systems. This section provides the design criteria and evaluations to demonstrate that these systems function within the specified limits throughout the unit operating lifetime.

6.2.1 CONTAINMENT FUNCTIONAL DESIGN

A physical description of the containment and the design criteria relating to construction techniques, static loads, and seismic loads is provided in Section 3.8. This section pertains to those aspects of containment design, testing, and evaluation that relate to the accident mitigation function.

6.2.1.1 Containment Structure

6.2.1.1.1 Design Bases

The safety design basis for the containment is that the containment must withstand the pressures and temperatures of the DBA without exceeding the design leakage rate, as required by 10 CFR 50, Appendix A, General Design Criterion 50, and that, in conjunction with the other containment systems and the other engineered safety features, the release of radioactive material subsequent to a DBA does not result in doses in excess of the guideline values specified in 10 CFR 100. The radiological consequences of the DBA are presented in Section 15.6.

a. Assumed Accident Conditions

   For the purpose of determining the design pressure requirements for the containment structure and the containment internal structures, the following simultaneous occurrences were assumed:

   1. The postulated reactor coolant system pipe rupture, as listed in Table 6.2.1-1, was assumed to be concurrent with the loss of offsite power and the worst single active failure. No two pipe breaks were assumed to occur simultaneously or consecutively.

For design loadings on the systems used to mitigate the consequences of a postulated reactor coolant system pipe rupture, a safe shutdown earthquake was assumed.

2. The postulated secondary system pipe rupture, as identified in Section 6.2.1.4, was assumed concurrent with the loss of offsite power and the worst single active failure. No two pipe breaks were assumed to occur simultaneously or consecutively.

3. The postulated inadvertent operation of a containment heat removal system is considered a low probability event and was not considered to be concurrent with any other event.

The calculated maximum containment structure internal and external pressures are listed in Table 6.2.1-2. These calculated pressures are based on the conservative analyses described in Section 6.2.1.1.3 and demonstrate that a substantial margin exists (approximately 20 percent on internal pressure and 10 percent on external pressure) between the calculated maximum pressure and the design pressures.

The calculated maximum pressures on the containment internal structures (e.g. primary and secondary shield walls) are listed in Table 6.2.1-2. These pressures are based on the conservative analyses described in Section 6.2.1.2. The loads on the internal structures were calculated using the differentials between the maximum calculated subcompartment pressures and 14.7 psia, the pressure of the containment atmosphere at the time of peak subcompartment pressure.

b. Sources and Amounts of Mass and Energy Released

The sources and amounts of mass and energy released for the postulated reactor coolant system pipe ruptures and secondary system pipe ruptures are discussed in Sections 6.2.1.3 and 6.2.1.4, respectively.

c. Effects of the ESFs as Heat Removal Systems

The effects of the ECCS as an energy removal system are discussed in the determination of the mass and energy release data provided in Section 6.2.1.3. The only additional effect of this system considered is the long-term heat removal capability of the residual heat removal heat exchangers. In performing the containment design evaluation in Section 6.2.1.1.3, single failures of the ECCS are assumed to be consistent with the mass and energy release data assumptions for the break analyzed.

The effects of the containment heat removal systems, as active energy removal systems, have been considered in the containment design evaluation in Section 6.2.1.1.3. The most stringent single active failure of these systems is assumed to be consistent with the mass and energy release data assumptions for each break analyzed. The total heat removed by each of the containment heat removal systems up to the time of the calculated peak containment pressure is listed in Table 6.2.1-8. The design bases of the containment heat removal systems are discussed in Section 6.2.2.

The functional performance of the containment and the ECCS also rely upon the operation of the containment isolation system, as described in Section 6.2.4. Required isolation operations are assumed for purposes of the containment design evaluation in Section 6.2.1.1.3.

d. Parameters Affecting Capability for Post-Accident Pressure Reduction

The principal parameters which affect post-accident pressure reduction are 1) the heat absorbed by the heat sinks inside the containment, 2) the heat removed by the containment air coolers, and 3) the heat transferred to the containment sump by the containment spray system.

A conservative amount of heat sink material has been calculated, and its heat absorption capability has been considered in the containment design evaluation in Section 6.2.1.1.3. The parameters describing the heat sinks credited with heat absorption are provided in Table 6.2.1-4.

The pressure reduction capability of the containment air coolers and the containment spray system consider the parameters provided in Table 6.2.1-3. The assumed start time of these active heat removal systems considers a diesel start time of 12 seconds, load sequencing times, and the maximum startup time of the systems.

In support of case c, large break LOCA (DECLG $C_D = 0.6$, Maximum SI with 12-second diesel generator start) of Table 15.6-10, an evaluation of the assumptions used in the LOCA and MSLB containment pressurization calculations, with respect to the full functioning times of the containment spray system and the containment air coolers, was performed. The evaluation shows that the containment pressurization calculations for both LOCA and MSLB provided sufficient margin so that a 12-second diesel generator start time does not change the assumed full functioning times of the containment spray and the containment air coolers. Therefore, additional LOCA and MSLB containment pressurization calculations are not required for case c of Table 15.6-10, since this case is bounded by the previously performed containment calculations.

e. Parameters Affecting Heat Removal from the Containment

Heat is transferred from the containment to the outside environment via the fan coolers and residual heat removal heat exchangers through the component cooling water and essential service water systems and released to the ultimate heat sink. A small amount of heat is also transferred through the containment wall and dome to the outside atmosphere.

The component cooling water system is described in Section 9.2.2, the essential service water system is described in Section 9.2.1, and the ultimate heat sink is described in Section 9.2.5.

Single failures in systems which remove energy from the containment are considered to be consistent with the single failures assumed in the development of the mass and energy release data. The energy removal capability of the containment air coolers, the containment spray system, and the residual heat removal system consider the parameters provided in Table 6.2.1-3. The long-term energy inventories and total heat transferred to the various containment heat removal mechanisms, as a function of time, are diagrammed in Figures 6.2.1-25 and 6.2.1-26 for the double-ended pump suction guillotine (DEPSG) break with minimum safety injection and DEPSG break with maximum safety injection cases, respectively.

f. Bases for Containment Depressurization Rate

To meet the containment safety design basis of limiting the release of radioactive material subsequent to a DBA so that the doses are within the guideline values specified in 10 CFR 100, the containment pressure is reduced to less than 50 percent of the peak calculated pressure within 24 hours after an accident. Chapter 15.0 contains the assumptions used in the analysis of the offsite radiological consequences of the accident.

g. Bases for Minimum Containment Pressure Used in ECCS Performance Studies

The minimum containment pressure transient used in the analysis of the emergency core cooling system's capability is based on the conservative overestimated heat removal capability and pressure reduction capability of the containment structures and the containment systems and on the conservative reactor coolant system thermal analysis provided in Section 15.6. The determination and evaluation of the minimum containment pressure transient are provided in Section 6.2.1.5.

6.2.1.1.2 Design Features

The principal containment and containment subcompartment design parameters are provided in Table 6.2.1-2. General arrangement drawings for the reactor containment are provided in Figures 1.2-9 through 1.2-18. Simplified arrangement drawings illustrating the nodalization model used for the containment subcompartment analyses are provided in Figures 6.2.1-27 through 6.2.1-33, 6.2.1-43 through 6.2.1-55, and 6.2.1-76.

a. Missile and Pipe Whip Protection

Missile shield considerations are described in Section 3.5. The structural design of the containment and the containment subcompartments is discussed in Section 3.8. The designed structural strength considers the effects of pipe whip and jet forces, as discussed in Section 3.6.

b. Codes and Standards

The codes, standards, and guides applied in the design of the containment structure and the containment internal structures are identified in Section 3.8.

c. Inadvertent Operation of the Containment Spray System

The design external pressure load on the reactor containment is provided in Table 6.2.1-2. The lowest calculated internal pressure is also provided in Table 6.2.1-2, and is the result of an assumed inadvertent actuation of the containment spray system. The analysis performed to determine the lowest calculated internal pressure following an inadvertent actuation of the containment spray system is provided in Section 6.2.1.1.3. At least a 10-percent margin exists between the lowest calculated internal pressure and the design external pressure load.

d. Entrapment of Recirculation Water

Locations within the reactor containment which may entrap spray water and subtract from the water inventory considered to be available in the containment sump are identified in Section 6.2.2.1. The effect of this potential water loss is considered in determining the net positive suction head available to the RHR and containment spray pumps. Any special provisions which reduce the amount of the entrapped water are discussed in Section 6.2.2.1.

e. Normal Operation of Systems Which Control the Containment Environment

The functional capability and frequency of operation of the systems provided to maintain the containment and subcompartment atmospheres within prescribed pressure, temperature, and humidity limits during normal operation are discussed in Sections 6.2.2.2 and 9.4.6.

6.2.1.1.3 Design Evaluation

a. Analysis of Postulated Ruptures

In the event of a LOCA in the containment, much of the released reactor coolant will flash to steam. This release of mass and energy raises the temperature and pressure of the atmosphere within the containment. The severity of the temperature and pressure peaks depends upon the nature, size, and location of the postulated rupture.

In order to identify the worst case, the spectrum of hypothetical accidents listed in Table 6.2.1-1 has been analyzed. The analytical model and computer code designed to predict containment pressure and temperature responses following the accidents are described in item b. of this section.

A summary of the results of the containment pressure and temperature analysis for this spectrum of postulated accidents is provided in Table 6.2.1-8. The peak containment pressure calculated resulted from the assumed (DEPSG) break with minimum safety injection and with the worst single failure being the loss of one emergency diesel.

The calculated containment pressure and temperature responses as a function of time for the spectrum of postulated accidents are illustrated in Figures 6.2.1-1 through 6.2.1-12.

To assess the impact of the plant uprating on the containment integrity analyses, the containment pressure and temperature responses following a postulated LOCA are re-analyzed at uprated power (3565 MWt) conditions using the mass and energy releases data that are re-generated using the Westinghouse 1979 M&E release model (Ref. 26). The analyses are performed for a spectrum of possible pipe break sizes and locations at rerated conditions to assure that the worst case has been identified.

The results of the containment integrity analyses at rerated conditions show that the peak calculated containment pressure and temperature following a postulated LOCA are less limiting than the peak containment pressure and temperature calculated in the original WCGS licensing basis analyses. Since the long term LOCA mass and energy releases utilized in the original licensing basis containment integrity analyses were already based upon an NSSS power of 3579 MWt, the original licensing basis containment analysis information presented in the USAR Section 6.2.1 remains unchanged as a result of the rerate analysis. The peak containment pressure and temperature calculated in the original WCGS licensing basis analyses are shown in Figures 6.2.1-1 and 6.2.1-7.

b. Computer Codes for Analyses of Containment Response to LOCA

The temperature and pressure conditions in the containment due to a spectrum (including break size and location) of postulated loss-of-coolant accidents have been analyzed by the CONTEMPT-LT/28 computer code (Ref. 24). CONTEMPT-LT/28 is the most recent code in a series of computer programs developed by the Idaho National Engineering Laboratory for the USNRC to analyze the transient behavior of LWR containment systems. The licensee's application of CONTEMPT-LT/28 for the calculation of the containment environment response to a postulated primary or secondary pipe break has been reviewed and accepted by the NRC (Ref. 25).

CONTEMPT-LT calculates the time variation of compartment pressures, temperatures, mass and energy inventories, heat structure temperature distributions, and energy exchange with adjacent compartments. Models are provided to describe containment heat removal systems that include fan cooler systems, spray systems and residual heat removal systems. Up to four compartments can be modeled with CONTEMPT-LT, and any compartment except the primary system can have a liquid pool region and an air-vapor atmosphere region above the pool. Each region is assumed to have a uniform temperature, but the temperatures of the two regions may be different. The program user defines which compartments are used, specifies input mass and energy additions, defines heat structure and leakage systems, and describes the time advancement and output control. The mass and energy release data used in the analysis are developed and described in Section 6.2.1.3.

The heat removal due to containment air cooler operation is simulated in the CONTEMPT-LT/28 code by specifying input values from a curve of heat removal rate versus containment atmosphere temperature. This curve is based upon the cooling coil thermal-physical design and is given in Figure 6.2.1-15. The fan coolers assumed start time is provided in Tables 6.2.1-6 and 6.2.1-7 for the DEPSG breaks with minimum safety injection and with maximum safety injection, respectively. This start time is based upon the diesel start time of 12 seconds, the loading sequence, and the startup time of the system. The parameters describing the containment air coolers are given in Table 6.2.1-3.

c. Initial Conditions

Initial conditions used for the containment analysis are listed in Table 6.2.1-5.

The initial containment conditions were selected based on the range of the normal expected conditions within the containment with consideration given to maximizing the calculated peak containment pressure. Parametric studies have been performed to determine the effects of varying these initial containment conditions (Ref. 1). The results of these studies showed that varying the initial containment conditions over a wide range of values changes the calculated peak pressure by less than 1 percent. Therefore, the initial containment conditions are relatively unimportant parameters with respect to the containment pressure temperature analysis. Nevertheless, in order to account for initial temperature instrument uncertainty, the limiting case (DEPSG break with minimum safety injection) was evaluated with a bounding initial containment temperature of 130 F.

The conservatisms in the assumptions made with respect to the containment heat removal systems and the emergency core cooling system operability are discussed in Sections 6.2.2 and 6.3, respectively.

d. Results of the Failure Mode and Effects Analysis

Single active failures have been considered in the emergency core cooling system and in the containment heat removal systems with respect to maximizing energy release to the containment and minimizing the heat removal from the containment. The criteria used to determine the worst single active failure was the calculated peak containment pressure. Therefore, single active failures in the containment heat removal systems were considered consistent with the mass and energy release data determined by the corresponding common mode failure in the emergency core cooling system.

The worst calculated peak containment pressure was the result of a double-ended reactor coolant pump suction guillotine break with minimum performance of the emergency core cooling system and the containment heat removal systems.

e. Containment Design Parameters

The principal containment design parameters are provided in Table 6.2.1-2.

f. Engineered Safety Features Design Parameters

The engineered safety features design parameters used in the containment analysis are listed in Table 6.2.1-3. The parameters identified as full capacity were used when no failure was assumed to affect the operation of that system, and the parameters identified of minimum capacity were used when a single failure was assumed to affect the operation of that system. The containment air cooler duty curve per air cooler used in the analysis is given in Figure 6.2.1-15. The limiting case (DEPSG break with minimum safety injection) modeled the containment air cooler duty curve given in Table 6.2.1-57C.

The containment air cooler duty curve per air cooler used in the remaining analyses is given in Figure 6.2.1-15.

g. Results of Postulated Accidents Analyzed

A summary of the results of the containment pressure temperature analyses for the spectrum of postulated accidents is tabulated in Table 6.2.1-8.

h. Secondary System Pipe Rupture Containment Analysis

A complete discussion of secondary system pipe ruptures inside the containment with respect to the containment pressure and temperature responses is provided in Section 6.2.1.4.

i. Containment Passive Heat Sinks

With respect to the modeling of the containment passive heat sinks for the heat transfer calculations used in the containment pressure temperature analysis, the method discussed in Reference 24 provides the justification for 1) the computer mesh spacing used for concrete, steel, and steel-lined concrete heat sinks, 2) the steel-concrete interface resistance used for the steel-lined concrete heat sinks, and 3) the heat transfer correlations used in the heat transfer calculations.

The specific passive heat sinks considered in the containment pressure temperature analysis and their parameters are listed in Table 6.2.1-4. Figures 6.2.1-13 and 6.2.1-14 show the condensing heat transfer coefficient as a function of time for the DEPSG with minimum safety injection and DEPSG with maximum safety injection cases, respectively.

Zero heat transfer is specified at the outside surface of the containment exposed to the earth, and between the containment sump liquid and the containment atmosphere within the containment.

j. Analysis of Inadvertent Operation of a Containment Heat Removal System

Inadvertent actuation of the containment spray system results in the lowest calculated containment internal pressure.

As discussed in Section 6.2.2.1, the containment spray system can only be actuated in two ways, either automatically upon receipt of two-out-of-four containment high pressure signals or manually from the control room.

Section 7.3.8 discusses the engineered safety features actuation system and demonstrates that the system design precludes a single active or passive failure from inadvertently actuating the containment spray system. Manual actuation of the containment spray system can only be accomplished by the reactor operator deliberately switching on two switches on the main control board. The main control board is designed with physical separation of these switches to prevent accidental actuation of the spray system. Thus, inadvertent actuation of the sprays is precluded by design, and only a deliberate actuation of the containment spray system could result in the reactor building being sprayed.

Although precluded by design, inadvertent actuation of the containment spray system has been assumed, and the resultant reduction in the containment pressure has been calculated. The postulated inadvertent actuation of the containment spray system is assumed, concurrent with the following conservative containment and environmental conditions:

	Summer	Winter
Initial containment temperature,°F	120	100
Initial containment pressure, psia	14.7	14.7
Initial containment relative humidity, %	100	100
Containment spray flow rate, gpm (per train)	3,900*	3,900*
RWST water temperature,°F	60	37

*Runout flow rates for the containment spray system.

Actuation of the containment spray system could be postulated under any set of containment and environmental conditions. However, no consistent set of realistic conditions can categorically be selected as the worst case initial condition to be used in the containment pressure analysis. These assumed initial conditions are defined as limiting in that these conditions 1) represent the largest differences in the containment ambient temperature and the RWST temperature and 2) the 100-percent humidity case maximizes the amount of mass transferred out of the containment atmosphere.

Using Henry's law of partial pressures and the Ideal Gas Law and assuming that the inadvertent operation of the containment spray system will reduce the containment vapor temperature to coincide with that of the RWST water being sprayed, the maximum reduction in the containment pressure is provided in Table 6.2.1-2.

The containment design external pressure load is provided in Table 6.2.1-2, and shows a minimum of 10-percent margin above the maximum reduction in the containment pressure calculated by the above-described method. Thus, corrective action by the operator is not required to ensure that containment integrity is maintained.

The control room operator is notified that the containment spray system is operating through the following means:

1. The containment spray actuation annunciator light is on, and an audible alert alarm is sounded.
2. The running status light of the containment spray pumps is on.
3. The open status lights of the containment spray system isolation valves is on.
4. The containment normal sump and the incore instrumentation tunnel level indicators and level alarms are actuated.
5. The flow indicators for the discharge of the containment spray pumps indicate flow in the containment spray pumps.
6. The NPIS computer visually informs the operator that the containment spray system is actuated.

k. Accident Chronology

The chronology of events occurring after a DEPSG break with minimum safety injection is given in Table 6.2.1-6. The chronology of events after a DEPSG break with maximum safety injection is given in Table 6.2.1-7.

l. Mass and Energy Balances

A mass and energy balance for the reactor coolant system, steam generators, and the safety injection system is provided in Section 6.2.1.3.2 and shows the distribution of energy prior to the accident, at the end of the blowdown phase, at the end of the core reflood phase, and at the end of the post-reflood phase.

A mass and energy balance for the reactor and containment systems for the DEPSG break with minimum safety injection and DEPSG break with maximum safety injection are provided in Tables 6.2.1-9 and 6.2.1-10, respectively. These tables provide the distribution of energy at the following times:

1. Prior to the accident
2. Blowdown peak pressure
3. End of blowdown
4. Peak containment pressure
5. End of reflood
6. Approximately one day after recirculation

m. Long-Term Cooling Following a LOCA

The long-term system behavior during various LOCAs has been evaluated to verify the ability of the ECCS and the containment heat removal systems to keep the reactor vessel flooded and maintain the containment below design conditions for all times following a LOCA. This evaluation is based on the conservative predictions of the performance of these engineered safety features consistent with the single failures assumed for each accident analyzed. The heat generation rate from shutdown fissions, heavy isotope decay, and fission product decay is provided in Figure 6.2.1-16.

The containment pressure and temperature transients for the DEPSG break with minimum safety injection up to 10^6 seconds are shown in Figures 6.2.1-1 and 6.2.1-7, respectively. These figures demonstrate the containment systems' capability of rapidly reducing the containment pressure and temperature and maintaining those parameters to acceptably low values. The containment pressure and temperature transients for the DEPSG break with maximum safety injection up to 10^6 seconds are shown in Figures 6.2.1-2 and 6.2.1-8, respectively. For all other accidents analyzed, the pressure and temperature transients are provided for 10^3 seconds. These transients demonstrate similar characteristics to the large DEPSG break transients discussed above and, since the performance of the containment heat removal systems should be similar, long-term cooling is ensured.

The sump temperature transients for the DEPSG break with minimum safety injection and the DEPSG break with maximum safety injection are provided in Figures 6.2.1-17 and 6.2.1-18, respectively.

The energy removal rates for the containment fan coolers, the RHR heat exchangers, and the containment passive heat sinks for the DEPSG break with minimum safety injection and the DEPSG break with maximum safety injection as a function of time are shown in Figures 6.2.1-19 through 6.2.1-24.

The containment system energy inventory as a function of time is plotted for the DEPSG break with minimum safety injection and maximum safety injection in Figures 6.2.1-25 and 6.2.1-26, respectively. All mechanisms of energy removal from and transfer within the containment are addressed in these figures. Included are the vapor energy, sump energy, energy contained in heat sinks, total energy removed from the containment by fan coolers and by the residual heat removal system, and net energy transferred by sprays from the containment vapor to the sump.

For the DBA at the time of the calculated peak containment pressure, the vapor energy is 310.8 x 10^6 Btu, the energy deposited in the sump is 82.1 x 10^6 Btu, the containment passive heat sinks have absorbed 81.0 x 10^6 Btu, 2.0 x 10^6 Btu have been removed by the containment fan coolers, 3.6 x 10^6 Btu have been transferred from the containment vapor to the sump via the containment sprays, and no energy has been removed by the RHR system. Safety injection is switched to the recirculation mode at 1,509 seconds, and the containment sprays are switched to the recirculation mode at 3,227 seconds after the accident.

n. Accumulator Nitrogen Release

Table 6.2.1-11 provides the nitrogen release rate from the accumulators following the discharge of their liquid volumes. The added mass and associated energy of this nitrogen release are accounted for in the LOCA analysis.

o. Normal Containment Ventilation System Evaluation

   The functional capability of the normal containment ventilation systems to maintain the temperature, pressure, and humidity in the containment and containment subcompartments is discussed in Sections 6.2.2.2 and 9.4.6.

p. Post-Accident Monitoring

   Instrumentation for post-accident monitoring is discussed in Section 7.5.

6.2.1.2 Containment Subcompartments

6.2.1.2.1 Design Basis

Subcompartments within the containment, principally the reactor cavity, the steam generator loop compartments, and the pressurizer compartment, are designed to withstand the transient differential pressures and jet impingement forces of a postulated pipe break. Venting of these chambers maintains the differential pressures within the structural limits. In addition, restraints on the reactor coolant pipes, reactor vessel, steam generators, etc., are designed so that neither pipe whip nor vessel upset forces threaten the integrity of the subcompartments or of the containment structure.

Analysis of the pressure transients in the reactor cavity, steam generator compartment, and pressurizer compartment has been performed to verify the adequacy of the structural design of these structures under accident conditions. The following is a synopsis of the pipe breaks analyzed:

a. For the reactor cavity subcompartment analysis, the design basis break is a double-ended cold leg guillotine break within the reactor cavity. Pipe restraints are employed to limit the break flow area to less than 150 square inches.

b. For the steam generator loop compartments, the design basis break is a steam generator inlet elbow longitudinal split with a break flow area of 763 square inches, a double-ended steam generator outlet nozzle break restrained to a break flow area of 436 square inches, and a double-ended reactor coolant pump outlet nozzle break restrained to a break flow area of 236 square inches.

c. The pressurizer compartment is divided into two compartments: 1) the pressurizer vault and 2) the pressurizer surge line compartment.

The design basis break for these subcompartments is the double-ended pressurizer surge line break. In addition to this break, the pressurizer spray line break and the three break cases from the steam generator loop compartment analysis were considered in the selection of the design analysis break. In all cases, the pressures in the pressurizer compartment were substantially lower than those resulting from the pressurizer surge line break.

6.2.1.2.2 Design Features

All design features provided for alleviating pressure buildup within the subcompartments are discussed in the subcompartment design evaluation in Section 6.2.1.2.3. Reference 2 describes the design features which limit the movement of the pipe after the postulated break.

6.2.1.2.3 Design Evaluation

a. Mass and Energy Release Rate Transient Model

The computer programs used to develop the mass and energy release transients for subcompartment pressurization analyses are described in Reference 3. Tables 6.2.1-12 through 6.2.1-16 provide tabulations of the mass and energy release rates versus time for the spectrum of breaks analyzed.

b. Subcompartment Pressure Analyses Model

The COPDA computer code (Ref. 4) employs a finite difference technique to solve the time dependent equations for the conservation of mass, energy, and momentum to perform the subcompartment analyses. This code and the assumptions inherent to it are described fully in Reference 5.

1. Reactor Cavity Rupture Analysis

The design break is a double-ended cold leg break that is postulated to occur at the reactor vessel nozzle to cold leg weld. The reactor cavity design and the reactor coolant loop design are such that the analyses provided in Reference 2 verify that no break need be considered in the reactor cavity pipe penetrations (see Section 3.6). Pipe movement, and thus break flow area, is mechanically restrained to limit the effective break size to less than 150 square inches. The mass and energy release data used in the pressure response analysis are presented in Table 6.2.1-12.

The reactor cavity nodalization model is shown in Figures 6.2.1-27 through 6.2.1-33. As may be seen in the figures, node boundaries were chosen wherever significant restrictions to flow occurred. Thus, node boundaries were selected at the reactor coolant loop nozzles, the neutron detector wells, the shield support platform at the reactor vessel flange, the nozzle support ledge, and the incore instrumentation support platform. Since all restrictions to flow were considered, further nodalization was neither necessary nor appropriate.

The model included water-filled shield bags located at the reactor vessel flange. The purpose of the bags was to provide shielding at the top of the reactor cavity annulus and yet not prevent the venting of mass and energy from the cavity to the containment in the event of a LOCA. These bags have been replaced with a Permanent Reactor Cavity Seal Ring. (The considered effect of bags breaking, as described below, is for analysis purposes only.) The bag material and bag life are based on expected containment environmental conditions and dose rates. The shielding features are discussed in Section 12.3.2.2.1. The neutron shield water bags were designed to completely cover the reactor cavity opening with a minimum water depth of 12 inches.

For the original design, bags were designed to rupture when pressure was exerted on them sufficient to lift them from their support platform. For this analysis the bags were assumed to remain intact and rigid until they reached a height of 1.0 foot above the support platform before rupturing. The top boundaries of the nodes below the shield bags were then assumed to occur at the bottom surface of the bags. Thus, the volumes, vent areas, and 1/a's, which are the inertial terms in the momentum equation associated with these compartments were treated as dynamic parameters in the COPDA code, varying with the changing height of the bags. Volumes, vent areas, flow coefficients, and 1/a's were calculated to obtain a conservative estimate of pressures near the break.

In the analysis, the insulation on the reactor cavity wall was conservatively assumed to remain intact and to be pressed flush against the wall. The insulation below the shield support platform is constructed of a material that, on impact, will break apart into small crushable pieces and a powder. This insulation does not present any obstruction to flow in the event of a LOCA, nor will the pieces formed act as missiles. The insulation around the reactor coolant piping was assumed to block any possible venting through the piping penetrations; thus no credit was assumed for these vent areas. In the lower region of the reactor cavity, venting through the incore instrumentation support platform was assumed to be blocked by insulation. The design of the reactor cavity precludes blockage by insulation within the reactor cavity annulus. Tables 6.2.1-17 and 6.2.1-19 show the volume of each subcompartment as well as the initial conditions prior to the postulated accident. The vent areas, 1/a's, and head loss coefficients used in the calculation of the flow coefficients are given in Tables 6.2.1-18 and 6.2.1-20 for all of the flowpaths between subcompartments.

The homogeneous frozen flow option was employed in the analysis. This flow option is described in Reference 5. The resulting peak pressure for each subcompartment is listed in Table 6.2.1-17. The complete pressure histories for all of the subcompartments are shown in Figures 6.2.1-34 through 6.2.1-39.

The subcompartment pressures, when applied to the projected areas of the subcompartments on the reactor vessel, yield the force on the vessel. Time-histories of the horizontal and vertical forces and the upending moment imposed on the reactor vessel by the asymmetric pressurization of the reactor cavity are presented in Figures 6.2.1-40 through 6.2.1-42. The force and moment coefficients for each subcompartment are given in Table 6.2.1-21.

2. Steam Generator Loop Compartments

The steam generator loop compartment is subjected to double-ended breaks of the pump suction line, the cold leg, the hot leg, a longitudinal split of the hot leg, and double-ended branch line breaks. All double-ended breaks are mechanically restrained so that the largest breaks in the hot leg, cold leg, and pump suction are 763 in^2, 236 in^2, and 436 in^2, respectively. These three breaks envelope all postulated breaks within the steam generator loop compartment. These breaks were analyzed, using the same 59-node model, to determine the maximum pressures on the walls of the compartment and on the enclosed equipment, i.e., the steam generator, the reactor coolant pump, and the pressurizer. The blowdown data for the three breaks are given in Tables 6.2.1-13 through 6.2.1-15. The nodalization model for the analyses is given in Figures 6.2.1-43 through 6.2.1-55. Only breaks in loop 4 were analyzed, since this loop has the smallest vent area directly to the remainder of the containment due to the presence of the pressurizer, and thus results in the highest pressures.

To ensure conservative design of the loop compartment walls and the equipment supports, the loads calculated for loop 4 were applied to the other three steam generator loop compartments by appropriate translation and rotation of the force vector axes. The volumes of the subcompartments, as well as the initial conditions prior to the transient, are given in Table 6.2.1-22.

As with the reactor cavity analysis, the node boundaries were selected wherever significant restrictions to flow occurred. A sensitivity study was performed in which the number of nodes in the steam generator compartment was varied. The resulting forces on the compartment walls and on the equipment in all cases were less than the forces calculated with the 59-node model. Therefore, it was assumed that the nodalization employed in the original model was both adequate and conservative. All major obstructions, such as columns, pumps, tanks, grating, and the steam generators, were considered in the calculation of the subcompartment volumes and vent areas. In addition, the values for volume were reduced by 5 percent to allow for minor obstructions, such as cable trays, supports, and various piping. The principal obstructions within the steam generator loop compartments were the reactor coolant pumps and the steam generators. Flow through the reactor cavity was neglected. The flow coefficients associated with the flow paths were calculated in the same manner as for the reactor cavity. The head loss coefficients used in the calculation of the flow coefficients, as well as the vent areas and 1/a's for each flowpath, are listed in Table 6.2.1-23.

The fluid flow from one subcompartment to another was calculated, using the homogeneous frozen flow option in the analysis. The peak pressures for each subcompartment are listed in Table 6.2.1-22. The complete pressure histories for those subcompartments near the break for each of the three break cases analyzed are shown in Figures 6.2.1-56, 6.2.1-57, 6.2.1-61, and 6.2.1-69. When the subcompartment pressures were applied to their projected areas on the steam generator and the reactor coolant pump, the forces were determined on these pieces of equipment. The forces on the reactor coolant pump and the steam generator are shown in Figures 6.2.1-58, 6.2.1-59, 6.2.1-62 through 6.2.1-67, and 6.2.1-70 through 6.2.1-74. The coefficients used to calculate the forces are given in Tables 6.2.1-24 and 6.2.1-25.

The component and resultant forces on the steam generator and reactor coolant pump for the three breaks analyzed are illustrated in Figures 6.2.1-60, 6.2.1-68, and 6.2.1-75.

3. Pressurizer Vault

The pressurizer vault is subjected to a pressurizer spray line break, a pressurizer surge line break, and a reactor coolant loop break. The pressurizer surge line compartment located directly below the pressurizer vault is subject to a pressurizer surge line break and reactor coolant pipe break within the steam generator compartment adjacent to the pressurizer vault. Analyses showed that the worst postulated break for both the pressurizer vault and the surge line compartment was the double-ended pressurizer surge line break. The mass and energy release data for this case are given in Table 6.2.1-16.

In the model, the pressure is relieved through large vents in the top of the pressurizer vault, and through the surge line compartment, out into the steam generator loop compartment and then up to the remainder of the containment. Figure 6.2.1-76 provides a simplified elevation view of the pressurizer vault, and Figure 6.2.1-77 shows a schematic diagram of the flow model.

The subcompartment volumes along with the peak calculated pressures and the design pressures in the pressurizer vault and the surge line compartment are given in Table 6.2.1-26. The pressure histories of those subcompartments directly below the pressurizer are given in Figure 6.2.1-78. Table 6.2.1-27 summarizes the head loss coefficients used to calculate the flow coefficients and the vent areas and 1/a's for all of the flow paths.

c. Nodalization Model Adequacy

The determination of nodalization models used for the subcompartment analysis is adequate and based on the following criteria:

1. The models are physically representative of the geometry investigated.

2. The models are of adequate detail to consider all significant obstructions and flow losses.

3. The selection of nodal boundaries and volumes reflect the conservative theoretical thermo and fluid dynamic application.

A determination that these criteria are met is based on previously performed developmental subcompartment analysis, Bechtel experience in the performance of other PWR subcompartment analyses, and comparisons with information in the public domain (such as NUREG/CR-1199, and NUREG-0609).

6.2.1.3 Mass and Energy Release Analyses for Postulated Loss-of-Coolant Accidents

The containment system receives mass and energy releases following a postulated rupture of the reactor coolant system (RCS). These releases continue through blowdown and post-blowdown. The release rates are calculated for pipe failure at three distinct locations: 1) hot leg, 2) pump suction, and 3) cold legs.

Because of the pressure in the RCS before the postulated rupture, the mass and energy flows rapidly from the RCS to the containment. As the water exits from the rupture, a portion of it flashes into steam due to the pressure and temperature in the containment, compared to the pressure and temperature of the RCS. The blowdown reduces the pressure in the RCS.

During the reflood phase, these breaks have the following different characteristics. For a cold leg pipe break, all of the fluid which leaves the core must vent through a steam generator and becomes superheated. However, relative to breaks at other locations, the core flooding rate (and, therefore, the rate of fluid leaving the core) for cold leg breaks is low because all the core vent paths include the resistance of the reactor coolant pump. For a hot leg pipe break, the vent path resistance is relatively low, which results in a high core flooding rate, but the majority of the fluid which exits the core bypasses the steam generators in venting to the containment. The pump suction break combines the effects of the relatively high core flooding rate, as in the hot leg break, and steam generator heat addition, as in the cold leg break. As a result, the pump suction break yields the highest energy flow rates during the post-blowdown period. The spectrum of breaks analyzed includes the largest cold and hot leg breaks, reactor inlet and outlet, respectively, and a range of pump suction breaks from the largest to a 3.0 ft^2 break.

Because of the phenomena of reflood, as discussed above, the pump suction break location is the limiting case, with the double-ended pump suction break being the most limiting. This conclusion is supported by studies of smaller hot leg breaks which have been shown on similar plants to be less severe than the double-ended hot leg. Cold leg breaks, however, are lower both in the blowdown peak and in the reflood pressure rise. Thus, an analysis of smaller pump suction breaks is representative of the spectrum of break sizes.

The LOCA analysis calculational model is typically divided into three phases, which are: 1) blowdown, which includes the period from accident occurrence (when the reactor is at steady state full power operation) to the time when zero break flow is first calculated, 2) refill, which is from the end of blowdown to the time the emergency core cooling system (ECCS) fills the vessel lower plenum, and 3) reflood, which begins when water starts moving into the core and continues until the end of the transient. For the pump suction break, consideration is given to a possible fourth phase; that is, froth boiling in the steam generator tubes after the core has been quenched. For a description of the calculational model used for the mass and energy release analysis, see Reference 3.

6.2.1.3.1 Mass and Energy Release Data

a. Blowdown Mass and Energy Release Data

Tables 6.2.1-28 through 6.2.1-32 present the calculated mass and energy releases for the blowdown phase of the various breaks analyzed with the corresponding break size.

b. Reflood Mass and Energy Release Data

The lower vessel plenum is assumed to refill immediately following blowdown, hence the refill phase is skipped. Tables 6.2.1-33 through 6.2.1-38 present the calculated mass and energy releases for the reflood phase of the various breaks analyzed along with the corresponding safeguards assumption (maximum or minimum).

c Dry Steam Post-Reflood Mass and Energy Release Data

The calculated mass and energy releases for the post-reflood phase with dry steam are provided in the reflood mass and energy release tables (Tables 6.2.1-35 through 6.2.1-38) after the end of the 10-foot entrainment occurs. These tables correspond to the hot leg, cold leg, and small pump suction breaks analyzed.

d. Two-Phase Post-Reflood Mass and Energy Release Data

Tables 6.2.1-39 and 6.2.1-40 present the two-phase (froth) mass and energy release data for a double-ended pump suction break, using minimum and maximum safeguards assumptions, respectively. The following procedure was followed to account for the depressurization, equilibration, and decay heat mass and energy releases to 106 seconds.

1. Depressurization Energy Release

   The froth mass and energy release was initially tabulated based on a reference temperature for heat stored in the steam generator metal and secondary fluid of saturation at the containment design backpressure of 60.0 psig. Additional two-phase mass and energy releases become available due to the energy within the steam generators, as the containment depressurizes to atmospheric conditions.

2. Depressurization (Two-Phase Mixture)

   Tables 6.2.1-41 and 6.2.1-42 show the available depressurization energy of the steam generators above atmospheric pressure (14.7 psia).

   This energy is brought out in two stages. In the first, the sources above are brought into equilibrium with the actual containment pressure. The rate for this phase is set by the froth calculation models. In the second, the sources give up additional energy as the containment pressure decreases. The rate for this stage is set by the containment depressurization rate.

   The depressurization mass and energy release rates can be determined if the depressurization time is known. The depressurization time was estimated by choosing a conservatively low value that would maximize the depressurization mass and energy release rates to the containment (3,600 seconds for normal dry containment). First, a containment pressure calculation was performed, neglecting the depressurization energy release. For this case, the containment will depressurize faster and, hence, a conservative depressurization time is calculated. The second containment pressure calculation is made, utilizing depressurization time with the procedure for calculating depressurization mass and energy release rates described in this section.

   The steam generator depressurization mass and energy release rate from the broken and intact loops were calculated and added to the initial mass and energy releases, which were based on a containment back pressure of 60.0 psig, described below.

3. Broken Loop Steam Generator - Equilibration Stage

   The amount of energy in the steam generator is directly proportional to pressure and, hence, the fraction to be brought out equals the difference between reference pressure (60.0 psig) and the actual containment pressure divided by reference pressure. Since the broken loop steam generator is in equilibrium with the reference pressure of 60.0 psig prior to the beginning of froth, a conservative value for steam generator heat release was assumed. A rate of 100,000 Btu/sec would release all of the available energy in 209 seconds. This value is conservative.

4. Broken Loop Steam Generator - Depressurization Stage

   The amount of energy to be brought out is the original amount of energy remaining in the broken loop steam generator given in Tables 6.2.1-41 and 6.2.1-42, less what is brought out to reach equilibrium. The heat addition rate is this amount divided by the assumed depressurization time. The mass boiloff rate is this rate divided by latent heat. The energy addition rate is the boiloff rate times saturated vapor enthalpy.

5. Intact Loop Steam Generator - Equilibration Stage

   The same procedure as for the broken loop is used here. However, metal and core energy is lumped with the steam generator energy for this calculation. The fraction to be brought out to attain equilibrium equals the difference between the reference containment pressure and the actual containment pressure divided by the reference value. The rate of addition to the containment is 90.0 lb/sec at 1,034 seconds. This cools the steam generator and metal at 37,576 Btu/sec. Thus, the duration of the extension of the post-reflood table is the fraction times the available energy divided by the rate of cooling. This was not extended beyond recirculation because the continued condensation effect is implicit in these numbers and should change after recirculation.

6. Intact Loop Steam Generator - Depressurization Stage

Again the procedure used here is the same as the broken loop case except that the decay heat should be added to the heat addition rate, which was not included in the initial post-reflood tables. The amount of energy to be brought out is the original energy remaining given in Tables 6.2.1-41 and 6.2.1-42, less what is brought out to reach equilibrium. The heat addition rate is this amount divided by the depressurization time. The mass boiloff rate is this rate divided by latent heat. The energy addition rate is the boiloff rate times saturated vapor enthalpy. Beyond the equilibration stage, the mass boiloff rate due to decay heat is added to the depressurization mass boiloff rates. This rate is the decay heat rate divided by latent heat, including ECCS water subcooling prior to recirculation. The corresponding energy addition rate is the boiloff rate times saturated vapor enthalpy.

The continued condensation benefit is not implicit in these numbers, and thus this calculation may extend beyond recirculation.

7. Decay Heat

Figure 6.2.1-16 presents the decay heat which is used for the depressurization calculation.

8. Post-Recirculation Energy Release

Recirculation for the maximum safety injection case occurs at 849 seconds, which is during the broken loop depressurization stage. During this stage, the energy release is a function of the recirculated safety injection water sensible heat, the reactor decay heat (Figure 6.2.1-16), the broken loop depressurization heat release, and the actual containment pressure. The intact loop equilibration and depressurization releases are accounted for in the same way.

Recirculation for the minimum safety injection case occurs at 1,509 seconds, which is during the intact loop depressurization stage. During this stage, the energy release is a function of the recirculated safety injection water sensible heat, the reactor decay heat, the broken and intact loop depressurization heat releases, and the actual containment pressure.

Following the end of broken and intact loop depressurization to the end of the transient, the energy release is a function of decay heat and sensible heat only. End of depressurization occurs at 3,772 and 3,775 seconds for the maximum and minimum safety injection cases, respectively.

6.2.1.3.2 Energy Sources

The sources of energy considered in the LOCA mass and energy release analysis are given in the energy balance tables (Tables 6.2.1-43 through 6.2.1-48). These energy sources are:

a. RCS, accumulators, and pumped safety injection sensible heat

b. Decay heat

c. Core stored energy

d. Thick and thin metal energy

e. Steam generator energy

The energy balance tables show the initial energy distribution and the energy distribution at end-of-blowdown (EOB), end-of-entrainment (EOE), end-of-froth (EOF), and end-of-froth intact loops (EOFIL) for the two-phase post-reflood analyses. For the dry steam post-reflood analyses, the energy distribution at an assumed recirculation time of 1,500 seconds is given instead of EOF and EOFIL.

The methods and assumptions used to release the various energy sources are given in Reference 3.

The following items ensure that the core energy release is conservatively analyzed for maximum containment pressure.

a. Core power level of 3,636 MWt (102 percent of ultimate core power level)

b. Allowance in temperature for instrument error and dead band (+4 F)

c. Margin in volume (1.4 percent)

d. Allowance in volume for thermal expansion (1.6 percent)

e. Margin in core power associated with use of engineered safeguards design rating (ESDR)

f. Allowance for calorimetric error (2 percent of ESDR)

g. Conservatively modified coefficients of heat transfer

h. Allowance in core-stored energy for effect of fuel densification

i. Margin in core-stored energy (+15 percent)

j. Maximum calculated operating temperature (627.3 F) with above assumptions

6.2.1.3.3 Description of Blowdown Model

A description of the model used to determine the mass and energy released from the RCS during the blowdown phase of a postulated LOCA is provided in Reference 3. All significant correlations are discussed.

6.2.1.3.4 Description of Core Reflood Model

A description of the model used to determine the mass and energy released from the RCS during the reflood phase of a postulated LOCA is provided in Reference 3. All significant correlations are discussed. Transients of the principal parameters during reflood are given in Tables 6.2.1-49 and 6.2.1-50 for the limiting case pump suction breaks with maximum and minimum safeguards.

6.2.1.3.5 Description of Long-Term Cooling Model

The calculational procedure used to determine the mass and energy released during the post-reflood phase of a postulated LOCA is described in Reference 3.

6.2.1.3.6 Single Failure Analysis

The effect of single failures of various ECCS components on the mass and energy releases is included in these data. The two analyses for the DEPSG breaks bound this effect.

No single failure is assumed in determining the mass and energy releases for the maximum safeguards case. For the minimum safeguards case, the single failure assumed is the loss of one emergency diesel. This failure results in the loss of one pumped safety injection train. The analysis of both maximum and minimum safeguards cases ensures that the effect of all credible single failures is bounded.

6.2.1.3.7 Metal-Water Reaction

In the mass and energy release data presented here, no Zr-H_2O reaction heat was considered because the clad temperature did not rise high enough for the rate of the Zr-H_2O reaction to be of any significance.

6.2.1.3.8 Reactor Coolant System Mass and Energy Balance

Reactor coolant system mass and energy balances are tabulated for hot leg, cold leg, and pump suction breaks in Tables 6.2.1-43 through 6.2.1-48.

6.2.1.3.9 Additional Information Required for Confirmatory Analysis

System parameters and hydraulic characteristics needed to perform confirmatory analysis are provided in Tables 6.2.1-51 through 6.2.1-55.

6.2.1.4 Mass and Energy Release Analysis for Postulated Secondary Pipe Ruptures Inside Containment

Steam line ruptures occurring inside a reactor containment structure may result in significant releases of high energy fluid to the containment environment, possibly resulting in high containment temperatures and pressures. The high pressures and temperatures can result in failure of any equipment which is not qualified to perform its function in an adverse environment. This could degrade the effectiveness of the protection system in mitigating the consequences of the steamline rupture. In addition, the containment structure is designed to withstand a limited internal pressure (i.e., 60 psig). Thus, an associated containment response analysis may be performed to demonstrate that the conditions inside the containment during a steamline rupture do not violate the existing environmental qualification (EQ) envelopes, and to demonstrte that the containment design pressure is not exceeded.

Consistent with the NRC-approved methodology documented in Reference 6, the analyses are performed to maximize the amount of mass and energy released to the containment. The releases following a steamline rupture are dependent upon many possible configurations of the plant steam system and containment designs, as well as the plant operating conditions and the size of the rupture. There are competing effects as power and break size change, and thus multiple cases are typically analyzed. Therefore, the steamline break event is analyzed for a spectrum of pipe break sizes and various plant conditions from hot standby to 102% of full power (i.e., re-rated power of 3579 MWt). Break sizes are considered beginning with the full double-ended break and decreasing in area until no water entrainment is calculated to occur. The spectrum of powers and breaks analyzed is listed in Table 6.2.1-56.

6.2.1.4.1 Significant Parameters Affecting Steam Line Break Mass and Energy Releases

There are four major factors that influence the release of mass and energy following a steam line break: steam generator fluid inventory, primary to secondary heat transfer, protective system operation, and the state of the secondary fluid blowdown. The following is a list of those plant variables which determine the influence of each of these factors:

a. Plant power level

b. Main feedwater system design

c. Auxiliary feedwater system design

d. Postulated break type, size, and location

e. Availability of offsite power

f. Safety system failures

g. SG reverse heat transfer and reactor coolant system metal heat capacity

h. Steam Generator Fluid Mass

i. MSIV and MFIV Closure Times

j. Safety Injectin System

k. Protection System Actuations

l. Operator Response Time

The following is a discussion of each of these variables.

6.2.1.4.1.1 Plant Power Level

Steam line breaks can be postulated to occur with the plant in any operating condition ranging from hot standby to full power. Since steam generator mass decreases with increasing power level, breaks occurring at lower power generally result in a greater total mass release to the plant containment. However, because of increased energy storage in the primary plant, increased heat transfer in the steam generators, and the additional energy generation in the nuclear fuel, the energy release to the containment from breaks postulated to occur during power operation may be greater than for breaks occurring with the plant in a hot standby condition. Additionally, steam pressure and the dynamic conditions in the steam generators change with increasing power and have significant influence on both the rate of blowdown and the amount of moisture entrained in the fluid leaving the break following a steambreak event.

Because of the opposing effects of changing power level on steam line break releases, no single power level can be singled out as a worst case initial condition for a steam line break event. Therefore, several different power levels spanning the operating range as well as the hot standby condition have been analyzed.

6.2.1.4.1.2 Main Feedwater System Design

The rapid depressurization which occurs following a rupture may result in large amounts of water being added to the steam generators through the main feedwater system. Rapid closing isolation valves are provided in the main feedwater lines to limit this effect. Also, the piping layout downstream of the isolation valves affects the volume in the feedwater lines that cannot be isolated from the steam generators. As the steam generator pressure decreases, some of the fluid in this volume will flash into the steam generator, providing additional secondary fluid which may exit out the rupture.

The feedwater addition which occurs prior to closing of the feedwater line isolation valves influences the steam generator blowdown in several ways. First, the rapid addition increases the amount of entrained water in large-break cases by lowering the bulk quality of the steam generator inventory. Secondly, because the water entering the steam generator is subcooled, it lowers the steam pressure, thereby reducing the flow rate out of the break.

Finally, the increased flow rate causes an increase in the heat transfer rate from the primary to secondary system, resulting in greater energy being released out the break. Since these are competing effects on the total mass and energy release, no "worst case" feedwater transient can be defined for all plant conditions. In the results presented, the worst effects of each variable have been used. For example, moisture entrainment for each break is calculated assuming conservatively small feedwater additions so that the entrained water is minimized. Determination of total steam generator inventory, however, is based on conservatively large feedwater additions.

The effects of any flashing of the feedwater trapped between the steam generator and the isolation valves is included in the analyses. The failure of the MFIV on the faulted loop results in additional fluid being added to the faulted steam generator. The quantity of the additional fluid to be released is based on the volume between the isolation valve and the main feedwater control valve (MFCV) on the faulted loop. Thus, the mass added to the faulted steam generator from both the pumped main feedwater flow and the feedline flashing will be larger with a failure of a feedwater isolation valve.

6.2.1.4.1.3 Auxiliary Feedwater System Design

Within the first minute following a steam line break, the auxiliary feed system is initiated on any one of several protection system signals. Addition of auxiliary feedwater to the steam generators increases the secondary mass available for release to the containment, as well as increases the heat transferred to the secondary fluid. The effects on steam generator mass are maximized by assuming auxiliary feed flow to the faulted steam generator starting from the time a safety injection signal is initiated on low steamline pressure or high containment pressure and continuing until manually stopped by the plant operator.

The maximum auxiliary feedwater flow delivered to the faulted steam generator represents the most limiting single failure from the perspective of mass and energy releases following a postulated steamline break. Failure of one protection train is assumed so that only one motor and the turbine driven AFW pump are operating during the transient. To maximize the AFW flowrate to the ruptured steam generator, the control valve on the discharge side of the operating motor driven AFW pump feeding the faulted generator is assumed to fail in the wide open position.

6.2.1.4.1.4 Postulated Break Type, Size, and Location

a. Postulated Break Type

Two types of postulated pipe ruptures are considered in evaluating steam line breaks.

First is a split rupture in which a hole opens at some point on the side of the steam pipe or steam header but does not result in a complete severance of the pipe. A single, distinct break area is fed uniformly by all steam generators until steam line isolation occurs. The blowdown flow rates from the individual steam generators are interdependent, since fluid coupling exists between all steam lines. Because flow limiting orifices are provided in each steam generator, the largest possible split rupture can have an effective area prior to isolation that is no greater than the throat area of the flow restrictor times the number of plant primary coolant loops. Following isolation, the effective break area for the steam generator with the broken line can be no greater than the flow restrictor throat area.

The second break type is the double-ended guillotine rupture in which the steam pipe is completely severed and the ends of the break displace from each other. Guillotine ruptures are characterized by two distinct break locations, each of equal area but being fed by different steam generators. The largest possible guillotine rupture can have an effective area per steam generator no greater than the throat area of one steamline flow restrictor.

The type of break influences the mass and energy releases to containment by altering both the nature of the steam blowdown from the piping in the steam plant and the effective break area fed by each steam generator prior to steam line isolation. For example, a double-ended rupture in a pipe having a cross-sectional area of 2.4 square feet would appear as a 1.4-square-foot rupture to a single steam generator feeding one end of the break, but would appear as a 0.8-square-foot rupture to each of the steam generators feeding the other end of the break.

b. Postulated size

Break area is also important when evaluating steam line breaks. It controls the rate of releases to the containment as well as exerts significant influence on the steam pressure decay and the amount of entrained water in the blowdown flow. The data presented in this section include releases for three break areas at each of five initial power levels. Included are two double-ended and one split rupture, as follows:

1. A full double-ended pipe rupture downstream of the steam line flow restrictor. For this case, the actual break area equals the cross-sectional area of the steam line, but the blowdown from the steam generator with the broken line is controlled by the flow restrictor throat area (1.4 square feet). The reverse flow from the intact steam generators is controlled by the smaller of the pipe cross section, the steam stop valve seat area, or the total flow restrictor throat area in the intact loops. The reverse flow has been conservatively assumed to be controlled by the flow restrictors in each of the intact loop steam generators. Actually, the combined flow from the three steam generators must pass through an 18-inch (1.42 square feet) line, which would greatly restrict the flow.

2. A small double-ended rupture having an area just larger than the area at which water entrainment ceases. Entrainment is assumed in the forward direction only. Dry steam blowdown is assumed to occur in the reverse direction.

3. A split break that represents the largest break which neither generates a steam line isolation signal from the primary protection equipment nor results in moisture entrainment. Steam and feedwater line isolation signals are generated by high containment pressure signals for these cases. Being a split rupture, the effective area seen by the faulted steam generator will increase by a factor of 4, following steam line isolation. Conceivably, moisture entrainment could occur at that time. However, since steam line isolation for these breaks generally does not occur before 20-60 seconds, it is conservatively assumed that the pressure has decreased sufficiently in the affected steam generator to preclude any moisture carryover.

4. A break representing the largest double-ended rupture for which only dry steam blowdown occurs need not be presented. Studies (Ref. 7) have shown that this break size is typically smaller than the largest split break (no entrainment) for which blowdown for the split rupture will be more severe than the no-entrainment DER at any given power level.

c. Postulated Break Location

Break location affects steam line blowdowns by virtue of the pressure losses which would occur in the length of piping between the steam generator and the break. The effect of the pressure loss is to reduce the effective break area seen by the steam generator. Although this would reduce the rate of blowdown, it would not significantly change the total release of energy to the containment. Therefore, piping loss effects have been conservatively ignored in all blowdown results, except in the small double-ended ruptures in which moisture entrainment occurs. The effects of pipe friction are conservatively assumed to be sufficiently large in this case to prevent moisture entrainment in the reverse flow, thus minimizing water relief to the containment.

6.2.1.4.1.5 Availability of Offsite Power

Loss of offsite power following a steamline rupture would result in tripping of the RCPs, main feedwater pumps, and a possible delay of AFW initiation due to emergency diesel generator starting delays. Each of these occurrences aids in mitigating the effects of the steamline break releases by either reducing the fluid inventory available to feed the blowdown or reducing the energy transferred from the primary coolant system to the steam generators.

The effects of the assumption of the availability of offsite power has been enveloped in the analysis. Loss of offsite power has been assumed where it delays the actuation of the containment heat removal systems (i.e., containment sprays and containment air coolers) due to the time required to start the emergency diesel generators. Offsite power has been assumed to be available where it maximizes the mass and energy released from the break due to 1) the continued operation of the reactor coolant pumps which maximizes the energy transferred from the reactor coolant system to the steam generators and 2) continued operation of the feedwater pumps and actuation of the auxiliary feedwater system which maximizes the steam generator inventories available for release.

6.2.1.4.1.6 Safety System Failures

In addition to assuming a loss of offsite power, the following single active failures were considered:

a. Loss of one emergency diesel

b. Failure of one main steam isolation valve

c. Failure of one main feedwater isolation valve

The loss of one diesel results in the loss of one train of each of the containment heat removal systems. As discussed in Section 6.2.1.4.3.3, this is the most severe single active failure.

The effect of a main steam isolation valve failure is to provide additional fluid which may be released to the containment via the break. This results from the blowdown of all the steam piping between the break location and the isolation valves in the intact loops. The effect of the failure of the MSIV and the associated bypass valve on the faulted loop is considered. It should be noted that closure of the faulted loop MSIV does not terminate the break flow from the faulted steam generator, since the limiting break is postulated to be located between the steam generator and the MSIV. However, the faulted loop MSIV and the associated bypass valve do isolate the break from the remainder of the steamline and the other steam generators. If the faulted loop MSIV and the associated bypass valve fail to close, blowdown from multiple steam generators is prevented by the closure of the corresponding MSIV for each intact steam generator. But failure of the MSIV and the associated bypass valve does increase the unisolable steamline volume containing steam which will be released to the containment.

The failure of a main feedwater isolation valve results in additional fluid being released to the containment following a main steam line break. The additional fluid to be released is the volume between the isolation valve and the feedwater control valve.

6.2.1.4.1.7 Steam Generator Reverse Heat Transfer and Reactor Coolant System Metal Heat Capacity

Once steam line isolation is complete, those steam generators in the intact steam loops become sources of energy which can be transferred to the steam generator with the broken line. This energy transfer occurs via the primary coolant. As the primary plant cools, the temperature of the coolant flowing in the steam generator tubes drops below the temperature of the secondary fluid in the intact units, resulting in energy being returned to the primary coolant. This energy is then available to be transferred to the steam generator with the broken steamline.

Similarly, the heat stored in the metal of the reactor coolant piping, the reactor vessel, and the reactor coolant pumps is transferred to the primary coolant as the plant cooldown progresses. This energy also is available to be transferred to the steam generator with the broken line.

The effects of both the reactor coolant system metal and the reverse steam generator heat transfer are included in the results presented in this document.

6.2.1.4.1.8 Steam Generator Fluid Mass

A maximum initial steam generator mass in all the steam generators was used in all of the analyzed cases. The use of a high initial steam generator mass maximizes the steam generator inventory available for release to containment. The initial mass has been calculated as the value corresponding to the programmed level (i.e., 50% narrow-range span) plus 10% to account for the SG water level uncertainties, plus 10% to account for mass uncertanties. For split breaks, the mass in the unisolable steam line volume is also included in the initial faulted loop SG mass.

6.2.1.4.1.9 MSIV and MFIV Closure Times

A MSIV/MFIV stroke time delay of 15 seconds was conservatively assumed in the analyses of these steamline break events. Note: The actual analysis assumption consists of a total delay of 17 seconds, which includes a 2-second allowance for signal processing delays.

6.2.1.4.1.10 Safety Injection System

Minimum safety injection system (SIS) flowrates corresponding to the failure of one SI system train are assumed in this analysis. A minimum SI flow is conservative since the reduced boron addition maximizes a return to power resulting from the RCS cooldown. The higher power generation increases heat transfer to the secondary side, maximizing steam flow out of the break. The delay time to achieve full SI flow is assumed to be 27 seconds for this analysis with offsite power available.

6.2.1.4.1.11 Protection System Actuations

The protection systems available to mitigate the effects of a MSLB accident inside containment include reactor trip, safety injection, steamline isolation, and feedwater isolation. The setpoints used are conservative values with respect to the plant-specific values delineated in the Technical Specification Bases.

For the full double-ended rupture MSLB at all power levels and certain small double-ended ruptures at high power levels, the first protection system signal is low steamline pressure (2-of-3 channels per loop, lead/lag compensated in each channel) in any loop that initiates safety injection and steamline isolation; the SI signal produces a reactor trip signal. Feedwater system isolation and AFW actuation occur as a result of the SI signal.

For the split breaks at all power levels and certain small double-ended ruptures at median to low power levels, the steamline break protection function typically relies on the high containment pressure signals for reactor trip and feedline and steamline isolations. Specifically, a safety injection signal is generated on a hi-1 (6 psig) containment pressure signal, and a steamline isolation signal is generated on a hi-2 (20 psig) containment pressure signal. The timing of these signals must be determined iteratively with the containment response analysis and then modeled in LOFTRAN using “manual” actuation input parameters.

6.2.1.4.1.12 Operator Response Time

As long as AFW is being delivered to the faulted steam generator, the steamline break mass and energy release to containment will continue. Operator action is credited to re-align the AFW system to terminate the flow to the faulted steam generator, while continuing to feed the intact steam generators. A 20 minutes operator action time confirmed by simulator scenario measurements, is credited in this analysis. Actual termination of auxiliary feedwater flow to the affected steam generator due to operator action is expected to occur prior to 600 seconds (10 minutes), as discussed in USAR Section 10.4.9.

6.2.1.4.2 Description of Blowdown Model

The MSLB mass and energy releases have been performed, based upon the NRC-approved methodology documented in Reference 6. The system transient that provides the break flows and enthalpies of the steam release through the steam line break has been analyzed with the LOFTRAN code (Reference 7). Blowdown mass and energy releases determined include the effects of core power generation, main and auxiliary feedwater additions, engineered safeguards systems, reactor coolant system thick metal heat storage, and reverse steam generator heat transfer. The specific plant design input which was assumed is proved for each case in Table 6.2.1-57. Table 6.2.1-57A and 6.2.1-57B provide the mass and energy release data for the cases which resulted in the highest temperature and pressure, respectively.

6.2.1.4.3 Containment Response Analysis

The GOTHIC computer code (Reference 28) was used to determine the containment responses following the postulated main steam line breaks. The following assumptions were made to obtain these responses.

6.2.1.4.3.1 Initial Conditions

The initial containment conditions are the same as those used in the containment response analysis for the postulated reactor coolant system pipe ruptures (see Table 6.2.1-5).

6.2.1.4.3.2 Input Parameters and Assumptions

1. The mass and energy release data used to determine the containment response for the spectrum of steamline breaks are calculated using the LOFTRAN code (Ref. 7), along with the assumptions and models described in Section 6.2.1.4.1.

2. Loss of offsite power is assumed as it delays the actuation of the containment heat removal systems (i.e., containment sprays and containment air coolers) due to the time required to start the emergency diesel generators.

3. Loss of one emergency diesel generator, associated with the loss of offsite power, is assumed. As a result, only one train of the containment heat removal systems (i.e., containment sprays and containment air coolers) is operable.

4. The heat removal capacity of the containment fan coolers is degraded uniformly by 20% based on their actual performance capability determined by the fan cooler vendor, shown in Table 6.2.1-57C.

5. The heat removal capability of fan coolers is not credited until a total response time of at least 70 seconds has elapsed. This response time considered the time interval between the time of steamline break initiation/LOOP and the time full containment cooling system air and safety grade cooling water flow is established. Purging and filling of the voids that are expected to reside in the fan coolers and cooling water pipe lines as a result of the drain down scenario associated with LOOP is also accounted for.

6. The containment spray pump performance is assumed to be degraded by 5%. This results in a reduction of the spray injection flowrate from the calculated flowrate of 3086 gpm to 2931.7 gpm.

7. If the containment pressure reaches the containment Hi-3 pressure setpoint (30 psig, including uncertainty) before 27 seconds, full flow spray is conservatively assumed to occur at 60 seconds, accounting for time to attain operating speed and design flow of the containment spray pump and fill up the spray lines. Note: The load sequencer applies power to containment spray pumps at 27 seconds. Otherwise, the containment spray injection starts 30 seconds after the containment pressure reaches the actuation setpoint (i.e., containment Hi-3 pressure). The 30 seconds time delay accounts for the spray pump startup and spray line filling.

8. The surface area for the liquid pool is assumed to the 0 ft^2 in order to neglect the heat transfer from the vapor region to liquid region.

6.2.1.4.3.3 Description of Analysis Methods

A simplified schematic of the Wolf Creek containment, along with the GOTHIC containment model for the MSLB, is shown in Figure 6.2.1-79 and Figure 6.2.1-80, respectively. The model is comprised of three volumes representing the containment volume, the outside air and a separate volume representing the fan cooler ducts. The containment (Volume 1) is modeled with a single lumped parameter node. Two boundary conditions (1F and 2F) are used to represent the sources of mass and energy from the break and the spray injection system, respectively. Flow paths connect the boundary conditions to the containment volume. Fourteen heat sinks, a fan cooler component and a volumetric fan are also shown.

The direct heat transfer coefficient set is used for the GOTHIC calculation, along with the diffusion layer model (DLM) mass transfer correlation, for all of the internal heat sinks in the Wolf Creek containment MSLB evaluation model. The DLM is used to calculate condensation mass transfer between the heat sinks and the atmosphere. The DLM model is described in Reference 28 and the qualification for use in containment design basis analyses are described in Reference 30.

6.2.1.4.3.4 Containment Pressure-Temperature Results

The containment pressure and temperature response to a postulated MSLB has been analyzed, based on the developed GOTHIC model, for the 16 cases. The peak calculated containment pressure and temperature for each case is presented in Table 6.2.1-58. The full double-ended MSLB at 25% power (Case 10) and the full double-ended MSLB at the 102% power (Case 1), are found to result in the highest containment peak pressure and temperature, respectively. The sequence of events following a postulated main steam line break is listed in Tables 6.2.1-59 and 6.2.1-60 for the worst pressure and temperature cases, respectively. Figures 6.2.1-81 and 6.2.1-82 show the calculated containment pressure, vapor temperature, and sump water temperature for these two limiting cases.

As illustrated in Figure 6.2.1-79, case 10, full double-ended MSLB at 25% power, results in a peak pressure of 52.85 psig. This case represents the peak calculated containment pressure for the spectrum of breaks analyzed. The condensing heat transfer coefficient versus time for this case is provided in Figure 6.2.1-83.

It is important to note that the peak calculated pressure is coincident with the termination of the auxiliary feedwater flow to the affected steam generator, which was assumed to occur at 1,200 seconds (20 minutes). Actual termination of auxiliary feedwater flow to the affected steam generator due to operator action is expected to occur prior to 600 seconds (10 minutes), as discussed in Section 10.4.9. In all cases, the peak calculated containment pressure demonstrates considerable margin below the containment design pressure.

As illustrated in Figure 6.2.1-82, case 1, full double-ended rupture at 102-percent power, results in a peak vapor temperature of 364.9°F. This case represents the peak calculated containment vapor temperature for the spectrum of breaks analyzed. The condensing heat transfer coefficient versus time for this case is provided in Figure 6.2.1-84.

For the spectrum of breaks analyzed, the calculated containment vapor temperature for some cases exceeds the specified containment design temperature of 320 F for a short period of time. The 320 F containment design temperature is the design temperature for safety-related equipment and instrumentation located within the containment and not the maximum temperature allowed for the containment atmosphere vapor.

It is important to note that the original containment analysis using CONTEMPT-LT/28 showed the calculated peak containment temperature was 386.5°F. Since the re-calculated peak containment temperature is less than the CONTEMPT-LT/28 analysis result, which was utilized in the current analysis of record for the equipment surface temperatures, no revised equipment surface temperature analysis is necessary. The existing equipment surface temperatures described below remain valid and the temperature profiles presented in USAR Figures 3.11(B)-7 and 3.11(B)-7A for the equipment environmental qualification remain bounding.

Figure 6.2.1-85 provides plots of surface temperature versus time for various representative materials within the containment. These curves are calculated using a model based on the acceptable methodology for safety-related component thermal analysis discussed in Appendix B of Reference 8, in conjunction with CONTEMPT-LT/28 analysis for the case resulting in the highest material surface temperatures. These figures clearly show that the actual equipment temperatures, following a postulated secondary system break, are well below their design temperatures and are, in fact, approximated more closely by the containment vapor saturation temperature.

Cables located inside the containment are qualified to higher temperatures (340 to 385 F) than their surfaces are expected to experience as shown in Figure 7A of the NUREG-0588 submittal. The calculated temperature for each type of cable is below the qualification temperature; however, due to the low mass to surface area ratios for cables, the calculated jacket/cable surface temperatures exceed the containment vapor saturation temperature.

6.2.1.4.4 Results of Postulated Feedwater Line Breaks Inside Containment

The main feedwater addition is generally below the steam generator water level; therefore, main feedwater line break (MFLB) scenarios always commence with two-phase blowdowns. The enthalpy of the blowdown is less than the enthalpy of saturated steam at the secondary-side operating pressures. As a result, the long-term integrated energy released following an MFLB is bounded by the long-term integrated energy released following an MSLB. It is expected that MFLB cases would not produce peak containment pressure or temperature conditions as severe as MSLB cases; therefore, MFLB cases are not considered for long-term containment pressure and temperature analyses.

6.2.1.4.5 Additional Information Required for Confirmatory Analysis

No additional information is deemed necessary for the performance of confirmatory analyses.

6.2.1.5 Minimum Containment Pressure Analysis for Performance Capability Studies on Emergency Core Cooling System

For PWR plants, there is a direct dependence of core flooding rate on containment pressure following a design-basis loss-of-coolant accident; i.e., the core flooding rate will increase with increasing containment pressure. A decrease in containment pressure tends to result in a decreased core inlet flooding rate and an increased peak cladding temperature (PCT). Therefore, Appendix K to 10 CFR Part 50 requires that the containment pressure used to evaluate the performance capability of a PWR ECCS does not exceed a pressure calculated conservatively for that purpose. It further requires that the calculation include the effects of operation of all installed pressure-reducing systems and processes. Therefore, the operation of all ESF containment heat removal systems operating at maximum heat removal capacity; i.e., with all containment spray trains operating at maximum flow conditions and all emergency fan cooler units operating, are assumed to insure a conservatively low containment backpressure for the ECCS performance evaluation.

The containment backpressure used for the BELOCA ASTRUM Uncertainty Analysis is calculated using the methods and assumptions discussed in Section 15.6.5.3. Input parameters, including the containment initial conditions, net free containment volume, passive heat sink materials, thicknesses, and surface areas, and starting time and number of containment cooling systems used in the analysis, are described in the following paragraphs.

6.2.1.5.1 Mass and Energy Release Data

The Mass and Energy releases used in the minimum Containment Pressure calculation were generated in the WCOBRA/TRAC Reference Transient simulation. This data is shown in Table 6.2.1-63 (discussed in Section 15.6.5.3.2). The Table 6.2.1-63 mass and energy releases are taken from the 'Reference Transient' case of Section 15.6.5.3.1, which did not include the fuel TCD modeling. The conservatively low containment backpressure from this COCO study is bounding since the core stored energy increase when explicitly modeling fuel TCD, which would tend to increase energy released through the break and hence increase containment pressure.

6.2.1.5.2 Initial Containment Internal Conditions

The initial values used in the analysis are provided in Table 6.2.1-65.

These containment initial conditions are representatively low values anticipated during normal full power operation.

6.2.1.5.3 Containment Volume

The volume used in the analysis was 2.7 x 10^6 ft^3

6.2.1.5.4 Active Heat Sinks

The containment spray system and containment air coolers operate to remove heat from the containment.

Pertinent data for these systems which were used in the analysis are presented in Table 6.2.1-65.

The sump temperature was not used in the analysis because the maximum peak cladding temperature occurs prior to initiation of the recirculation phase for the containment spray system. In addition, heat transfer between the sump water and the containment vapor space was not considered in the analysis.

6.2.1.5.5 Steam-Water Mixing

Water spillage rates from the broken loop accumulator are determined as part of the core reflooding calculation and are included in the containment code (COCO) calculational model.

6.2.1.5.6 Passive Heat Sinks

The passive heat sinks used in the analysis, with their thermo-physical properties, are given in Table 6.2.1-66. The passive heat sinks and thermophysical properties were derived in compliance with Branch Technical Position CSB 6-1, "Minimum Containment Pressure Model for PWR ECCS Performance Evaluation."

6.2.1.5.7 Heat Transfer to Passive Heat Sinks

The inputs to the containment pressure calculation are skewed in order to obtain a conservative (low) pressure transient. For example, the Tagami correlation is increased by a factor of 5 to obtain the maximum condensing heat transfer coefficient at the end of blowdown. The condensing heat transfer coefficients used for heat transfer to the steel Containment structures are included in the Containment calculation model. The COCO calculated Containment Pressure and the $\underline{W}$COBRA/TRAC calculated Containment Pressure for the PCT/CWO limiting case are shown in Figure 6.2.1-86.

6.2.1.6 Tests and Inspections

Refer to Sections 6.2.6 and 6.6

6.2.1.7 Instrumentation Requirements

Instrumentation is provided to actuate the engineered safety features and to monitor the containment temperature, pressure, and sump level. Design details and logic of the instrumentation are discussed in Sections 7.1, 7.2, 7.3, and 7.5.

6.2.2 CONTAINMENT HEAT REMOVAL SYSTEMS

The functional performance objective of the containment heat removal system, as an engineered safety features system, is to reduce the containment temperature and pressure following a LOCA or main steam line break (MSLB) accident by removing thermal energy from the containment atmosphere. These cooling systems also serve to limit offsite radiation levels by reducing the pressure differential between the containment atmosphere and the external environment, thereby diminishing the driving force for the leakage of fission products from the containment to the environment. The containment heat removal systems include the residual heat removal system discussed in Sections 5.4.7, 6.2.1, and 6.3, the containment spray system (CSS) discussed in Section 6.2.2.1, and the containment cooling system discussed in Section 6.2.2.2.

6.2.2.1 Containment Spray System

6.2.2.1.1 Design Bases

6.2.2.1.1.1 Safety Design Bases

SAFETY DESIGN BASIS ONE - The CSS is protected from the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, or external missiles (GDC-2).

SAFETY DESIGN BASIS TWO - The CSS is designed to remain functional after a SSE or to perform its intended function following the postulated hazard of a pipe break (GDC-3 and 4).

SAFETY DESIGN BASIS THREE - Safety functions can be performed, assuming a single active component failure coincident with the loss of offsite power (GDC-38).

SAFETY DESIGN BASIS FOUR - The active components are capable of being tested during plant operation. Provisions are made to allow for inservice inspection of components at appropriate times specified in the ASME Boiler and Pressure Vessel Code, Section XI (GDC-39 and 40).

SAFETY DESIGN BASIS FIVE - The CSS is designed and fabricated to codes consistent with the quality group classification assigned by Regulatory Guide 1.26 and the seismic category assigned by Regulatory Guide 1.29. The power supply and control functions are in accordance with Regulatory Guide 1.32.

SAFETY DESIGN BASIS SIX - The capability of isolating components or piping is provided so that the CSS safety function is not compromised. This includes isolation of components to deal with leakage or malfunctions (GDC-38).

SAFETY DESIGN BASIS SEVEN - The containment isolation valves in the system are selected, tested, and located in accordance with the requirements of GDC-54 and 56 and 10 CFR 50, Appendix J, Type A testing.

SAFETY DESIGN BASIS EIGHT - The CSS, in conjunction with the containment fan cooler system and the emergency core cooling system, is designed to be capable of removing sufficient heat and subsequent decay heat from the containment atmosphere following the hypothesized LOCA or MSLB to maintain the containment pressure below the containment design pressure. Section 6.2.1 provides the assumptions as to sources and amounts of energy considered and the analysis of the containment pressure transient following a LOCA or MSLB accident inside the containment (GDC-38).

SAFETY DESIGN BASIS NINE - The CSS remains operable in the accident environment.

SAFETY DESIGN BASIS TEN - The containment spray water does not contain substances which would be unstable in the thermal or radiolytic environment of the LOCA or cause extensive corrosive attack on equipment.

SAFETY DESIGN BASIS ELEVEN - The CSS is designed so that adequate net positive suction head (NPSH) exists at the suction of the containment spray pumps during all operating phases, in accordance with Regulatory Guide 1.1.

SAFETY DESIGN BASIS TWELVE - The CSS is designed to prevent debris which could impair the performance of the containment spray pumps, valves, eductors, or spray nozzles from entering the recirculation piping. Design is in accordance with Regulatory Guide 1.82, as discussed in Table 6.2.2-1.

6.2.2.1.1.2 Power Generation Design Bases

The CSS has no power generation design bases.

6.2.2.1.2 System Design

6.2.2.1.2.1 General Description

The CSS, shown schematically in Figure 6.2.2-1, consists of two separate trains of equal capacity, each independently capable of meeting the design bases. Each train includes a containment spray pump, spray header and nozzles, spray additive eductor, valves, and the necessary piping, instrumentation, flushing connections, and controls. The containment spray additive tank supplies 30 weight percent (nominal) sodium hydroxide to both trains. The refueling water storage tank supplies borated injection water to the containment spray system. Each train takes suction from separate containment recirculation sumps during the recirculation phase.

The CSS provides a spray of cold or subcooled borated water, adjusted with NaOH, from the upper regions of the containment to reduce the containment pressure and temperature during either a LOCA or MSLB inside the containment.

Each CSS pump discharges into the containment atmosphere through an independent spray header. The spray headers are located in the upper part of the reactor building to allow maximum time for the falling spray droplets to reach thermal equilibrium with the steam-air atmosphere. The condensation of the steam by the falling spray results in a reduction in containment pressure and temperature. Each spray train provides adequate coverage to meet the design requirements with respect to both containment heat removal and iodine removal. Further discussion of the iodine removal function of the CSS is provided in Section 6.5.2.

In the CSS, only the containment recirculation sumps and the spray headers, nozzles, and associated piping and valves are located within the containment. The remainder of the system is located within the auxiliary building, separated from that portion in the containment by motor-operated isolation valves.

During the recirculation phase, leakage outside of the containment is detected with the auxiliary building radiation indicators and alarms, temperature alarms, and auxiliary building sump alarms. The motor-operated isolation valves in each train assure train isolation capability in the event of leakage during the recirculation phase. Leakage detection within the auxiliary building is discussed in Section 9.3.3.

6.2.2.1.2.2 Component Description

Mechanical components of the CSS, except those in the spray additive subsystem, are described in this section. Description of the mechanical components in the spray additive subsystem is provided in Section 6.5.2. Component design parameters are given in Table 6.2.2-2.

Each component in the CSS is designed and manufactured to withstand the environmental effects, including radiation, found in Table 3.11(B)-2.

CONTAINMENT SPRAY PUMPS - The two CS pumps are the vertical centrifugal type, driven by electric induction motors. The motors have open drip-proof enclosures and are provided with adequate insulation which allows continuous operation of a 100-percent-rated load at 50 C ambient. Power for these motors is supplied from the Class IE 4,160-Volt busses. Power supply availability is discussed in Section 8.3.

The pump motors are specified to have the capability of starting and accelerating the driven equipment, under load, to a design point running speed within 4 seconds, based on 75 percent of the rated motor voltage. The pumps are designed to withstand a thermal transient from 37°F to 300°F occurring in 10 seconds, which exceeds the severity of the transient occurring when pump suction is switched from the RWST to the containment sump.

The shaft seals on the pumps are reliable, easy to maintain, and compatible with the fluids to be circulated. They are designed to operate at a temperature of 300°F, which exceeds the maximum temperature to which they will be exposed following an accident.

The containment spray pumps are designed to handle the runout flow associated with the startup transient, when minimal discharge head is applied.

CONTAINMENT SPRAY HEADER AND NOZZLES - Each containment spray header contains 197 hollow cone nozzles, each capable of the design flow and differential pressure given in Table 6.2.2-2. These nozzles have a 7/16-inch spray orifice. The nozzles produce a drop size distribution, as described in Figure 6.5-2, at system design conditions. Special tests performed on the spray nozzles are discussed in Section 6.5.2.2.2. The spray solution is completely stable and soluble at temperatures of interest in the containment and, therefore, does not precipitate or otherwise interfere with nozzle performance. The nozzles of each header are oriented to provide greater than 90-percent area coverage at the operating deck of the reactor building. The area coverage at the operating deck (based on the calculated post-LOCA containment saturation temperature) is provided in Table 6.5-2 for various nozzle orientations. The containment spray envelope reduction factor as a function of post-LOCA containment saturation temperature is provided in Figure 6.5-4. The spray header design, nozzle spacing, and orientation are shown in Figure 6.2.2-2. The containment spray header and nozzles are designed to withstand the impulse of a water hammer at the commencement of flow.

CONTAINMENT RECIRCULATION SUMPS - The two containment recirculation sumps are collecting reservoirs from which the containment spray pumps and the residual heat removal pumps separately take suction after the contents of the refueling water storage tank have been expended. The sumps are located as far as feasible from the reactor coolant system piping and components which could become sources of debris. Thermal insulation used inside containment will be a significant source of debris. The majority of insulation is removable fiberglass blanket type enclosed in a stainless steel jacket with quick-release latches. Limited quantities of other types of insulation are used in widely dispersed locations. Insulation other than removable fiberglass blanket type has been evaluated to ensure that it will not be subject to degradation under a design basis accident or, if in a few dispersed locations the insulation should degrade under DBA conditions, the debris generated as a result of the degradation is trapped by the building components so that the debris will not adversely affect the performance of the sump. The strainer arrangement consisting of stacked modules with fine mesh perforated plates completely surrounds the inlet piping to prevent floating debris and high-density particles from entering. Sources of debris, as indicated above, are physically remote from the recirculation sumps. Debris generated as a result of a LOCA will either be retained in an area such as the reactor cavity or refueling pool or must follow a tortuous path to reach the recirculation sump strainers. Figure 6.2.2-3 shows the stacked module arrangement.

However, the strainers have been evaluated to meet the intent of Regulatory Guide 1.82. To limit any possible vortexing, vortex breakers are placed in the suction lines from containment sumps to the containment spray pumps. Additionally, the strainers have been evaluated for the possibility of vortexing and found to be acceptable. The suction lines from the containment sumps to the containment spray pumps are sloped to assure switchover capability. These lines, up to and including the isolation valve, are encased in guard piping.

REFUELING WATER STORAGE TANK - The refueling water storage tank (RWST) is an austenitic stainless steel tank containing borated water at a concentration of 2,400 to 2,500 ppm boron. The design parameters are given in Table 6.2.2-2.

The tank is an atmospheric storage tank vented directly to the atmosphere. Thermal insulation and heating are provided to prevent the tank contents from freezing. A manway is provided for tank internal inspection. Tank level indication and high and low level alarms are also provided. Additional information is provided in Section 6.3.

VALVES - CSS motor-operated valves are capable of being operated from the control room. All valves are purchased with seats capable of limiting through leakage to less than 2 cubic centimeters per hour per nominal inch of pipe diameter. This is demonstrated as required by the valve purchase specifications prior to installation. Those valves with leakage criteria are tested as described in section 6.2.6. If leakage exceeds the criteria, maintenance is performed to reduce the leakage. Other MOVs without specific leakage criteria are tested as described in section 3.9(B).6. Gate and Globe valves are provided with backseats.

Encapsulation - The containment spray system suction lines from the containment recirculation sumps are each provided with a single gate isolation valve outside the containment. The piping from the sump up to and including the valve and its motor operator is enclosed in an encapsulation arrangement which is leaktight at the containment design pressure. A seal is provided so that the ambient inside the encapsulation is not connected directly to the containment sump or containment atmosphere. A single passive or active failure in the sump lines or in the encapsulation arrangement does not provide a path for leakage to the environment.

PIPING - The piping of each spray header contains a test connection. Air can be introduced into this connection to verify spray nozzle flow. Check valves immediately upstream of each spray ring header prevent system contamination due to pressurization in the containment and provide containment isolation backup protection.

A containment spray pump test line between the pumps' discharges and the RWST and lines between each pumps suction and discharge are installed for periodic testing.

6.2.2.1.2.3 System Operation

The CSS has two phases of operation, which are initiated sequentially following system actuation; they are the injection phase and the recirculation phase.

INJECTION PHASE - The CSS is actuated either manually from the control room or on the coincidence of two-out-of-four containment Hi-3 pressure signals.

Both containment spray pumps start and the motor-operated spray ring header isolation valves open to begin the injection phase. The same coincident signal opens the motor-operated additive eductor suction valves to the sodium hydroxide tank. A summary of the accident chronology for the containment spray system is provided in Table 6.2.2-3 for the injection phase of a LOCA and MSLB inside the containment, respectively.

The containment spray pump inlet nozzle, located at El. 1,970, takes suction from the RWST, located at El. 2,000'-6", through locked open valves. Approximately 95 percent of the pump discharge is directed to the containment spray ring headers. These headers are located at elevations up to approximately 2203 feet, the highest practical level to maximize iodine removal (discussed in Section 6.5.2).The headers are located outside of and above the internal containment structures which serve as missile barriers and are thereby protected from missiles generated during a LOCA or MSLB. The remaining portion of the containment spray pump discharge is bypassed through the spray additive eductors where it is used as the motive flow to draw the spray additive solution from the containment spray additive tank and direct it to the containment spray pump suction. The containment spray additive tank supplies the spray additive solution to the eductor through a motor-operated valve. Further discussion of the operation of the spray additive subsystem is provided in Section 6.5.2.2.3. If the level in the NaOH tank reaches low-low prior to switching to the recirculation phase, the spray additive tank isolation valves are automatically closed to terminate the flow of spray additive solution and prevent N_2 from being drawn into the pump suction.

On coincidence of two-out-of-four low-low-1 level signals from the RWST level transmitters, the emergency core cooling system (ECCS) pumps switch suction to the containment recirculation sump, as described in Section 6.3.2. Switchover for the spray pumps is manually initiated when the low-low-2 level in the RWST is reached. The low-low-2 level alarm ensures that the system piping remains full of water and that adequate NPSH for the spray pumps is maintained. The RWST low-low-2 level alarms and level indicators inform the operator of the need to make this switchover.

The time length of the containment spray injection phase is given in Table 6.2.2-4. These times are based on the minimum RWST volume and are given for credible combinations of minimum and maximum containment spray and ECCS operation and runout flow rates of these pumps. The containment spray additive design flow rate is given in Table 6.5-2.

RECIRCULATION PHASE - The recirculation phase initiated by the operator manually shifting containment spray pump suction from the RWST to the containment recirculation sump. The accident chronology for the containment spray system for the recirculation phase of a LOCA is provided in Table 6.2.2-3.

The RWST suction line valves remain open during the switchover to the recirculation phase to preclude the loss of supply to the containment spray pumps in the highly unlikely event that the isolation valve in the recirculation line is delayed in opening. The operator then remote manually closes the motor-operated valves in the RWST suction lines. If the predetermined amount of spray additive defined in Section 6.5.2 has been added, a permissive signal from the spray additive tank level switches allows the operator to remote manually close the motor-operated valves in the spray additive supply lines to the containment spray additive eductor. If this minimum level in the spray additive tank has not been reached, the valves cannot be manually closed.

The suction line from the containment recirculation sump to the spray pump is a sloped line which precludes air from entering the system. The single valve in the containment sump recirculation line for the containment spray pump is encapsulated and located outside the containment. The flow paths from the spray pumps are the same as in the injection phase. Check valves are provided in the recirculation sump suction lines to prevent the establishment of a flow path between the RWST and the containment sump.

Containment spray in the recirculation mode maintains an equilibrium temperature between the containment atmosphere and the recirculation sump water. The length of time that the CSS operates during the recirculation phase is determined by the operator. The spray cannot be terminated until completion of the injection phase.

6.2.2.1.3 Safety Evaluation

Safety evaluations are numbered to correspond to the safety design basis.

SAFETY EVALUATION ONE - The safety-related portions of the CSS are located in the reactor and auxiliary buildings. These buildings are designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles, and other appropriate natural phenomena. Sections 3.3, 3.4, 3.5, 3.7(B), and 3.8 provide the basis for the adequacy of the structural design of these buildings.

SAFETY EVALUATION TWO - The safety-related portions of the CSS are designed to remain functional after a SSE. Sections 3.7(B).2 and 3.9(B) provide the design loading conditions that were considered. Section 3.6 provides the hazards analysis to assure that the system performs its intended function.

SAFETY EVALUATION THREE - There are two spray system trains with complete redundancy of active components. Each train is capable of providing full design flow and cooling. In the event of the failure of a pump, valve, actuation system, or any other component in one train, the other train would be unaffected. To assure that a single failure will neither initiate a spurious containment spray nor prevent the activation of a necessary component, the containment spray pumps and containment header valves are actuated by the independent containment spray actuation signal (CSAS). The containment spray additive tank and refueling water storage tank are common to the two trains. Redundant level indication for each of these tanks is provided. No power-operated valve is installed in the common suction lines from the tanks so that it is impossible for an active failure to disable both trains during the injection phase. Single failure analysis for the CSS is given in Table 6.2.2-5 and for the spray additive subsystem in Table 6.5-4.

The emergency power supply pump room cooling and control and instrumentation systems serving one train are independent of comparable supporting systems for the other train. All vital power can be supplied from either onsite or offsite power systems, as described in Chapter 8.0. Minimum availability of the CSS is discussed in Technical Specifications.

SAFETY EVALUATION FOUR - The CSS is initially tested with the program given in Chapter 14.0. Functional testing is done in accordance with Section 6.2.2.1.4.

Section 6.6 provides the ASME Boiler and Pressure Vessel Code, Section XI requirements that are appropriate for the CSS.

SAFETY EVALUATION FIVE - Section 3.2 delineates the quality group classification and seismic category applicable to the safety-related portion of this system and supporting systems. Section 6.2.2.1.2.2 shows that safety-related components meet the design and fabrication codes given in Section 3.2. All the power supplies and the control functions necessary for the safe function of the CSS are Class IE, as described in Chapters 7.0 and 8.0.

SAFETY EVALUATION SIX - Section 6.2.2.1.2.1 describes provisions made to identify and isolate leakage or malfunction and to isolate the nonsafety-related portions of the system.

SAFETY EVALUATION SEVEN - Sections 6.2.4 and 6.2.6 provide the safety evaluation for the system containment isolation arrangement and testability.

SAFETY EVALUATION EIGHT - As shown by the containment analysis and the description of the analytical methods and models given in Section 6.2.1, the containment spray system, in conjunction with the emergency core cooling system and the containment fan coolers, is capable of removing sufficient heat energy and subsequent decay heat from the containment atmosphere following the hypothesized LOCA and MSLB inside the containment to maintain the containment pressure below the design pressure. Curves showing sump temperature, heat generation rates, heat removal rates of the containment heat removal systems, and containment total pressure, vapor pressure, and temperature as a function of time for minimum engineered safety features performance are also given in Section 6.2.1.

During the injection phase, all pressure transient analyses take credit for a spray system capable of delivering borated 100°F spray water at the design flow rate. For the design basis LOCA and MSLB accident, credit is taken for spray flow initiation within 60 seconds.

A minimum water volume of 394,000 gallons is maintained in the RWST to ensure that, after a LOCA, sufficient water is injected for emergency core cooling and for rapidly reducing the containment pressure and temperature. In addition, this volume ensures that sufficient water is available in the containment sump to permit recirculation flow to the core and the containment and to meet the NPSH requirements of the residual heat removal and containment spray pumps and assures that a sufficient water volume is available in the RWST to allow for manual switchover of the containment spray pumps.

For the recirculation phase, while the safety injection system pumps are still operating after a LOCA, containment pressure transient analysis in Section 6.2.1 assumes residual heat removal by heat exchangers, as described in Section 5.4.7. Credit is taken for heat removal from heat exchangers during the recirculation phase based on a tube side inlet temperature equal to the recirculation sump temperature, which is given in Section 6.2.1 as a function of time after the accident.

Each spray header train provides a minimum of 90-percent area coverage at the operating deck, as demonstrated in Figure 6.2.2-4. Area coverage by these spray nozzles varies as a function of saturation temperature. The design basis coverage for the nozzles at various orientations is provided in Table 6.5-2 and is based on the calculated containment saturation temperature. Figure 6.5-4 provides the curve of the containment spray envelope reduction factor to determine the design basis coverage. The minimum of 90-percent area coverage at the operating deck is used as a layout guide for the location of the spray nozzles on the containment spray headers to assure 100-percent volumetric coverage above the operating floor of the containment. Physical obstructions, such as the containment polar crane, are not considered to impede the spray coverage due to the extreme turbulence created by the containment air coolers, the spray within the containment, and the blowdown resulting from the postulated rupture. Thus, the header layout coupled with the extreme turbulence assures the validity of a one-region model above the operating deck for accident dose calculations (see Chapter 15.0).

Discussion of the volume of containment covered by the sprays is provided in Section 6.5.2.

SAFETY EVALUATION NINE - That part of the CSS located inside the containment is designed to remain operable in the containment accident environment described in Section 3.11(B). The material compatibility of the containment spray system in contact with the post-accident recirculation fluids is discussed in Section 6.1. That part of the CSS located in the auxiliary building is designed to remain operable in the auxiliary building accident environment described in Section 3.11(B).

SAFETY EVALUATION TEN - The basic borate spray solution is stable under the anticipated LOCA thermal and radiolytic conditions. The borate solution is chemically compatible with components with which it may come into contact. The use of materials which react with sodium hydroxide to release hydrogen (principally zinc and aluminum) has been minimized in equipment located inside the containment. An analysis of hydrogen generation following a LOCA is given in Section 6.2.5.

SAFETY EVALUATION ELEVEN - System piping size and layout provides adequate NPSH to the containment spray pump during all anticipated operating conditions, in accordance with Regulatory Guide 1.1. In calculating available NPSH, the conservative assumption has been made that the water in the containment sump after a design basis LOCA is a saturated liquid, and no credit has been taken for anticipated subcooling. That is, although NPSH = elevation head + (containment pressure - liquid vapor pressure) - suction line losses, the (containment pressure - liquid vapor pressure) term has been assumed to be zero. Calculated NPSH exceeds required NPSH by at least 10 percent. The recirculation piping penetrating the containment sumps is nearly horizontal to minimize vortexing. In addition, a vortex breaker is provided in the inlet of the piping from the sump.

In calculating the water level within the reactor building which contributes to the NPSH available to the containment spray pumps at the beginning of its recirculation phase, consideration has been given to the potential mechanisms of water loss within the reactor building. These water loss mechanisms include water present in the vapor phase, water loss to compartments below El. 2,000, water loss above El. 2,000, and water loss due to wetted surfaces. Tables 6.2.2-6 and 6.2.2-6a identify each water source which releases water to the reactor building and its associated mass and each potential water loss mechanism and the volume of water not assumed to contribute to the water level within the containment for a large LOCA and a MSLB, respectively. The static head available to contribute to the NPSH of the pump, suction line losses, and the minimum NPSH available are also given in Table 6.2.2-7. The CSS pump NPSH versus flow is shown in Figure 6.2.2-5. The reduction in water level due to potential water loss mechanisms is considered in the calculated NPSH available.

SAFETY EVALUATION TWELVE - Recirculation sump construction provides straining down to 0.045-inch strainer hole size to prevent entrained particles in excess of that size from entering the containment recirculation sump and containment spray system suction piping. Restrictions in the reactor core channels and ECCS throttle valves are the minimum restrictions and, therefore, the basis of the strainer hole opening size.

Since the containment spray pumps are designed to operate with entrained particles up to 1/4 inch in diameter and the minimum constriction size in the spray nozzles is 7/16 inch, this strainer hole size is adequate to assure proper system operability.

Each strainer provides sufficient NPSH to the ECCS pumps to maintain recirculation cooling during an event.

The sump curb does not allow flow into the sump below 6 inches above the concrete floor level surrounding the sump. This arrangement leaves ample depth for buildup of high-density debris without affecting sump performance. Additionally, the velocity of recirculated fluids approaching the curb will be between 0.01 and 0.08 fps for all modes of operation following a LOCA or MSLB, and thus a low velocity settling region for high-density particles is provided. Table 6.2.2-9 provides flow velocities at several times and locations for a large LOCA and an MSLB.

Any debris which eludes the curb passes into the sump through the 0.045 inch perforated plate and will be drawn into the suction piping for the containment spray and residual heat removal systems. Such debris is small enough to pass through any restrictions in the ECCS throttle valves, the Containment Spray System, or the reactor vessel channels, and will eventually be pumped back into the containment.

A comparison of the containment recirculation sump design features with each of the positions of Regulatory Guide 1.82, "Sump for Emergency Core Cooling and Containment Spray Systems," is provided in Table 6.2.2-1.

6.2.2.1.4 Tests and Inspections

Testing and inspection of components of the CSS, except those in the spray additive subsystem, are discussed in this section. Testing and inspection of components in the spray additive subsystem are discussed in Section 6.5.2.4.

Each containment spray pump has a shop test to generate complete performance curves. The test includes verifying total differential developed head (TDH), efficiency and brake horsepower for various flow rates. An NPSH test for various flow rates was performed on one pump. A shop thermal transient analysis, from ambient temperature to 350 F in 10 seconds, has been performed on the CSS pump. Results of that analysis assure that the design is suitable for the switchover from the injection to the recirculation phase.

The strainer configuration on the containment recirculation sumps is shop tested to verify that all design requirements are adequately met.

The spray nozzles' design parameters were verified with prototype tests in the vendor's shop. Results of those test are provided in Section 6.5.2.2.2.

PREOPERATIONAL TESTING - Instruments are calibrated prior to system preoperational testing. Alarm functions are checked for operability and limits during preoperational testing. The flow paths and flow capacities of all components are verified during preoperational tests.

The functional test of the ECCS, described in Section 6.3, demonstrates proper transfer to the emergency diesel generator power source in the event of a loss of power. A test signal simulating the containment spray signal is used to demonstrate the operation of the spray system up to the isolation valves on the pump discharge. The isolation valves are closed for the test. These isolation valves are functionally tested separately.

The spray header nozzle performance is verified during the preoperational testing by blowing air through the nozzles and observing the movement of the telltales.

The objectives of preoperational testing are to:

a. Demonstrate that the system is adequate to meet the design pressure and temperature conditions. Components are tested in conformance with applicable codes.

b. Demonstrate that the spray nozzles in the containment spray header are clear of obstructions by passing air through them, utilizing test connections.

c. Verify that the proper sequencing of valves and pumps occurs on initiation of the CSS and demonstrate the proper operation of remotely operated valves.

d. Verify the operation of the spray pumps. Each spray pump is operated at full flow to verify that it meets the design curve generated during shop testing. Both design point and runout flow rates are utilized to verify that the pump performance is within design. In addition, each spray pump is operated at minimum flow, which is directed back to the refueling water storage tank. A flow orifice is provided to regulate minimum flow to that required for routine testing.

The sump strainers have been evaluated for vortex formation, air ingestion and void fraction, and the results were determined to be acceptable. In addition, head loss testing was performed on the strainers. Data from these tests together with known pressure drops across suction lines and valves (determined using standard engineering calculations) verified that the available net positive suction head is adequate.

Further details of each test which was performed are discussed in Chapter 14.0.

OPERATIONAL TESTING - The CSS is designed to permit periodic determination of proper system operability, as specified in the Technical Specifications. The objectives of operational testing are to:

a. Verify that the proper sequencing of valves and pumps occurs on initiation of the containment spray signal and demonstrate the proper operation of remotely operated valves.

b. Verify the operation of the spray pumps. Each pump is run at full flow and the flow is directed back to the pump suction or the RWST.

To assure the structural and leaktight integrity of components, the operability and performance of the active components, and the operability of the system as a whole, the system is periodically tested up to the last isolation valve before the containment penetration. The testing is accomplished by using a recirculation line back to the RWST, or a test line between each pumps suction and discharge, which allows a flow path to achieve full flow testing. During the full flow test alignment, some flow can be directed back to the RWST as needed for a heat sink. Sodium hydroxide is not sent to the RWST so the eductor subsystem is to be tested by other means, as discussed in Section 6.5.2. All instrumentation will also be periodically checked and calibrated. The CSS actuation is verified as follows:

a. A containment spray actuation signal (CSAS) subchannel is actuated during normal operation to start the containment spray pump.

b. A separate CSAS slave relay is actuated during normal reactor operation to ensure the opening of the containment header valves. The CSS pump is not operating.

A visual inspection is performed to verify that no loose debris (rags, trash, clothing, etc.) is present in the containment which could be transported to the containment sump and cause restriction of the pump suctions during LOCA conditions. Visual inspections are performed:

a. for all accessible areas of the containment prior to establishing containment operability, and

b. at least once daily of the areas affected within containment by containment entry and during the final entry when containment operability is established.

6.2.2.1.5 Instrumentation Requirements

The CSS instrumentation was designed to facilitate automatic operation, remote control, and continuous indication of system parameters. Discussion of instrumentation in the spray additive subsystem is provided in Section 6.5.2.5.

The containment has redundant analog level channels for sump recirculation with indication and alarms in the control room.

These circuits aid the operator in determining the presence and rate of increase of the sump water level.

All system motor-operated valves have position indication provided in, and are operable from, the control room. This allows the operator to continuously monitor system status and remotely operate valves, as necessary. Details of the design and logic of the instrumentation are discussed in Chapter 7.0.

6.2.2.1.6 Materials

The CSS is constructed primarily of corrosion-resistant austenitic stainless steel and contains none of the restricted materials discussed in Section 6.1.1.1.2.

Construction materials for components in the CSS, except for components in the spray additive subsystem, are provided in Table 6.2.2-2. Discussion of construction materials for components in the spray additive subsystem is provided in Table 6.5-3.

Further discussion of the materials associated with the CSS, including containment spray fluid chemistry, is given in Section 6.5.2.6.

6.2.2.2 Containment Cooling System

The containment cooling system (CtCS), in conjunction with the containment HVAC systems described in Section 9.4.6, functions during normal plant operation to maintain a suitable atmosphere for equipment located within the containment. Subsequent to a DBA within the containment, the containment cooling system provides a means of cooling the containment atmosphere to reduce pressure and thus reduce the potential for containment leakage of airborne and gaseous radioactivity to the environment.

6.2.2.2.1 Design Bases

6.2.2.2.1.1 Safety Design Bases

The CtCS, excluding the system ductwork downstream of the cooler discharge plenum, is safety related and required to function following a DBA to achieve and maintain the plant in a safe shutdown condition.

SAFETY DESIGN BASIS ONE - The CtCS is protected from the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, or external missiles (GDC-2).

SAFETY DESIGN BASIS TWO - The CtCS is designed to remain functional after a safe shutdown earthquake or to perform its intended function following a postulated hazard, such as a fire, internal missile, or pipe break (GDC-3 and 4).

SAFETY DESIGN BASIS THREE - Safety functions can be performed, assuming a single active component failure coincident with the loss of offsite power (GDC-38).

SAFETY DESIGN BASIS FOUR - Active components are capable of being tested during plant operation. Provisions are made to allow for inservice inspection of components at appropriate times specified in the ASME Boiler and Pressure Vessel Code, Section XI (GDC-39 and 40).

SAFETY DESIGN BASIS FIVE - The CtCS is designed and fabricated to codes consistent with the quality group classification assigned by Regulatory Guide 1.26 and the seismic category assigned by Regulatory Guide 1.29. The power supply and control functions are in accordance with Regulatory Guide 1.32.

SAFETY DESIGN BASIS SIX - The capability of isolating components, systems, or piping is provided, if required, so that the system's safety function is not compromised. This includes the bypassing of the nonsafety-related ductwork portions of the system.

SAFETY DESIGN BASIS SEVEN - The CtCS, in conjunction with the CSS, is capable of removing sufficient heat energy and subsequent decay heat from the containment atmosphere following the LOCA or MSLB accident to maintain the containment pressure below design values.

Section 6.2.1, Containment Functional Design, provides the assumptions as to sources and amounts of energy considered and the analyses of the containment pressure transient following a LOCA or an MSLB accident inside the containment. Actual containment fan cooler system parameters are such that those used in the analyses are equal to or more conservative than the actual containment fan cooler system capability.

SAFETY DESIGN BASIS EIGHT - The containment coolers, including the fan/motor combination, remain operable in the accident environment.

SAFETY DESIGN BASIS NINE - The containment coolers, in conjunction with Essential Service Water System (ESWS), provides sufficient heat energy to maintain the ESWS inlet trash racks from being blocked with frazil ice.

6.2.2.2.1.2 Power Generation Design Bases

POWER GENERATION DESIGN BASIS ONE - The containment cooling system, operating in conjunction with the containment heating, ventilating, and air-conditioning system described in Section 9.4.6, is designed to limit the ambient containment air temperature during normal plant operation to 120°F. During normal plant operations, the hydrogen mixing fans are designed to provide sufficient air flow through the steam generator compartments so that a suitable environment for the equipment in the steam generator compartment can be maintained.

6.2.2.2.2 System Description

6.2.2.2.2.1 General Description

The containment cooling system provides cooling by recirculation of the containment air across air-to-water heat exchangers. The bulk of this cooled air is supplied to the lower regions of the steam generator compartments. The remaining air is supplied to the instrument tunnel and at each level (operating floor and below) of the containment outside the secondary shield wall. The air supplied to each steam generator compartment is drawn upwards through the compartments by the hydrogen mixing fans and discharged into the upper elevations of the containment.

6.2.2.2.2.2 Component Description

Design parameters for the major components of the containment cooling system are provided in Table 6.2.2-2.

CONTAINMENT COOLER FAN - The containment cooler fans are located vertically in the bottom of the cooler housing. Fans are vaneaxial fans with two-speed motors. The fans and motors are designed for high-speed operation during normal plant operations and for low-speed operation under post-LOCA conditions.

CONTAINMENT COOLER HOUSING/DISCHARGE PLENUM - The containment cooler housing and discharge plenums are constructed of structural steel framework and galvanized steel coverings.

The containment cooler housing, including the section of ductwork containing the fusible link plates, is designed to sustain a differential pressure of 2 psi during pressure transients associated with accident conditions. An analysis which was performed to establish the differential pressure across the cooler housing indicates the maximum differential to be less than 0.1 psi (2.8 in. w.g.) under accident conditions. Ductwork was not considered in the analysis since it is designed to separate from the cooler by action of the fusible link plates. The fusible link plates are steel plates which are hinged to the ductwork and held in a closed position by the fusible links (typical detail is shown in Figure 6.2.2-6). The plates employ a release mechanism so that after fusion of the links the plates release from the ductwork. The fusible links are designed to release at a temperature of approximately 160°F. The open area vacated by the plates exceeds the cross-sectional area of the fan, thus providing an unrestricted flow path.

6.2.2.2.2.3 System Operation

NORMAL OPERATION - Containment coolers are operated as required to provide containment cooling capabilities, of approximately 9.2 x 10^6 Btu/hr. In hot weather, four coolers are normally operated at high speed to maintain proper air flow distribution. During cold weather some fans may be operated at slow speed or switched off, but in all conditions at least one fan cooler in each train is maintained in operation in Modes 1 through 4 to assure heat input to the ESW system adequate to prevent frazil ice from blocking the ESW intakes during certain winter weather conditions. The coolers are normally operating with service water providing flow to the coils. The coil heat removal capabilities were designed assuming a tube fouling factor of 0.002.

Condensate from the fan cooler coils is collected and measured to detect leaks into the containment atmosphere, as discussed in Section 5.2.5.

PLANT SHUTDOWN/REFUELING - The containment coolers may be operated during shutdown/refueling operations to provide supplemental air distribution within the containment. The containment cooler fans may be operated at low speed to reduce noise levels within the containment during this mode of operation. The coolers may be operated with the service water to provide supplemental cooling or without service water for supplemental heating by utilizing the motor heat load.

CONTAINMENT INTEGRATED LEAK RATE TESTING - The containment coolers may be operated during containment integrated leak rate testing (ILRT) to control containment temperature. The coolers are operated with service water to provide cooling and without service water to provide heating, by utilizing the motor heat load, during the test procedure. The fans are operated at low speeds during this elevated pressure condition to prevent motor overload.

POSTACCIDENT OPERATION - Following an SIS, the fans are designed to start automatically in slow speed if not already running. If running in high (normal) speed, the fans automatically shift to slow speed. Assuming loss of offsite power, the containment cooler fans are started 45 seconds after generation of the SIS.

To compensate for the reduced air flow over the coils and to maximize heat removal, the cooling water flow through the cooling coils for each unit is automatically increased from 925 gpm to 1,000 gpm upon receipt of a SIS. The fusible link plates open to allow unrestricted flow through the air coolers. Under design accident conditions, each containment cooler is capable of removing at least the amount of heat assumed in the containment P/T response analysis as shown on Figure 6.2.1-15. The coil heat removal capabilities were designed assuming a tube fouling factor of 0.002.

The fan can be operated from the control room at any time, but cannot be manually operated at high speed if a containment high pressure signal is in effect in order to prevent motor overload.

The postaccident air-distribution system is designed to discharge the air from each unit through the opening left by the fusible link plate. The fusible link plates are steel plates which are hinged to the ductwork and held in a closed position by the fusible links. The plates employ a release mechanism, using counterbalance weights to ensure that after fusion of the links the plates will release from the ductwork without the aid of the fan head and against the pressure differential established during the pressure transient. The fusible links are designed to release at a temperature of approximately 160°F. The open area vacated by the plates approximately equals the cross-sectional area of the fan, thus providing an unrestricted flow path.

Under design conditions, it is assumed that the existing ductwork is restricted so that all the air is discharged through this opening. Under these conditions, the throw is approximately 100 feet. Thus, the discharge from the units is well beyond their intake regions, preventing any short circuiting. The air streams drop off toward the end of the throw and tend to settle toward the bottom of the containment due to the slightly lower temperatures and the air flow patterns established by natural convection caused by post accident conditions inside the containment (Ref. 26). The volume of air recirculated in one hour by the combined air flows of one train of the containment coolers is approximately three times the containment free volume. These air flow patterns and recirculation volumes provide adequate circulation and, therefore, sufficient post accident mixing of the containment atmosphere.

6.2.2.2.3 Safety Evaluation

Safety evaluations are numbered to correspond to the safety design bases in Section 6.2.2.2.1.

SAFETY EVALUATION ONE - The safety-related portions of the containment cooling system are located in the reactor building. This building is designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles, and other appropriate natural phenomena. Sections 3.3, 3.4, 3.5, 3.7(B), and 3.8 provide the bases for the adequacy of the structural design of these buildings.

SAFETY EVALUATION TWO - The safety-related portions of the containment cooling system are designed to remain functional after a SSE. Sections 3.7(B).2 and 3.9(B) provide the design loading conditions that were considered. Sections 3.5 and 3.6 provide the hazards analyses to assure that a post accident safe shutdown, as outlined in Section 7.4, can be achieved and maintained.

SAFETY EVALUATION THREE - The system description for the containment cooling system shows that complete redundancy is provided and, as indicated by Table 6.2.2-8, no single failure will compromise the system's safety functions. All vital power can be supplied from either onsite or offsite power systems, as described in Chapter 8.0.

SAFETY EVALUATION FOUR - The containment cooling system is initially tested with the program given in Chapter 14.0. Periodic inservice functional testing is done in accordance with Section 6.2.2.2.4.

Section 6.6 provides the ASME Boiler and Pressure Vessel Code, Section XI requirements that are appropriate for the containment cooling system.

SAFETY EVALUATION FIVE - Section 3.2 delineates the quality group classification and seismic category applicable to the safety-related portion of this system and supporting system. All the power supplies and control functions necessary for safe function of the containment cooling system are Class IE, as described in Chapters 7.0 and 8.0.

SAFETY EVALUATION SIX - Section 6.2.2.2.2.3 describes provisions made to allow the bypassing of the nonsafety-related ductwork portions of the system.

SAFETY EVALUATION SEVEN - As shown by the containment analysis and the description of the analytical methods and models given in Section 6.2.1, the containment cooling system, in conjunction with the containment spray system, is capable of removing sufficient energy and subsequent decay heat from the containment atmosphere following the hypothesized LOCA or MSLB accident inside the containment to maintain the containment below the design pressure. Both analyses assume the single failure which results in the minimum containment cooling capability.

Curves showing sump temperature, heat generation rates, heat removal rates of the containment heat removal systems, and containment total pressure, vapor pressure, and temperature as a function of time for minimum engineered safety features performance are given in Section 6.2.1. The containment cooler heat removal rates as a function of containment temperature and pressure are given in Figure 6.2.1-15. This data has been furnished by American Air Filter and is supported by their topical report (Ref. 10). A constant essential service water temperature of 95°F at the coil inlet has been assumed. This is the maximum conservatively calculated temperature that would exist at any time during the accident. The assumptions used in calculating this temperature are discussed in Section 9.2.5.

SAFETY EVALUATION EIGHT - The containment cooler fan/motor combination is qualified to operate during the DBA, in accordance with IEEE-334, 1974. Section 6.2.2.2.2.2 provides the basis for the assumption of structural integrity of the cooler housing and discharge plenum during a DBA. American Air Filter (Ref.10) demonstrates the compatibility of the housing and plenum materials with the DBA environment.

SAFETY EVALUATION NINE - As described in Section 9.2.1.2.2.3 and Table 9.2-25, the containment cooling system supports the ESWS by providing part of the heat energy needed to maintain the ESWS inlet trash racks from being blocked with frazil ice.

6.2.2.2.4 Tests and Inspections

Preoperational Chapter 14.0. One containment cooler fan is tested in accordance with AMCA Standard testing is described in Test Code 211, "Certified Rating for Air-Moving Devices."

The analytical data used to predict coil performance for both normal and DBA conditions are based upon the tests and data in Reference 10.

Major components are accessible during normal plant operation for inspection, maintenance, and periodic testing.

6.2.2.2.5 Instrumentation Applications

Each containment cooler is monitored for leaving air temperature via the plant computer. Each containment cooler motor is monitored for vibration. In addition, containment air temperature will also be monitored in the area of each containment cooler intake. Direct control room indication is provided for the inlet air temperatures. The leaving air temperature can be displayed in the control room via the plant computer.

Each containment cooler fan is operable from the control room.

6.2.3 SECONDARY CONTAINMENT FUNCTIONAL DESIGN

Based on the fission product removal and control systems discussed in Section 6.5 and the radiological consequences analyzed in Chapter 15.0 following a LOCA, no secondary containment is required for WCGS.

6 2.4 CONTAINMENT ISOLATION SYSTEM

The containment isolation system allows the normal or emergency passage of fluids through the containment boundary while preserving the ability of the boundary to minimize the release of fission products following a LOCA or fuel handling accident within the containment.

6.2.4.1 Design Bases

6.2.4.1.1 Safety Design Bases

SAFETY DESIGN BASIS ONE - The containment isolation system is protected from the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, and external missiles (GDC-2).

SAFETY DESIGN BASIS TWO - The containment isolation system is designed to remain functional after a safe shutdown earthquake and to perform its intended function following the postulated hazards of fire, internal missiles, or pipe breaks (GDC-3 and 4).

SAFETY DESIGN BASIS THREE - The containment isolation system is designed and fabricated to codes consistent with the quality group classification assigned by Regulatory Guide 1.26 and the seismic category assigned by Regulatory Guide 1.29. The power supply and control functions are in accordance with Regulatory Guide 1.32.

SAFETY DESIGN BASIS FOUR - Piping systems penetrating the primary reactor containment are provided with leak detection, isolation, and containment capabilities having redundancy, reliability, and performance capabilities which reflect the importance to safety of isolating these piping systems. Such piping systems are designed with a capability to periodically test the operability of the isolation valves and associated apparatus and to determine if valve leakage is within acceptable limits (GDC-54).

SAFETY DESIGN BASIS FIVE - Each line that is part of the reactor coolant pressure boundary and that penetrates the primary reactor containment is provided with containment isolation valves as follows:

a. One locked closed isolation valve inside and one locked closed isolation valve outside the containment; or

b. One automatic isolation valve inside and one locked closed isolation valve outside the containment; or

c. One locked closed isolation valve inside and one automatic isolation valve outside the containment. A simple check valve is not used as the automatic isolation valve outside the containment; or

d. One automatic isolation valve inside and one automatic isolation valve outside the containment. A simple check valve is not used as the automatic isolation valve outside the containment; or

e. Some other defined bases that meet the intent of containment isolation as an alternative to a through d above.

Isolation valves outside the containment are located as close to the containment as practical and, upon loss of actuating power, automatic isolation valves are designed to take the position that provides the greater safety (GDC-55).

SAFETY DESIGN BASIS SIX - Each line that connects directly to the containment atmosphere and penetrates the primary reactor containment is provided with containment isolation valves as follows:

a. One locked closed isolation valve inside and one locked closed isolation valve outside the containment; or

b. One automatic isolation valve inside and one locked closed isolation valve outside the containment; or

c. One locked closed isolation valve inside and one automatic isolation valve outside the containment. A simple check valve is not used as the automatic isolation valve outside the containment; or

d. One automatic isolation valve inside and one automatic isolation valve outside the containment. A simple check valve is not used as the automatic isolation valve outside the containment; or

e. Some other defined bases that meet the intent of containment isolation, as an alternative to a through d above.

Isolation valves outside the containment are located as close to the containment as practical and, upon loss of actuating power, automatic isolation valves are designed to take the position that provides greater safety (GDC-56).

SAFETY DESIGN BASIS SEVEN - Each line that penetrates the primary reactor containment and is neither part of the reactor coolant pressure boundary nor connected directly to the containment atmosphere h as:

a. At least one containment isolation valve which is either automatic, locked closed, or capable of remote manual operation; or

b. Some other defined bases that meet the intent of containment isolation as an alternative to a above.

Valves are outside the containment and located as close to the containment as practical. A simple check valve is not used as the automatic isolation valve. For a closed system, the design is commensurate with quality group B (GDC-57).

SAFETY DESIGN BASIS EIGHT - The containment isolation system, in conjunction with other plant features, serves to minimize the release of fission products generated following a LOCA or fuel handling accident within the containment.

6.2.4.1.2 Power Generation Design Basis

The containment isolation system has no power generation design basis.

6.2.4.2 System Description

6.2.4.2.1 General Description

Each piping system which penetrates the containment is provided with containment isolation features which serve to minimize the release of fission products following a LOCA or fuel handling accident. Provisions are made to allow for passage of emergency fluid through the boundary following a postulated accident. Figure 6.2.4-1 provides the arrangement for each piping penetration, along with design information and justification of how the appropriate General Design Criteria are met. NRC SRP 6.2.4 and Regulatory Guide 1.141 provide acceptable alternative arrangements to the explicit arrangements given in GDC-55, 56, and 57. Each penetration is provided with a redundant barrier so that in the event that a single failure is postulated and one barrier does not perform as intended the containment integrity is maintained. Table 6.2.4-1 lists each penetration under the appropriate GDC and provides a reference to the section that describes the system of which the containment penetration is an integral part.

Piping penetration sleeves have been assigned numbers P-1 through P-17 and P-21 through P-104. Numbers P-18, 19, and 20 were not utilized. The fuel transfer tube was assigned to P-17; however, this is not a true piping penetration since it utilizes a blind flange which serves as the containment boundary and is subject to Type B testing. Penetrations 36 and 68 have been assigned to outage activities. They utilize a bolted flange closure and are subject to Type B testing. The remainder of the "P" numbers between 1 and 104 not appearing on Figure 6.2.4-1 are spare sleeves to which closure heads have been permanently attached, as shown in Figure 3.8-47. These penetration sleeves include P-31, 33, 35, 37, 38, 46, 47, 50, 60, 61, 72, 77, 81, 94, 96, 100, and 102. The leaktight integrity of the sleeve and closure head is verified during the periodic Type A tests.

For those systems which have automatic isolation valves or for which remote manual isolation is provided, Section 6.2.4.5 describes the vital power supply and associated actuation system.

Two phases of valve actuation are considered in Figure 6.2.4-1. The actuation signal which occurs directly as a result of the event initiating containment isolation is designated as the primary actuation signal. The primary valve position is a consequence of the primary actuation signal. If a change in valve position is required at any time following primary actuation, a secondary actuation signal is generated which places the valve in the secondary position.

The closure times for automatic isolation valves are provided in Figure 6.2.4-1. The containment purge system provides a direct path between the containment and outside atmospheres. As described in Section 9.4, the 18-inch 4,000 cfm minipurge lines may be open during normal plant operation and during shutdown condition and are provided with isolation valves capable of three-second closure. The 36-inch 20,000 cfm purge lines are open only during a shutdown condition and are provided with an isolation valve capable of 10-second closure. An analysis of the radiological consequences and the effect on the containment backpressure due to the release of containment atmosphere are discussed in Section 6.2.1.5 and Chapter 15.0.

In the event of a LOCA, the secondary shield wall prevents any missiles or jet impingement from damaging or degrading the performance capability of containment isolation. Sections 3.5 and 3.6 discuss in detail the missiles and pipe break effects, and Section 3.8 discusses the internal structures, including the secondary shield wall. The operators for all power-operated containment isolation valves inside the containment are located above the maximum water level, following a LOCA. In addition, lines associated with those penetrations which are considered closed systems inside the containment are protected from the effects of a LOCA.

Provisions are made to ensure that closure of the containment isolation valves is not inhibited by entrapped debris in the valve body. For the majority of the systems, the fluid is demineralized water; thus quality does not affect valve operation. For containment purge lines, screens are provided in the lines upstream of the isolation valves. For the containment sump lines, including the emergency sump, a provision is provided to prevent large debris from entering the system.

Some other defined bases for containment isolation are provided in NRC SRP 6.2.4 and Regulatory Guide 1.141. Compliance with Regulatory Guide 1.141 is provided to the extent specified in Table 6.2.4-2. For the ECCS and containment spray system penetrations, the acceptability of the alternative arrangement relies upon provisions for the detection of possible leakage from these lines outside the containment. Section 9.3.3 describes the leak detection provisions that have been made in the plant drainage system. Other provisions, such as containment water level and system flow, temperature, and pressure instrumentation, may be used by the operator.

In addition to containment isolation, Figure 6.2.4-1 also contains systems which are required for post-LOCA mitigation. Since these systems, such as the ECCS, perform additional safety-related functions, they are associated with engineered safety features and are so indicated on Figure 6.2.4-1. Because these systems are required to operate for post-LOCA mitigation and because they are closed systems external to the containment, the length of the piping between the containment and the system outside the isolation valves is not shown.

6.2.4.2.2 Component Description

Codes and standards applicable to the piping and valves associated with containment isolation are listed in Table 3.2-1. Containment penetrations are classified as quality group B and seismic Category I.

Section 3.11 provides the post-LOCA environment that is used to qualify the operability of power-operated isolation valves located inside the containment.

The containment penetrations are designed to meet the stress requirements of NRC BTP MEB 3-1 and the classification and inspection requirements of NRC BTP APCSB 3-1, as described in Section 3.6. Section 3.8 discusses the interface between the piping system and the containment liner.

6.2.4.2.3 System Operation

During normal operation, many penetrations are not isolated. Lines which are not required for the passage of emergency fluids are automatically isolated upon receipt of isolation signals, as discussed in Sections 6.2.4.5 and 7.0. Other open lines to the containment can be isolated subsequent to the LOCA by remote-manual operation when dictated by the emergency system functional requirements. Lines not in use during power operation are normally closed, and remain closed under Technical Specification, administrative control during reactor operation; refer to Section 6.2.4.4 for a further discussion.

Upon detection of high radioactivity indicative of a fuel handling accident during refueling, the isolation valves in the containment purge system are closed to minimize any fission product release to the environment.

6.2.4.3 Safety Evaluation

Safety evaluations are numbered to correspond to the safety design bases in Section 6.2.4.1.1.

SAFETY EVALUATION ONE - The piping and valves associated with the containment isolation system are located in the reactor and auxiliary buildings. These buildings are designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles, and other appropriate natural phenomena. Sections 3.3, 3.4, 3.5, 3.7(B), and 3.8 provide the bases for the adequacy of the structural design of these buildings.

SAFETY EVALUATION TWO - The piping and valves associated with the containment isolation system are designed to remain functional after a safe shutdown earthquake. Sections 3.7(B).2, 3.9(B), and 3.9(N) provide the design loading conditions that were considered. Sections 3.5 and 3.6 provide the hazards analyses to assure that a post accident safe shutdown, as outlined in Section 7.4, can be achieved and maintained.

SAFETY EVALUATION THREE - Section 3.2 delineates the quality group classification and seismic category applicable to the safety-related portion of this system and supporting systems. Figure 6.2.4-1 shows that the components meet the design and fabrication codes given in Section 3.2. All the power supplies and control functions necessary for the safe function of the containment isolation system are Class IE, as described in Chapters 7.0 and 8.0.

SAFETY EVALUATION FOUR - Figure 6.2.4-1 shows the arrangement for each line penetrating the containment and provides the design information that demonstrates that GDC-54 is met. Leak detection capabilities are discussed in Section 9.3.3 and in the system descriptions associated with the applicable penetrations. Tests and inspections for piping penetrations are discussed in Sections 6.2.4.4 and 6.2.6.

SAFETY EVALUATION FIVE - Figure 6.2.4-1 shows the arrangement and justifies compliance with the intent of GDC-55 for lines that are part of the reactor coolant pressure boundary and that penetrate the primary reactor containment. A list of penetrations subject to GDC-55 is provided in Table 6.2.4-1.

SAFETY EVALUATION SIX - Figure 6.2.4-1 shows the arrangement and justifies compliance with the intent of GDC-56 for lines that are connected directly to the containment atmosphere and penetrate the primary reactor containment. A list of penetrations subject to GDC-56 is provided in Table 6.2.4-1.

SAFETY EVALUATION SEVEN - As indicated in Table 6.2.4-1, there are no penetrations which are subject to GDC-57. Note that the containment penetrations associated with the steam generators are not subject to GDC-57, since the containment barrier integrity is not breached. The boundary or barrier against fission product leakage to the environment is the inside of the steam generator tubes, the outside of the steam generator shell, and the outside of the lines emanating from the steam generator shell side. Figure 6.2.4-2 shows the arrangement and justifies compliance with containment isolation.

As shown in Section 18.2.11.2, several portions of the main steam lines are considered essential and do not receive an automatic signal to close. These include the atmospheric relief valves (PV-01, 02, 03, and 04) which receive no signal and the steam supply line isolation valves (HV-05 and 06) to the AFW pump turbines which open on AFAS.

SAFETY EVALUATION EIGHT - Sections 6.2.2, 6.5, and 9.4 and Chapter 15.0 provide an evaluation that demonstrates that the containment isolation system, in conjunction with other plant features, serves to minimize the release of fission products generated following a LOCA or fuel handling accident inside the containment.

6.2.4.4 Tests and Inspections

Preoperational testing is described in Chapter 14.0. The system associated with each penetration is in continuous use or is periodically in use, which demonstrates the system performance and structural and leaktight integrity of its components.

All manual valves which serve as containment isolation valves are locked or sealed closed. The manual valves in the process lines are subject to the surveillance requirements of the Technical Specifications. Manual valves serving as vents, drains, and test connections within the isolation valve envelope are subject to administrative procedures to ensure that they are in the proper position. Since each manual valve is locked or sealed closed, the design meets the recommendations of SRP 6.2.4, Section II.3.f.

The containment isolation system is testable through the operational sequence that is postulated to take place following an accident, including operation of applicable portions of the protection system and the transfer between normal and standby power sources.

The piping and valves associated with the containment penetration are designed and located to permit preservice and inservice inspection in accordance with ASME Section XI, as discussed in Section 6.6.

Each line penetrating the containment is provided with testing features to allow containment leakrate tests in accordance with 10 CFR 50, Appendix J, as discussed in Section 6.2.6.

6.2.4.5 Instrumentation Application

The generation of a CIS-A, SLIS, CIS-B, or CPIS which isolates the appropriate containment isolation valves is described in Section 7.3.

The CPIS serves to isolate the containment purge in the event of a fuel-handling accident or LOCA.

The CIS-A, SLIS, and CIS-B serve to actuate the containment isolation system following a LOCA. A CIS-A signal actuates all power-operated valves which can be immediately closed, since doing so will not increase the potential for damage to the containment equipment, or which are not required to be open for the operation of essential equipment post accident.

SLIS signal actuates appropriate power-operated valves based on system functional requirements, as discussed in the appropriate system description.

As described in Section 9.2.2 and shown on Figure 9.2-15, Sheet 3, CIS-B isolates component cooling water system (CCWS) to the components located within the containment. The CCWS is a seismically designed closed loop system both inside and outside of the containment. A hazards analysis of the system has ensured that the system boundary will remain intact following a LOCA or high energy line break.

Since the CCWS penetrations are classified as essential penetrations (refer to Section 18.2.11.2), isolation of the system is not provided until cooling to the RCPS is no longer warranted. During the short time period following an accident, passive failures are not postulated, and the pressure boundary would remain intact until a CIS-B is received. Also, the radiation monitor on the

CCWS surge tank closes the vent valve on high radiation (refer to Section 9.2.2.5) thus preventing release of radioactivity to the auxiliary building. As described in Section 9.3.3, Class IE level indication is provided in the auxiliary building sumps to help identify any liquid leakage from the CCW system. Figure 7.2-1, Sheet 8, shows the actuation logic for CIS-B. The pressure transmitters which actuate CIS-B also actuate the containment spray system. Diversity for CIS-B is provided in the logic for manual actuation of containment spray, which, when manually actuated, also automatically actuates CIS-B.

For those valves for which automatic closure is not desired, based on the system safety function, remote-manual operation is available from the control room.

Containment isolation valves equipped with power operators and which are automatically actuated may also be controlled individually by positioning hand switches in the control room. Except as noted below, containment isolation valves cannot be repositioned via hand switches in the control room when the automatic containment isolation signal is present. Reset of the automatic signal is required to permit remote manual control of a containment isolation valve. Containment isolation valves that require repositioning for post-event monitoring or sampling are provided with device level manual overrides which permit valve repositioning when the automatic isolation signal is reset. The device manual override is described in Section 7.3.5. Containment isolation valves with power operators are provided with open/closed indication, which is displayed in the control room. The valve mechanism also provides a local, mechanical indication of valve position.

All power supplies and control functions necessary for containment isolation are Class lE, as described in Chapters 7.0 and 8.0.

6.2.5 COMBUSTIBLE GAS CONTROL IN CONTAINMENT

10 CFR 50.44 was revised in 2003. The revised 10 CFR 50.44 no longer defines a design-basis LOCA hydrogen release, and eliminates the requirements for hydrogen control systems to mitigate such a release. The installation of hydrogen recombiners and/or vent and purge systems required by 10 CFR 50.44(b)(3) was intended to address the limited quantity and rate of hydrogen generation that was postulated from a design-basis LOCA. The Commission has found that the hydrogen release is not risk-significant because the design-basis LOCA hydrogen release does not contribute to the conditional probability of a large release up to approximately 24 hours after the onset of core damage. In addition, these systems were ineffective at mitigating hydrogen releases from risk-significant beyond design-basis accidents. With the elimination of the design-basis LOCA hydrogen release, hydrogen monitors are no longer required to mitigate design-basis accidents and, therefore, the hydrogen monitors do not meet the definition of a safety-related component as defined in 10 CFR 50.2.

The hydrogen control system (HCS) is an engineered safety feature which serves to control combustible gas concentrations in the containment. The HCS consists of redundant hydrogen recombiners, a redundant hydrogen monitoring system and a backup hydrogen purge system. The HCS in conjunction with the provisions for hydrogen mixing satisfies GDC-41. A redundant hydrogen mixing subsystem is also provided but is not required to assure adequate hydrogen mixing.

Sources of hydrogen gas in containment are as follows:

a. Metal-water reaction involving the zirconium fuel cladding and the reactor coolant

b. Radiolytic decomposition of the post-LOCA emergency cooling solutions (oxygen also evolves in this process)

c. Corrosion of metals and paints by solutions used for emergency core cooling or containment spray

6.2.5.1 Design Bases

6.2.5.1.1 Safety Design Bases

Portions of the HCS are safety related and are required to function following a LOCA.

SAFETY DESIGN BASIS ONE - The HCS is capable of withstanding the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, or external missiles (GDC-2).

SAFETY DESIGN BASIS TWO - The HCS is designed to remain functional after a SSE or a pipe break in containment (LOCA, steam line break, etc. (GDC-3 and 4).

SAFETY DESIGN BASIS THREE - Component redundancy is provided so that safety functions can be performed, assuming a single active component failure coincident with the loss of offsite power (GDC-44).

SAFETY DESIGN BASIS FOUR - The HCS is designed and fabricated to codes consistent with the quality group classification assigned by Regulatory Guides 1.7 and 1.26 and the seismic category assigned by Regulatory Guides 1.7 and 1.29. The power supply and control functions are in accordance with Regulatory Guides 1.7 and 1.32.

SAFETY DESIGN BASIS FIVE - The capability of isolating components, systems, or piping is provided, if required, so that the system's safety function is not compromised. This includes the isolation of components to deal with leakage or malfunctions and to isolate nonsafety-related portions of the system.

SAFETY DESIGN BASIS SIX - The containment isolation valves in the system are selected, tested, and located in accordance with the requirements of 10 CFR 50, Appendix A, General Design Criteria 54 and 56 and 10 CFR 50, Appendix J, Type C testing.

SAFETY DESIGN BASIS SEVEN - The HCS is capable of maintaining the containment hydrogen concentration below 4.0 volume percent, as required by Regulatory Guide 1.7.

SAFETY DESIGN BASIS EIGHT - The hydrogen purge subsystem serves as a backup to the hydrogen recombiners and is capable of venting and purging the containment atmosphere in order to maintain the hydrogen concentration below 4.0 volume percent following a LOCA. With the purge system operating, the doses at the exclusion area boundary and the low population zone outer boundary does not exceed the guideline values of 10 CFR 100. Except for the containment penetration and associated isolation valves, the purge subsystem is not redundant or seismic Category I, as allowed by Regulatory Guide 1.7.

SAFETY DESIGN BASIS NINE - The containment design and hydrogen mixing provisions ensure adequate mixing of the containment atmosphere in order to eliminate stagnant pockets and prevent stratification of the hydrogen-air mixture.

SAFETY DESIGN BASIS TEN - The hydrogen monitoring subsystem is designed to inform the operator of the hydrogen concentration inside the containment and to provide periodic samples of the post-LOCA containment atmosphere to be analyzed for hydrogen and/or oxygen and other substances, if required.

SAFETY DESIGN BASIS ELEVEN - The HCS is designed with provisions for periodic inspection and testing of all safety-related components (GDC-42 and 43).

6.2.5.1.2 Power Generation Design Bases

POWER GENERATION DESIGN BASIS - The hydrogen mixing subsystem provides continual mixing of the containment air during normal plant operation. The containment penetrations in the hydrogen monitoring subsystem are closed during normal plant operation. The remainder of the HCS performs no function during normal plant operations.

6.2.5.2 System Design

6.2.5.2.1 General Description

The total system for control of combustible hydrogen concentrations in the containment following a LOCA, shown schematically in Figures 6.2.5-1 and 9.4-6, consists of a hydrogen monitoring subsystem that provides containment atmosphere samples, hydrogen mixing provisions which assure a nearly uniform hydrogen concentration in the containment atmosphere, electric (thermal) hydrogen recombiners which provide the primary means of reducing containment hydrogen concentrations, and a hydrogen purge subsystem which is used as a backup system to the recombiners.

The hydrogen monitoring, mixing and recombiner subsystems are designed to meet seismic Category I requirements and the single failure criterion, as defined in Section 3.1. The function of the hydrogen mixing fans including the mixing provisions following a LOCA are discussed in Section 6.2.5.3, Safety Design Basis Nine Evaluation and Section 6.2.5.2.2.2, Hydrogen Mixing Provisions. Generation of hydrogen is discussed in Section 6.2.5.2.3.

Those portions of the HCS that are exposed to the post-accident environment are located within containment except for portions of the hydrogen monitoring system. Leakage outside the containment is detected with the auxiliary building radiation indicators and alarms. The solenoid-operated isolation valves in each train ensure train isolation capability in the event of leakage.

6.2.5.2.2 Component Description

Design data for major components of the HCS are presented in Table 6.2.5-1. Codes and standards applicable to this system are listed in Table 3.2-1.

6.2.5.2.2.1 Hydrogen Recombiner Subsystem

License Amendment No. 157 was issued by the NRC on January 31, 2005 and deleted the Technical Specification requirements for the hydrogen recombiners. The recombiners and their associated controls are still installed in the plant in a deenergized condition.

Each recombiner subsystem consists of a control panel located in the control building, a control switch located on the main control board, a power supply cabinet located in the control building, and a recombiner located on the operating deck of the containment. There are no moving parts or controls inside the containment. Heating of air within the unit causes air flow by natural convection. The recombiner is a completely passive device.

The power supply cabinet located in the control building contains an isolation transformer, plus a controller, to regulate the power supply to the recombiner. This equipment is not exposed to the post-LOCA environment. The controls for the power supply are located in the control room and are manually actuated.

Each hydrogen recombiner consists of the following design features:

a. A preheater section, consisting of a shroud placed around the central heaters to take advantage of heat conduction through the central walls, for preheating incoming air

b. An orifice plate to regulate the rate of air flow through the unit

c. A heater section, consisting of four banks of metal-sheathed electric resistance heaters, to heat the air flowing through it to hydrogen-oxygen recombination temperatures

d. An exhaust chamber which mixes and dilutes the hot effluent with containment air to lower the temperature of the discharge stream

e. An outer enclosure to protect the unit from impingement by containment spray

f. No need for external services except electrical power

Containment atmosphere is heated within the recombiner in a vertical duct, causing it to rise by natural convection. As it rises, replacement air is drawn through intake louvers downward through a preheater section which will temper the air and lower its relative humidity. The preheated air then flows through an orifice plate, sized to maintain a 100-scfm flow rate, to the heater section. The air flow is heated to a temperature above 1,150°F, the reaction temperature for the hydrogen-oxygen reaction. Any free hydrogen present reacts with atmospheric oxygen to form water vapor. After passing through the heater section, the flow enters a mixing section which is a louvered chamber where the hot gases are mixed and cooled with containment atmosphere before the gases are discharged directly into the containment. The air-discharge louvers are located on three sides of the recombiner. To avoid short-circuiting of previously processed air, no discharge louvers are located on the intake side of the recombiner.

Tests have verified that the hydrogen-oxygen recombination is not a catalytic surface effect associated with the heaters (see Section 6.2.5.4), but occurs due to the increased temperature of the process gases. As the phenomenon is not a catalytic effect, saturation of the unit cannot occur.

Two recombiners are provided to meet the requirements for redundancy and independence. Each recombiner is powered from a separate Class IE 480-V load center described in Chapter 8.0 and is provided with a separate power panel and control panel. No interdependency exists between this system and the other safety-related subsystems.

The unit is manufactured of corrosion-resistant, high-temperature material. The electric hydrogen recombiner uses commercial-type electric resistance heaters sheathed with Incoloy-800, which is an excellent corrosion-resistant material for this service. The recombiner heaters operate at significantly lower power densities than similar heaters used in commercial practice.

Operation of the recombiner is performed manually from a switch on the main control board or from a control panel located in the control room. The power panel for the recombiner contains an isolation transformer plus a controller to regulate power into the recombiner. This equipment is not exposed to the post-LOCA environment. For equipment test and periodic checkout, a thermocouple readout instrument is also provided in the control panel for monitoring temperatures in the recombiner.

6.2.5.2.2.2 Hydrogen Mixing Provisions

The containment design is such that mixing, adequate to prevent the formation of hydrogen pockets, is assured without reliance on the hydrogen mixing fans. The hydrogen mixing subsystem shown in Figure 9.4-6 is provided for defense-in-depth and consists of four mixing fans which enhance the uniform mixing of the containment atmosphere. When operating, these fans draw air from the steam generator compartments and discharge it toward the upper regions of the containment. This complements the air patterns established by the initial blowdown, the natural convection, the containment air coolers, which take suction from above the operating floor level and discharge to the lower regions of the containment, and the containment sprays which cool the air and cause it to drop to lower elevations. Two speed, hydrogen mixing fans are provided for additional mixing when operating. The design flow rate of the hydrogen mixing fans (high-speed operation) is based on air distribution requirements during normal operation when a containment air cooler is taken out of service. The design flow rate of the hydrogen mixing fans (low-speed operation) exceeds, with a large factor of safety, the air distribution requirements to ensure uniform concentrations of hydrogen throughout the containment. An elevation drawing showing the expected air flow patterns is provided in Figure 6.2.2-7. Further information is contained in Sections 6.2.2.2 and 6.2.5.3.

6.2.5.2.2.3 Hydrogen Monitoring Subsystem

License Amendment No. 157 was issued by the NRC on January 31, 2005 relocated the Technical Specification requirements for the hydrogen monitors to the Technical Requirements Manual. The NRC has indicated that since the monitors are required to diagnose the course of beyond design-basis accidents, the monitors must be maintained capable of diagnosing beyond design-basis accidents. The NRC has also indicated that the monitors no longer meet the definition of Category 1 in Regulatory Guide 1.97 and that the monitors may be categorized as Category 3 Regulatory Guide 1.97 instrumentation.

Each redundant hydrogen monitoring train in the hydrogen monitoring subsystem consists of a hydrogen analyzer and two associated sample lines with isolation valves inside and outside the containment. These sampling lines are designed to be free of water traps (runs where liquid could accumulate), and are equipped with sufficient heat tracing to prevent condensation of the sample being supplied to the analyzers.

After the sample has been analyzed, it is returned to the containment. The analyzers are located in accessible areas outside of the containment. The hydrogen monitoring subsystem pressure boundary outside the containment is in accordance with the criteria of Regulatory Guide 1.26, quality group B. Solenoid-operated isolation valves are provided to obtain samples from two locations within the containment for each train. One sampling point is above the main operating level near the intake of the containment air coolers, and the other is near the post-LOCA water level in the containment recirculation sumps. The operator may select either of these sampling points from the main control room.

The operation of the hydrogen gas analyzer is based on the measurement of thermal conductivity of the gaseous containment atmosphere sample. The thermal conductivity of the gas mixture changes proportionally to the changes in the concentration of the individual gas constituents of the mixture. The thermal conductivity of hydrogen is far greater (approximately seven times the thermal conductivity of air) than any other gases or vapors expected to be present. The operation of the hydrogen monitoring subsystem is not limited due to radiation, moisture, or temperature expected at the equipment location. The equipment qualification testing, including radiation exposure, aging and vibration, satisfies IEEE Standards 323-1974 and 344-1975.

6.2.5.2.2.4 Hydrogen Purge Subsystem

The hydrogen purge subsystem utilizes the Emergency Exhaust System to perform its functions. The emergency exhaust system is described in Section 9.4.3. The isolation valve is the only moving part located inside the containment. The hydrogen purge subsystem is designed to vent containment atmosphere at a rate of 100 scfm.

The hydrogen purge subsystem has one penetration through which the containment air is vented and filtered. This purge line is located in a missile-protected area, and draws air from well-ventilated areas of the containment in a manner which prevents either spray or sump water from entering the pipe. As indicated in Section 6.2.5.3, venting would not be initiated before 4 days after a LOCA, therefore, no separate air supply line is needed. Makeup air is available through the instrument air penetration; and, if this penetration is unavailable by the time purging would be necessary, an air bottle can be connected to a number of available penetrations. Should it be necessary to use this backup system, operational considerations and site meteorology would determine the timing and duration of the purges. In any case, sufficient purging would be performed to maintain the hydrogen concentration in the containment atmosphere below 4 volume percent.

6.2.5.2.3 Hydrogen Generation

Hydrogen is generated within the containment by various mechanisms, as described below.

a. Radiolytic Hydrogen Generation

   Water is decomposed into hydrogen and oxygen by the absorption of energy emitted by nuclides contained in the fuel and those intimately mixed with the LOCA water. The quantity of hydrogen that is produced by radiolysis is a function of both the energy of ionizing radiation absorbed by the LOCA water and the net hydrogen radiolysis yield, G(H_2), pertaining to the particular physical-chemical state of the irradiated water.

   Evidence indicates that the net hydrogen yield from the radiolysis of pure water is 0.44-0.45 molecule per 100 eV of absorbed energy when the gaseous radiolysis products are continuously purged from the water. In the presence of reactive solutes and water in the absence of gas purging of the solution, significant recombination of the products of radiolysis can occur, thereby reducing the net hydrogen yield. However, in accordance with Regulatory Guide 1.7, a value of 0.5 molecule/100 eV has been assumed for the net yield of hydrogen from radiolysis of all LOCA water.

   The assumptions given in Regulatory Guide 1.7 were used to determine the fission product distribution after the accident. This distribution is assumed to be intantaneous after the accident, and hydrogen production is assumed to begin immediately. Fifty percent of the halogens and 1 percent of the solids are assumed to be released from the fuel and intimately mixed with the water in the sump. All noble gas activity is released from the fuel and is present in the containment atmosphere. The decay energy was calculated using the method of Standard Review Plant section 6.2.5, Appendix A, which is based on two year reactor operation. Table 6.2.5-2 gives a summary of the remaining assumptions made in the analysis.

b. Zirconium-Water Reaction

   One of the major sources of hydrogen immediately following a LOCA is due to metal-water reaction. The extent of the metal-water reaction depends strongly on the course of events assumed for the LOCA and the effectiveness of the emergency core cooling systems. The extent of metal-water reaction is evaluated in accordance with the assumptions of Regulatory Guide 1.7.

Zirconium reacts with steam according to the reaction:

$Zr + 2H_2O \rightarrow ZrO_2 + 2H_2$

The hydrogen gas evolved from this reaction is calculated to be:

$$\frac{2 \text{ lb-mole } H_2/\text{lb-mole Zr}}{91.22 \text{ lb Zr/lb-mole Zr}} = \frac{0.022 \text{ lb-moles } H_2}{\text{lb Zr}}$$

The emergency core cooling system (ECCS) is designed to remove core heat at a rate that will prevent the fuel rods from heating to the point where significant Zr-H_2O reactions will take place. The LOCA analysis shows that with the passive accumulators and the active elements of high-pressure and low-pressure safety injection, less than 0.1 percent of the zirconium cladding will react with water to generate hydrogen (Section 15.6.5). In analyzing postaccident hydrogen generation, it has been conservatively assumed that 5 percent (50 times the calculated amount) of the total mass of zirconium in Zircaloy-4 fuel cladding reacts. For the estimated 54,000 pounds of zirconium metal in the active portion of the core, this amounts to 2,700 pounds of zirconium reacting. The total hydrogen generation from this source is then estimated to be 59.20 lb-moles H_2.

c. Corrosion of Metals and Paints in the Containment

Hydrogen is formed by corrosion of metals in the containment. The significant portion of this source of hydrogen is from the corrosion of zinc and aluminum. Table 6.2.5-3 gives the quantity of each material allowed in the containment. Figure 6.2.5-9 shows the temperature used in the corrosion calculation. Table 6.1-3 provides the qualification information for coating materials used inside containment.

Zinc in the containment is in two forms: zinc base paint and in galvanized steel. The containment, during the injection phase, is sprayed with a borated solution adjusted a pH between 9.0 and 11.0 with sodium hydroxide addition in operation, while a minimum pH of 4.0 could be experience in one of the spray trains in the event of a single failure in the spray additive subsystem. During the recirculation phase, the pH of the spray is calculated to be greater than 8.5. The corrosion rates for aluminum and zinc in this environment are given in Figures 6.2.5-7 and 6.2.5-8. Accelerated rates are used for the higher temperatures early in the accident as requested in Regulatory Guide 1.7.

The surface areas for the corrosion of metals and paints are assumed constant throughout the analysis.

d. Insignificant Sources of Hydrogen

During normal operation of the plant, hydrogen is dissolved in the primary system water. The concentration of hydrogen in primary coolant ranges as shown in Table 5.2-5. The total amount of hydrogen in the primary system has been calculated to be insignificant.

Table 6.1-10 identifies the quantity of organic lubricants found inside containment. The quantity of electrical cable insulation inside the containment is less than 50,000 pounds.

If it is assumed that the above organic materials, excluding coatings (that were already included in the analyses above), can be considered as unsaturated hydrocarbons, Reference 12 indicates that they would have a G value for hydrogen of 1 molecule per 100 eV of energy absorbed and a G value for methane of .01 to .4 molecules per 100 eV of energy absorbed. The integrated DBA dose that this material could be subjected to would be $<3.0 \times 10^7$ Rads over a 1-year period following an accident.

Applying these conservative assumptions, approximately 1.7 lb-moles of hydrogen and approximately .7 lb-moles of methane could be potentially released from these sources over the 1-year period.

This quantity of hydrogen is not considered to be a significant contribution compared to the sources identified in Figure 6.2.5-4, and is not included in the evaluation. Likewise, the small amount of methane that might be produced is not considered a significant contributor to combustibility.

The quantities of organic lubricants given in Table 6.1-10 are those quantities subject to be released into the containment. Due to the environmental qualification requirements for the cable insulation used inside containment, it is expected to essentially maintain its mechanical stability and not contribute any debris that might reach the containment sump.

After a LOCA, hydrogen is also generated by noble gas radiolysis. Calculations show that this total amount of hydrogen is insignificant when compared with the sources discussed in a, b, and c above.

6.2.5.2.4 System Operation

6.2.5.2.4.1 Normal Operation

Except for testing and the normal use of the hydrogen mixing subsystem, as discussed in Section 9.4.6, the system is not normally operated.

6.2.5.2.4.2 Accident Operation

10 CFR 50.44 was revised in 2003 and Revision 3 to Regulatory Guide 1.7 was issued in May 2003. The revised 10 CFR 50.44 no longer defines a design-basis LOCA hydrogen release, and eliminates the requirements for hydrogen control systems to mitigate such a release. License Amendment No. 157 was issued by the NRC on January 31, 2005 and deleted the Technical specification requirements for the hydrogen recombiners.

The HCS is normally on standby and is initiated manually from the control room following a LOCA. After a LOCA, sufficient emergency power is available to handle the load required to operate the electric (thermal) hydrogen recombiners. Hence, the electric recombiners are turned on when the presence of Hydrogen is detected (even though they are not required at this early point in time) in order to keep the hydrogen concentration as low as practicable.

The electric hydrogen recombiner subsystem is to be started when the presence of hydrogen is detected after a LOCA. However, inadvertent actuation immediately after a LOCA will not damage the recombiners in any manner, nor will their capability to perform their design function be impaired. The electric (thermal) recombiners are completely passive devices. The recombiners heat the containment hydrogen-air atmosphere that is introduced into the recombiner to a temperature greater than 1,150°F, causing the recombination of H2 and O2 to occur. Hence, the hydrogen volume percent is reduced. The air is then passed to a mixing chamber, in the top of the recombiner, where the hot air is mixed with the cooler containment air to discharge it back into the containment at a temperature of approximately 50°F above ambient. Section 6.2.5.3, Safety Evaluation Seven, demonstrates that the recombination rate is sufficient so that the volume percent of hydrogen is maintained at less than 3.0 volume percent.

The hydrogen purge subsystem is not required at any time unless failure of both recombiners results in a hydrogen concentration of 3.0 volume percent. In such a case, the purge subsystem will be manually initiated.

Although not required to function following indication of an accident condition, each hydrogen mixing fan will be automatically started or switched from high speed to low speed by an SIS. The hydrogen mixing fans are designed to withstand the pressure transients associated with a design basis LOCA and remain functional. The initial blowdown, natural convection, containment coolers and the containment sprays provide mixing of the containment post-LOCA atmosphere without reliance on the hydrogen mixing fans. The function of the hydrogen mixing fans including the mixing provisions following a LOCA are discussed in Sections 6.2.5.3 and 6.2.5.2.2.2. The operation of the containment sprays and containment coolers is described in Section 6.2.2.2.

The hydrogen monitoring subsystem is normally closed to the containment atmosphere. Following a LOCA, a CIS-A signal assures that the isolation valves, located in each sample line penetrating the containment, are closed. The operator will manually open the isolation valves after a LOCA and initiate hydrogen sampling. Once initiated, hydrogen analyzers provide a continuous measurement of hydrogen concentration within 30 minutes. Individual valve control switches are provided in the main control room with a provision for remote manual bypass as described in Section 7.3.8. Containment atmosphere samples, maintained in the vapor phase, are brought to the analyzer, which measures the concentration of hydrogen. From the analyzer, the sample is returned to the containment atmosphere. The hydrogen analyzer system is designed with the capability to obtain an accurate sample 30 minutes after initiation of safety injection.

6.2.5.3 Safety Evaluations

Safety evaluations are numbered to correspond to safety design bases.

SAFETY EVALUATION ONE - The safety-related portions of the HCS are located in the reactor, auxiliary, and control buildings. These buildings are designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles, and other appropriate natural phenomena. Sections 3.3, 3.4, 3.5, 3.7(B), and 3.8 provide the bases for the adequacy of the structural design of these buildings.

SAFETY EVALUATION TWO - The safety-related portions of the HCS are designed to remain functional after a SSE. Sections 3.7(B).2 and 3.9(B) provide the design loading conditions that were considered. Section 3.6 provides a hazards analysis which assures protection of the HCS and piping following a postulated LOCA or MSLB.

SAFETY EVALUATION THREE - Section 6.2.5.2 demonstrates that the required redundancy is provided and, as indicated by Table 6.2.5-5, no single failure can compromise the system's safety functions. All vital power can be supplied from either onsite or offsite power systems, as described in Chapter 8.0.

SAFETY EVALUATION FOUR - Section 3.2 delineates the quality group classification and seismic category applicable to the safety-related portion of this system and supporting systems. Table 6.2.5-1 shows that the components meet the design and fabrication codes given in Section 3.2. All the power supplies and control functions necessary for safe functioning of the HCS are Class IE, as described in Chapters 7.0 and 8.0. Comparison of the design to Regulatory Guide 1.7 positions is provided in Table 6.2.5-6.

SAFETY EVALUATION FIVE - Section 6.2.5.2.1 describes the provisions made to identify and isolate leakage or malfunction and to isolate the nonsafety-related portions of the system.

SAFETY EVALUATION SIX - Sections 6.2.4 and 6.2.6 provide the safety evaluation for the system containment isolation arrangement and testability.

SAFETY EVALUATION SEVEN - Since only one of the two completely separate recombiner systems is required, a single active or passive failure does not prevent the recombiners from fulfilling the design function.

Inadvertent actuation of the recombiners immediately after a LOCA will not damage the recombiners in any manner nor is their capability to perform their design function be hindered or impaired. Figure 6.2.5-2 shows the hydrogen volume concentration versus time within the containment as a result of one recombiner starting 1 day following a LOCA.

Tests have verified that recombination is not a catalytic surface effect, but that it occurs due to the increased temperature of the process gases (see Section 6.2.5.4). Since the phenomenon is not a catalytic effect, poisoning of the unit by fission products or containment spray will not occur. The heater-recombiner section consists of four vertically stacked assemblies of electric heaters. Each assembly contains individual heating elements. Since the temperature of each assembly results from the contribution of 60 individual heaters, failure of a few heaters will not affect the efficiency of the recombiner.

Only the recombiners are located in the containment. All auxiliary equipment associated with the recombiners is located outside the containment. The recombiners are designed to withstand, without impairment of function, exposure to the design temperature and pressure transient in the containment and are resistant to the chemical and radiation environment of the post-

LOCA containment environment. The auxiliary equipment located in the control building is designed to withstand, without impairment to function, the exposure to the post-LOCA control building environment.

The hydrogen generation rate and hydrogen accumulation within the containment, as a function of time, are given in Figures 6.2.5-3 and 6.2.5-4, respectively. The hydrogen concentration in the containment is given in Figure 6.2.5-5, assuming that no preventive action is taken.

The recombiners are located in the containment so that they process a flow of containment air containing hydrogen at a concentration which is generally typical of the average concentration throughout the containment.

The recombiners are located away from the high velocity air streams, such as could emanate from the fan cooler exhaust ports.

SAFETY EVALUATION EIGHT - In the extremely unlikely event that a LOCA occurs and the redundant recombiners fail to function properly, a purge subsystem may be utilized to control the hydrogen concentration inside the containment.

Since the purging of any amount of containment atmosphere is undesirable, the operation of the purge system would be initiated only when it has been determined that the recombiners are inoperable and only if samples taken from the containment atmosphere indicate that a hydrogen content of 3.0 volume percent has been attained.

The concept of purging allows considerable operational flexibility and, in practice, the specific mode of operation would be determined by the actual hydrogen generation rate and hydrogen concentration in the containment atmosphere, the amount of airborne activity in the containment, and the prevailing meteorological conditions.

Calculations, assuming no operation of the recombiners, show that the hydrogen concentration will reach 3 percent at 4 days. A 100-scfm purge initiated at that time would reduce the hydrogen concentration below the 3-percent level. The effect of the purge on the hydrogen volume concentration is shown in Figure 6.2.5-6.

SAFETY EVALUATION NINE - Reference 26 provides a complete description of containment mixing and concludes that sufficient air flow is provided to ensure proper hydrogen mixing without reliance upon the hydrogen mixing fans following a LOCA.

The open containment design provides for communication of the areas above and below the operating deck and the areas inside the secondary shield wall. Natural convection is a major contribution to the mixing design during all phases following a LOCA; however, other mechanisms assist the mixing process. Blowdown and steam release assist the mixing prior to the actuation of the containment air coolers and containment sprays. During the injection phase and the initial phases of recirculation from the containment sump, the containment sprays and air coolers assist the natural circulation mixing of the containment atmosphere. During the very long term, the natural circulation alone is adequate to prevent localized accumulations of hydrogen from exceeding combustible limits; however, two containment air coolers continue to operate to enhance mixing and cool the containment.

The hydrogen mixing subsystems as designed enhances the mixing provisions described in Reference 26 for defense-in-depth when operating. The operating hydrogen mixing fans increase the rate of air mixing in the containment by drawing air from the steam generator loop compartments and exhausting it into the upper containment air space where mixing occurs in the turbulence created by natural convection and by the operation of the containment sprays and containment air coolers. Although the hydrogen mixing fans are not required to operate Post-LOCA, each pair of hydrogen mixing fans is completely redundant, and powered from independent Class 1E power sources. Continued plant operation is allowed if the fans are out of service since other mixing provisions are available for adequate mixing. Further discussion of the mixing fans normal operation design bases is provided in Section 9.4.6.

SAFETY EVALUATION TEN - The hydrogen monitoring subsystem is designed to take air samples from a total of four locations (two for each redundant train) inside the containment. These samples are analyzed, and the results are indicated in the control room.

The hydrogen monitor and associated sample lines, located outside the containment, are considered to be an extension of the containment pressure boundary, and, therefore, are designed to withstand the pressure, temperature, and humidity transients associated with the design basis LOCA.

SAFETY EVALUATION ELEVEN - The HCS was initially tested with the program given in Chapter 14.0. Periodic inservice functional testing and inspection are done in accordance with Section 6.2.5.4.

6.2.5.4 Testing and Inspections

10 CFR 50.44 was revised in 2003 and Revision 3 to Regulatory Guide 1.7 was issued in May 2003. The revised 10 CFR 50.44 no longer defines a design-basis LOCA hydrogen release, and eliminates the requirements for hydrogen control systems to mitigate such a release. License Amendment No. 157 was issued by the NRC on January 31, 2005 and deleted the Technical Specification requirements for the hydrogen recombiners. Testing and Inspection of the equipment is no longer performed.

The analytical and test program for the electric recombiner includes proof-of-principle tests and full-scale prototype tests.

The proof-of-principle tests and prototype tests have been completed, and the results of these tests were submitted to the NRC in References 14 through 22.

Results of the proof-of-principle tests show that hydrogen-oxygen reaction occurs at air temperatures of about 1,150°F or above, and no detectable hydrogen was found in the effluent gases. Tests demonstrated that the recombination reaction occurred due to increased gas temperature and not to a catalytic surface effect.

A full-size prototype recombiner was constructed for testing. Hydrogen tests were conducted by erecting a steel building around the recombiner to permit simulation of a plant containment environment. During tests, a hydrogen air mixture was introduced into the building and the recombiner was operated. Hydrogen-air mixtures ranged from 0.6 to 4.0 volume percent. In all cases, the recombiner performed satisfactorily and no detectable hydrogen was found in the effluent gases. Tests were also performed with containment spray containing sodium tetraborate (2,500 ppm boron as boric acid adjusted to a pH of 10 with sodium hydroxide) impinging on the recombiner from spray nozzles mounted in the upper part of the building. In another test, steam was injected into the simulated containment. In all cases, the recombiner performed satisfactorily. Tests were conducted to show the effect of air currents on the recombiner. These tests also indicated satisfactory performance. During the test program, the power, sheath temperatures, and air temperatures in the recombiner, as well as containment hydrogen concentration and hydrogen concentration at the exit of the recombiner, were measured. These tests have shown satisfactory performance for all conditions of interest.

Upon installation, the recombiners are energized and brought up to temperature. If a recombiner's temperature exceeds 1,150°F, it is considered operable and capable of performing its design function. No hydrogen is present during the test, since the proof-of-principle tests and prototype tests indicate that recombination occurred solely because of the increased temperature.

The performance of the hydrogen gas analyzer is periodically verified by comparing the response of the thermal conductivity instrument to a known sample of reference gas.

Nondestructive examination is performed on the components of the hydrogen monitoring subsystem and the hydrogen purge subsystem. Periodic inservice testing of all fans, valves, and instrumentation is performed.

6.2.5.5 Instrumentation Requirements

6.2.5.5.1 Hydrogen Recombiner Subsystem

Controls for operation of the hydrogen recombiners are provided in the control room. A manual control station is provided for each train to regulate power to the heaters in the associated recombiner. The controller maintains the correct power input to bring the recombiner above the threshold temperature for the recombination process. The controller setting is adjusted to accommodate variations in the containment temperature, pressure, and hydrogen concentration in the post-LOCA environment. The system is designed to conform to the applicable portions of IEEE 279, 323, 344, and 383 and is powered from a Class IE source.

Proper recombiner operation is assured by measuring the power input to the heaters from a station outside the containment. The proper air flow through the recombiners is achieved through the use of an orifice plate built into each unit.

For convenience in testing and conducting periodic checkout of the recombiners, temperature indicators are provided. The temperature indicators are not required to assure proper operation of the recombiner during post-LOCA conditions.

6.2.5.5.2 Hydrogen Mixing Provisions

Although not required to assure adequate mixing, the operation of the hydrogen mixing fans is actuated automatically upon receipt of a safety injection signal. Control switches and indicator lights for the four hydrogen mixing fans are located in the control room. The system is designed to conform to the applicable portions of IEEE 279 and 334 and is powered from a Class 1E source. The function of the hydrogen mixing fans including the mixing provisions following a LOCA are discussed in Sections 6.2.5.3 and 6.2.5.2.2.2.

6.2.5.5.3 Hydrogen Purge Subsystem

Operation of the hydrogen purge subsystem is manually initiated from the control room. Instrumentation requirements of the hydrogen purge subsystem are described in more detail in Section 9.4.3.

The line penetrating the primary reactor containment is provided with power-operated isolation valves with position indicators and controls in the control room to allow operator control during post-LOCA operation. A complete discussion of the isolation valve provisions is presented in Section 6.2.4.

6.2.5.5.4 Hydrogen Monitoring Subsystem

A hydrogen analyzer is provided for periodic sampling of the containment atmosphere following a design basis event. The hydrogen analyzer has a readout scale of 0 to 10 percent. The output signal of the analyzer is indicated at the analyzer mounting location and recorded and alarmed in the main control room. In addition to the high hydrogen alarm, each analyzer provides malfunction alarms, including low sample flow, low temperature, and loss of power. The displays provided are described further in Section 7.5.

6.2.6 CONTAINMENT LEAKAGE TESTING

The reactor containment, containment penetrations, and containment isolation barriers are designed to permit periodic leakage rate testing as required by 10 CFR 50, Appendix A, General Design Criteria 52, 53, and 54. 10 CFR 50, Appendix J, outlines the containment leakage test requirements and establishes the acceptance criteria for such tests. The objective of the leakrate testing is to ensure that the leakage from the containment is within the limits set by Technical Specifications.

Compliance with 10 CFR 50 Appendix J, Types A, B, and C, testing is discussed in Sections 6.2.6.1, 6.2.6.2, and 6.2.6.3.

6.2.6.1 Containment Integrated Leakage Rate Test (Type A Test)

The containment was designed with an allowable leakage rate (La) of 0.20 percent (weight percent) of containment free air volume per day for the first 24 hours. The maximum leakage rate occurs at the calculated peak containment pressure bounding a LOCA, Pa = 48 psig. The actual leakage rate is determined by using the methods and requirements of 10 CFR 50, Appendix J, Option B for Type A tests as administered by the Containment Leakage Rate Testing Program.

The acceptance criteria specified in Appendix J for the Integrated Leakage Rate Test (ILRT or Type A test) includes a margin for possible deterioration of the containment leakage integrity during the service intervals between tests. The as left leakage rate prior to the first startup after performing an ILRT is required to be less than 0.75 La for the overall Type A leakage rate. At all other times between tests the acceptance criteria is based on an overall Type A leakage rate limit of less than or equal to 1.0 La.

6.2.6.1.1 ILRT Pretest Requirements

The containment integrated leakage rate test complements local leakage rate tests. Local leakage rate tests, in which potential leakage paths through the containment boundary, i.e. containment penetrations, are subjected to test conditions similar to those occurring during the integrated leakage rate test, allow detection and correction of leak paths through the containment without pressurizing the entire containment structure. These local leakage rate tests are the Type B and C tests described in Sections 6.2.6.2 and 6.2.6.3.

The significant ILRT and system alignment requirements are as follows.

The visual examination of containment concrete surfaces outside containment and steel liner plate inside containment to fulfill the requirement of 10 CFR 50, Appendix J, Option B testing, will be performed in accordance with the requirements and frequency specified by ASME Section XI code IWE/IWL. Except where relief has been authorized.

Closure of containment isolation valves for Type A testing is accomplished by normal means and without adjustment. Alternative methods of valve closure may be used provided they are documented and are equivalent to normal means. If a leakage path requires isolation to successfully complete an ILRT, its local leakage rate, measured after the ILRT, is added to the Type A test results. Normal and accident positions for each containment isolation valve are shown on Figure 6.2.4-1.

Portions of fluid systems that are part of the reactor coolant pressure boundary and are open indirectly to the containment atmosphere due to the LOCA conditions and are, therefore, extensions of the boundary of the containment are opened or vented to the containment atmosphere during the ILRT. Venting the reactor coolant system to the containment atmosphere fulfills this requirement. Figure 6.2.4-1 contains the applicable GDC or other defined criteria for the isolation valve arrangements provided.

Pathways that are open to the containment atmosphere under post-LOCA conditions are vented to the containment atmosphere during the ILRT. Pathways are considered open to the containment atmosphere if the system fluid is drained or driven off by the LOCA. This includes portions of pathways inside or outside containment that penetrate the containment and may rupture inside containment under a LOCA conditions. Vented pathways are also drained of fluid inside the containment, between the containment isolation valves and outside the containment to expose the pathways to post-LOCA differential pressure. For pathways not vented and drained, their local leakage rate is added to the Type A test results as directed by the Containment Leakage Rate Testing Program.

In exception to the above, for planning and scheduling purposes, or ALARA considerations, pathways which are local leakage rate testable may be left isolated and fluid filled, not vented and drained. The as-found and as-left leakage rate for all pathways that are not vented and drained will have been determined within the previous 24 calendar months of the time that the Type A test is performed. For pathways not vented and drained, their local leakage rate is added to the Type A test results as directed by the Containment Leakage Rate Testing Program.

In exception to the above, for pathways in systems which are required for proper conduct of the ILRT, or to maintain the plant in a safe condition during the ILRT, (e.g. essential service water lines to the containment air coolers) they may remain operable in their normal mode and need not be vented or drained. However, if these pathways are potential post-LOCA leakage pathways, their local leakage rate is added to the Type A test results as directed by the Containment Leakage Rate Testing Program.

Isolation, repair or adjustment to a leakage pathway that may affect the leakage rate through that pathway is permitted prior to or during the Type A test provided that the pathways are local leakage rate testable and that the Type A test results are corrected.

For portions of the pathways outside containment that are designed to Seismic Category 1 and at least Safety Class 2, are not vented. These systems (e.g. ECCS and Containment Spray) are normally filled with water and operating under post-accident conditions therefore they are also not drained. The containment isolation valves in these systems are closed if the associated subsystem is not operating. Normally, under post-accident conditions, a water seal is present inside the inner isolation valve during the long-term period. Should operational leakage exist outside the containment and the isolation valves leak, the containment sump water level (Elevation 2003'-10") will ensure that the water in the piping system will provide a water seal on the outside containment isolation valves which are located at Elevations 2002'-0" and ~1993'. These water seals ensure that containment air does not leak into the auxiliary building. These systems outside the containment are in their post accident alignment for the Type A test. These penetrations are identified in Section 6.2.6.3 and Figure 6.2.4-1.

The steam generator tubes and shell and the associated piping systems passing through the containment liner are considered to be an extension of the containment. Therefore, the secondary side of the steam generator and connecting systems are not vented to the containment atmosphere. During the Type A test, the secondary side of the steam generators are vented outside of the containment to ensure the most conservative test configuration. The systems associated with the secondary side of the steam generator are identified in Figure 6.2.4-1.

Pressurized gas lines inside containment are depressurized. Gas pressurized containment leakage pathways outside containment are isolated during the ILRT and vented between the outboard containment isolation valve and the pressurized test boundary isolation valve.

Pressurized components within containment (e.g. reactor coolant drain tank, pressurizer relief tank, accumulator tanks) are vented during the ILRT. This is done to protect the tanks from the external pressure of the test and to preclude leakage to or from the tanks which would detract from the accuracy of the test results.

The containment hydrogen monitors and associated sample lines, located outside containment, are considered to be extensions of the containment pressure boundary. For the ILRT, the containment isolation valves are normally open and the monitors and sample lines outside containment tested.

6.2.6.1.2 ILRT Test Method

Figure 6.2.6-1 shows the general equipment arrangement for a Type A test. For penetrations which are exempt from Type B or C tests, as noted in Figure 6.2.4-1, the leakage testing requirement of Appendix J is accomplished by the Type A test.

The Containment Leakage Rate Testing Program embraces the requirements of 10 CFR 50, Appendix J, Option B.

Documents which provide the methods and requirements for integrated leakage rate testing and for the Containment Leakage Rate Testing Program include:

a. 10 CFR, Appendix J, Option B. "Primary Reactor Containment Leakage Testing for water-cooled Power Reactors" (Option B: Performance-Based Requirements)

b. Regulatory Guide 1.163, September 1995. "Performance Based Containment Leak Test Program"

c. Industry Guideline NEI 94-01, revision 0. "Nuclear Energy Institute Industry Guideline for Implementing Performance Based Option of 10 CFR Part 50, Appendix J"

d. Standard ANSI / ANS 56.8-1994. "Containment System Leakage Testing Requirements"

e. Standard ANS / N45.4-1972. "Leakage Rate Testing of Containment Structures for Nuclear Reactors"

f. Bechtel Topical Report BN-TOP-1, revision 1. "Testing Criteria for Integrated Leakage Rate Testing of Primary Containment Structures for Nuclear Power Plants"

g. Amendment No. 152 dated March 17, 2004.

For ILRT performance in general, containment dry bulb temperature, pressure, and dew point temperature are periodically measured and recorded. These data are analyzed as they are taken so that the containment leakage rate and its statistical significance is known as the test progresses. Once the leak rate has been found with sufficient accuracy, a known additional leak is imposed and the measurements are continued, giving additional verification of the leakage rate.

6.2.6.2 Containment Penetration Leakage Rate Tests (Type B Tests)

Each of the following containment penetrations are tested with a Type B test.

a. Personnel access hatches (refer to Section 3.8.2)

b. Equipment hatch (refer to Section 3.8.2)

c. Fuel transfer tube (refer to Section 3.8.2)

d. Electrical penetrations (refer to Section 8.3)

e. Penetration 34, containment pressurization line

f. Penetration 51, ILRT pressurization pressure sensing line

g. Penetrations 36 and 68, Access hatches for outage activities.

These penetrations are provided with double seal closures and connections to allow for pressurization between the seals, except for Eddy Current Cable Penetrations P-36 and P-68 which are single seal closures used during outage activities. Each penetration is designed to withstand the calculated peak containment pressure while maintaining its seal. Personnel hatches have provisions for test clamps for support of the internal closure during testing. In addition, Penetrations 34 and 51, containment pressurization line and pressure sensing lines for the ILRT pressurization system, are also Type B tests.

The test pressure for Type B tests is the calculated peak pressure for the containment, Pa. The combined leakage rate for all Type B and C tests must be less than 0.6 L_a (maximum allowable leakage rate). The individual leakage rates and testing performed on the Type B penetrations are described in the Containment Leakage Rate Testing Program.

The test equipment utilized to perform the Type B tests is the same equipment used for Type C tests. The test equipment is described in Section 6.2.6.3. The test procedure is the same as the one used for Type C tests.

Type B tests are performed in accordance with Appendix J to 10 CFR 50, with the following addition: an additional test method may be used. This method measures the air flow rate to maintain the test volume at a constant pressure.

6.2.6.3 Containment Isolation Valve Leakage Rate Tests (Type C tests)

Figure 6.2.4-1 lists all valves which are associated with the penetrating piping systems. Figure 6.2.4-1 also indicates the containment isolation valves which are to be subjected to a Type C test. The following criteria were used to determine which containment isolation valves are local leak tested.

a. The penetrating system provides a direct connection between the inside and outside atmospheres of the containment under normal operation.

b. The system is isolated by containment isolation valves which close automatically to effect containment isolation in response to a CIS signal.

c. The system is not an engineered safety feature system consisting of a closed piping system outside of the containment.

The lines serving engineered safety feature systems which consist of closed piping systems outside the containment have isolation valves which were not leak tested. All of these lines will initially open or will be opened during some phase following a LOCA. Valves which are closed initially or closed at some time following a LOCA are positioned to effect proper system operation and not to effect a barrier against release of containment atmosphere. Should the valves leak slightly when closed, the fluid seal within the pipe and the closed piping system outside the containment would preclude release of containment atmosphere to the environs. Engineered safety features in this classification penetrate the containment at penetrations numbered P-13, 14, 15, 16, 21, 27, 48, 49, 52, 66, 79, 82, 87, 88 and 89. The containment pressure transmitters are designed to meet the requirements of Regulatory Guide 1.11 and are described in Chapter 7.0. These lines have no isolation valves and rely on closed systems both inside and outside of the containment to preclude the release of the containment atmosphere. These lines penetrate the containment at penetrations 103 and 104. The integrity of these closed systems are verified during the periodic Type A tests.

As noted in Section 6.2.4.3, the valves associated with the piping systems connected to the secondary side of the steam generators isolate the steam generators and are not considered containment isolation valves and are, therefore, not leak tested. All portions of the secondary side of the steam generators are considered an extension of the containment. These systems penetrate the containment shell at penetrations P-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 83, 84, 85, and 86. As shown on Figure 6.2.4-2 the water level in all steam generators are maintained above the tubes following a LOCA to preclude the entrance of containment atmosphere into the secondary side of the steam generators. This requirement has been included in the Emergency Operating Instructions.

The test equipment to be used during the Type C tests will consist of a connection to an air supply source, a pressure regulator, a pressure gauge, a flow indicator, and associated valving.

Isolation valves are positioned to their post-accident position by the normal method with no accompanying adjustments. Fluid systems are properly drained and vented with the valves aligned to provide a test volume and atmospheric air back pressure on the isolation valve(s) being tested.

The test volume is pressurized to the test pressure Pa, as specified in the Technical Specifications. The pressure regulator(s) maintain the test volume at a minimum of Pa. The air flow rate into the test volume is recorded, as is the pressure reading. These records are utilized to determine the leakage rate in cubic centimeters per minute.

For larger test volumes, a pressure decay method may be utilized to determine the leakage rate.

The total leakage rate for Type B and C tests must be less than 0.6 L_a.

The criteria for determining the direction in which the test pressure is applied to the isolation valves are as follows:

<u>Gate Valves</u>

Parallel disc	a.	Test in the DBA direction.
	b.	Testing can be performed between the discs if a test connection or drain is provided in the valve design.
Flexible wedge	a.	Test in the DBA direction.
	b.	Testing can be performed between the wedge sections if a test connection or drain is provided in the valve design.
Solid wedge	a.	Test in the DBA direction.

<u>Globe Valves</u>	If the DBA flow direction is over the disc (flow to close), the valve may be tested in the reverse direction. However, if the DBA flow direction is under the disc (flow to open), then the valve must be tested in this direction.
Butterfly Valves	Test in either direction.
Flanges	Test in either direction.

Testing of the isolation valves in the nonaccident pressure direction, as allowed above, is as conservative or more conservative than testing them in the accident pressure direction.

6.2.6.4 Scheduling and Reporting of Periodic Tests

Type A, B, and C tests are conducted at the intervals specified in the Containment Leakage Rate Testing Program.

Test results are retained for internal and external review.

The preoperational test report contains a schematic of the leak measuring system, instrumentation used, supplemental test method, test program, and analysis and interpretation of the leakage test data for the Type A test.

6.2.6.5 Special Testing Requirements

WCGS does not have a subatmospheric containment or a secondary containment, hence there are no special testing requirements beyond those delineated in Sections 6.2.6.1 through 6.2.6.4.

6.2.7 REFERENCES

1. Bechtel Power Corporation, "Performance and Sizing of Dry Pressure Containments," Topical Report No. BN-TOP-3, (Rev. 4), October 1977.

2. "Pipe Breaks for the LOCA Analysis of the Westinghouse Primary Coolant Loop," WCAP-8082-P-A (Proprietary) and WCAP-8172-A (Non-Proprietary), January 1975.

3. Shepard, R.M., et al, "Westinghouse Mass and Energy Release Data for Containment Design," WCAP-8264-P-A, Rev. 1, (Proprietary) and WCAP-8312-A, Rev. 2 (Non-Proprietary), August 1975.

4. Bechtel Power Corporation "COPDA, Compartment Pressure Design Analysis," (Bechtel Computer Code), 1973.

5. Bechtel Power Corporation, "Subcompartment Pressure and Temperature Transient Analysis," Topical Report No. BN-TOP-4, (Rev. 1), October 1977.

6. Land, R. E., "Mass and Energy Releases Following a Steam Line Rupture," WCAP-8822 (Proprietary) and WCAP-8860 (Non-Proprietary), September 1976.

7. WCAP-7907-P-A, "LOFTRAN Code Description," April 1984.

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26. WCAP-8264-P-A, Rev. 1, "Westinghouse LOCA Mass and Energy Release Model for Containment Design - March 1979 Version," April 1979.

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28. NAI 8907-02, Revision 17, "GOTHIC Containment Analysis Package User Manual," Version 7.2a(QA), January 2006

29. NAI 8907-06, Revision 16, "GOTHIC Containment Analysis Package Technical Manual," Version 7.2a(QA), January 2006

30. NRC Letter from Anthony C. McMurtray (NRC) to Thomnas Coutu (NMC), Enclosure 2, Safety Evaluation, September 29, 2003.

TABLE 6.2.1-1

SPECTRUM OF POSTULATED LOSS-OF-COOLANT ACCIDENTS

1. Double-ended pump suction guillotine (DEPSG) break, with minimum safety injection.
2. DEPSG with maximum safety injection.
3. 0.6 DEPSG - with maximum safety injection.
4. 3 ft^2 pump suction split with maximum safety injection.
5. Double-ended hot leg guillotine break with maximum safety injection.
6. ouble-ended cold leg guillotine break with maximum safety injection

TABLE 6.2.1-2

PRINCIPAL CONTAINMENT DESIGN PARAMETERS

Containment design internal pressure	60 psig
Containment peak calculated internal pressure	
LOCA	47.8 psig
MSLB	52.9 psig
Containment design external pressure load	3.0 psid
Containment calculated external pressure	2.72 psid
Containment design temperature	320°F
Containment peak calculated vapor temperature	
LOCA	307.2°F
MSLB	364.9°F
Peak calculated equipment temperature-MSLB	See Figure 6.2.1-85
Internal dimensions	
Cylindrical wall diameter	140 ft
Cylindrical wall height	135 ft
Curved dome height above spring line	70 ft
Volume	
Net free internal volume	2.50×10^6 ft^3
Containment design leak rate	
First 24 hrs	0.20 percent free vol/day
After 1 day	0.10 percent free vol/day
Containment Internal Compartments:	
Reactor cavity design pressure	See Table 6.2.1-17
Reactor cavity calculated pressure	See Table 6.2.1-17
Steam generator loop compartment design pressure	See Table 6.2.1-22
Steam generator loop compartment calculated pressure	See Table 6.2.1-22
Pressurizer vault design pressure	See Table 6.2.1-26
Pressurizer vault calculated pressure w/surge line break	See Table 6.2.1-26
Pressurizer surge line compartment design pressure	See Table 6.2.1-26
Pressurizer surge line compartment calculated pressure w/surge line break	See Table 6.2.1-26

TABLE 6.2.1-3

ENGINEERED SAFETY FEATURES DESIGN PARAMETERS USED AS INPUT TO THE CONTAINMENT ANALYSIS

	Full Capacity	Minimum Capacity
ECCS		
Passive safety injection system		
Number of accumulators	4	4
Nominal Pressure, psig	602-648	602-648
Nominal Liquid volume, ft3	850/accumulator	850/accumulator
Active safety injection systems		
High-pressure system injection		
Number of lines	4	4
Number of centrifugal charging pumps	2	1
Intermediate pressure safety injection		
Number of lines	4	4
Number of safety injection pumps	2	1
Low-pressure safety injection		
Number of lines	4	4
Number of RHR pumps	2	1
Total injection flow rate, lbm/sec	1,401	586
Total recirculation flow rate, gpm	9,600	4,800
Containment heat removal systems		
Containment spray system		
Number of lines	2	1

TABLE 6.2.1-3 (Sheet 2)

	Full Capacity	Minimum Capacity
Number of pumps	2	1
Number of headers	2	1
Injection flow rate, gpm	*2932/pump	*2932/pump
Recirculation flow rate, gpm	3434/pump	3434/pump
Containment air coolers		
Number of units	4	2
Duty per cooler	(See Figure 6.2.1-15)**	
Air-side flow rate, acfm through fan during DBA conditions.	69,400	69,400
RHR Heat Exchangers		
Type	Shell and U-type	
Number	2	1
Effective heat transfer coefficient times heat transfer area, Btu/hr F	2.3×10^6/unit	2.3×10^6/unit
Primary side flow through RHR heat exchanger, lb/hr	2.34×10^6/unit	2.34×10^6/unit
Secondary side flow through RHR heat exchangers, lb/hr	3.8×10^6/unit	3.8×10^6/unit
Source of cooling water	Component cooling water	
Flow begin, sec, minimum	849	1,509
Component cooling Water Heat Exchangers		
Type	Shell and straight tube	

*For containment integrity analyses, an injection flow rate of 2932 gpm/pump, representing a 5% degradation of the delivered flow rate of 3086 gpm/pump, is used.

**The limiting case (DEPSG break with minimum safety injection) modeled the containment air cooler duty curve given in Table 6.2.1-57C.

TABLE 6.2.1-3 (Sheet 3)

	Full Capacity	Minimum Capacity
Number	2	1
Effective heat transfer coefficient times heat transfer area, Btu/hr °F	5.86×10^8/unit	5.86×10^8/unit
Primary side flow through CCW heat exchangers, lb/hr	3.8×10^6/unit	3.8×10^6/unit
Secondary side flow through CCW heat exchangers, lb/hr (1)	3.68×10^6/unit	3.68×10^6/unit
Source of cooling water	Essential Service Water	
Temperature of cooling water, max, °F	95	95

(1) The essential service water flow to the CCW heat exchanger(s) may be reduced to as low as 3.58×10^6/unit in order to ensure that the design bases cooling water flows are provided to the remaining ESW system components.

TABLE 6.2.1-4

CONTAINMENT PASSIVE HEAT SINK PARAMETERS

Thermophysical Properties

Material	Volumetric Heat Capacity Btu/ft^3 - F	Thermal Conductivity Btu/hr ft F
Epoxy paint	49.9	0.97
Inorganic zinc paint	21.7	0.63
Stainless steel	53.9	8.40
Carbon steel	54.3	28.35
Concrete	30.03	0.80
Zinc coating	40.9	64.8
Air	0.0145	0.017

	Value
Heat Transfer Coefficient	
Containment atmosphere to heat sink surfaces	"Modified Tagami"
Containment atmosphere to containment sump water	0
Containment sump water to containment floor	0
Liner gap conductance	20 Btu/hr-ft^2-F
Containment walls to outside atmosphere	2.0 Btu/hr-ft^2-F

Passive Heat Sink Description

Containment walls

Geometry	Slab
Surface area, ft^2	58807
Composition, ft	
Epoxy paint	0.00033
Inorganic zinc paint	0.00033

TABLE 6.2.1-4 (Sheet 2)

Carbon steel	0.02083
Air gap	0.00085
Concrete	4.00000

Boundary conditions - Liner plate exposed to containment atmosphere; outside exposed to the outside atmosphere

Containment Dome

Geometry	Slab
Surface area, ft^2	30806
Composition, ft	
Epoxy paint	0.00033
Inorganic zinc paint	0.00033
Carbon steel	0.02083
Air gap	0.00085
Concrete	3.00000

Boundary conditions - Liner plate exposed to containment atmosphere; outside exposed to the outside atmosphere

Unlined Concrete

Geometry	Slab
Surface area, ft^2	65831
Composition, ft	
Concrete	1.72000

Boundary conditions - One side exposed to containment atmosphere; the other side insulated.

Stainless Steel Lined Concrete

Geometry	Slab
Surface area, ft^2	7197
Composition, ft	
Stainless steel	0.02083
Air gap	0.00085
Concrete	2.00000

Boundary conditions - One side exposed to containment atmosphere, the other side insulated.

TABLE 6.2.1-4 (Sheet 3)

Galvanized Steel Lined Concrete

Geometry	Slab
Surface area, ft^2	6679
Composition, ft	
Zinc coating	0.00011
Carbon steel	0.00529
Air gap	0.00085
Concrete	1.34300

Boundary Conditions - One side exposed to containment atmosphere, the other side insulated.

Stainless Steel

Geometry	Slab
Surface area, ft^2	18648
Composition, ft	
Stainless steel	0.01792

Boundary conditions - One side exposed to containment atmosphere, the other side insulated.

Galvanized Steel

Geometry	Slab
Surface area, ft^2	68451
Composition, ft	
Zinc coating	0.00011
Carbon steel	0.00783

Boundary conditions - One side exposed to containment atmosphere, the other side insulated.

Carbon steel - unpainted

Geometry	
Surface area, ft^2	1769
Composition, ft	
Carbon steel	.0208

Boundary Conditions - One side exposed to containment atmosphere, the other side insulated.

TABLE 6.2.1-4 (Sheet 4)

Carbon Steel - Painted

Geometry	Slab
Surface area, ft^2	13450
Composition, ft	
Epoxy paint	0.00033
Inorganic zinc paint	0.00033
Carbon steel (0 0.125 in thick)	0.00696
Surface area, ft^2	84088
Composition, ft	
Epoxy paint	0.00033
Inorganic zinc paint	0.00033
Carbon steel (0.125 0.25 in. thick)	0.01667
Surface area, ft^2	40471
Composition, ft	
Epoxy paint	0.00033
Inorganic zinc paint	0.00033
Carbon steel (0.25 0.5 in. thick)	0.02817
Surface area, ft^2	24306
Composition, ft	
Epoxy paint	0.00033
Inorganic zinc paint	0.00033
Carbon steel (0.5 1.0 in. thick)	0.05900
Surface area, ft^2	11932
Composition, ft	
Epoxy paint	0.00033
Inorganic zinc paint	0.00033
Carbon steel (0.5 2.5 in. thick)	0.11192
Surface area, ft^2	7804
Composition, ft	
Epoxy Paint	0.00033
Inorganic zinc paint	0.00033
Carbon steel (>2.5 in. thick)	0.27892

Boundary conditions - One side exposed to containment atmosphere, the other side insulated.

TABLE 6.2.1-5

CONTAINMENT AND REACTOR COOLANT SYSTEM INITIAL CONDITIONS FOR CONTAINMENT ANALYSIS

Reactor coolant system (at overpower of 102-percent engineered safeguards ratings)	
Reactor core power level, MWt	3636
Average coolant temperature, °F	595.0
Mass of reactor coolant, lb	504.52×10^3
Reactor coolant energy, Btu(1)	304.90×10^6
Reactor coolant system pressure, psia	2250
Containment	
Free volume, ft^3	2.5×10^6
Pressure, psia	14.7
Atmosphere temperature, °F	130(2)
Outside atmosphere temperature, °F	120(3)
Relative humidity, percent	50
Stored water	
Refueling water storage tank, gal	394,000 (4)
Refueling water temperature, °F	100
Essential service water temperature, °F	95
Accumulators (4) capacity, lbs	210,300

(1) All energies relative to 32 °F.
(2) The limiting cases (DEPSG break with minimum safety injection for the LOCA analyses and Case 1, Case 10, Case 13, and Case 16 for the MSLB analyses) modeled a temperature of 1309 °F. the remaining analyses modeled a temperature of 120 °F.
(3) In order to address a CONTEMPT code limitation, the limiting LOcA analysis (DEPSG break with minimum safety injection), the outside air temperature was conservatively modeled as 130 °F.
(4) This is the minimum volume maintained in the RWST.

TABLE 6.2.1-6

CHRONOLOGY OF EVENTS
DEPSG BREAK W/MIN SI

Event	Time (Sec)
Break occurs	0
Peak containment pressure during blowdown (41.2 psig)	18.0
Primary system blowdown complete	20.86
Accumulator injection begins	20.86
Charging pump injection begins	20.86
Safety injection pump injection begins	20.86
RHR pump injection begins	20.86
Containment spray injection begins	60.0
Peak temperature reached (307.2 ^{O}F)	60.0
Containment fan coolers begin removing heat	70.0*
Accumulators empty	92.5
Peak containment pressure reached(47.8 psig)	130.0
Reflood complete	130.7
ECCS recirculation	1509.0
Containment spray recirculation	3227.0
End of steam generator energy release	3775.0
Containment pressure less than 50 percent of peak calculated pressure	5500.0
End of analysis	10^6

*An analysis performed for Generic Letter 96-06 indicates that the water side of the containment coolers may not completely fill and pressurize until 65 seconds after a design basis event coincident with a loss of offsite power. The original calculation of containment peak temperature and pressure assumed that the containment coolers would begin removing heat from the containment at the design rate at 60 seconds after the event. The containment pressure/temperature profile was recalculated using 70 seconds as the assumption for when the containment coolers would begin removing heat from the containment environment. There was negligible effect on the pressure/temperature profile as a result of the additional 10 second delay.

TABLE 6.2.1-7

CHRONOLOGY OF EVENTS
DEPSG BREAK W/MAX SI

Event	Time (Sec)
Break occurs	0
Peak containment pressure during blowdown of (41.2) psig	18.0
Primary system blowdown complete	20.86
Accumulator injection begins	20.86
Charging pump injection begins	20.86
Safety injection begins	20.86
RHR pump injection begins	20.86
Containment fan coolers begin to remove heat	60.0*
Containment spray injection begins	60.0
Peak temperature reached (301.7 °F)	60.0
Accumulators empty	92.1
Peak containment pressure reached (45.9 psig)	120.0
Reflood complete	124.0
ECCS recirculation	849.0
Containment pressure less than 50 percent of peak calculated pressure	1050.0
Containment spray recirculation	1667.0
End of steam generator energy release	3772.0
End of analysis	10^6

*A calculation of the peak containment pressure and temperature was performed for the limiting minimum S.I. case using 70 seconds for the assumption of when the containment coolers begin removing heat for the containment (see Table 6.2.1-6). There was negligible change in the peak containment pressure and temperature. Therefore, the calculation for the less limiting case of DEPSG Break with Maximum S.I. was not revised.

TABLE 6.2.1-8

COMPARATIVE RESULTS: SUMMARY OF RESULTS OF CONTAINMENT PRESSURE AND TEMPERATURE ANALYSIS FOR THE SPECTRUM OF POSTULATED ACCIDENTS

Accident	1	2	3	4	5	6
Break location	Pump suction (PS)	PS	PS	PS	Hot Leg	Pump Discharge
Break type	Double-ended guillotine (DEG)	DEG	0.6 DEG	Split	DEG	DEG
Break size	10.24 ft^2	10.24 ft^2	6.14 ft^2	3 ft^2	9.18 ft^2	8.25 ft^2
Safety injection	min	max	max	max	max	max
Containment sprays	min	max	max	max	max	max
Containment fan coolers	min	min	min	min	min	min
Peak pressure, psig	47.8	45.9	45.4	46.0	41.7	38.4
Time to peak pressure, sec	130.0	120.0	115.0	140.0	17.0	15.0
Peak temperature, F	307.2	301.7	302.7	287.0	265.8	274.1
Time to peak temperature, sec	60.0	60.0	60.0	60.0	17.0	60.0
Energy released to containment at time of peak pressure, 10^6 Btu	449.28	452.9	445.74	435.21	324.5	309.9
Energy absorbed by passive heat sinks at time of peak pressure, 10^6 Btu	81.0	80.9	78.0	83.4	25.6	22.2
Energy in vapor region at time of peak pressure, 10^6 Btu	310.8	297.2	294.15	297.8	274.28	254.25
Energy in sump water at time to peak pressure, x10^6 Btu	82.1	92.5	90.94	97.87	50.52	54.1
Energy removed by containment fan coolers up to the time of peak pressure, x10^6 Btu	1.99	1.27	1.26	1.94	0.0	0.0
Energy removed by containment sprays up to time of peak pressure, x10^6 Btu	3.60	6.23	6.19	9.57	0.0	0.0

TABLE 6.2.1-9

CONTAINMENT MASS AND ENERGY BALANCE
DEPSG BREAK WITH MINIMUM SAFETY INJECTION

ENERGY BALANCE (X 10^6 Btu)

	Initial 0 sec	Blowdown Peak 18 sec	End of Blowdown 21 sec	End of Reflood 130 sec	Peak Pressure 130 sec	Beginning of Recirculation 1509 sec	1 Day into Recirculation 87,000 sec
Containment atmosphere	24.1	274.3	271.3	310.8	310.8	262.7	45.2
Containment sump	0.0	51.2	54.5	82.1	82.1	441.9	376.2
Heat sinks	0.0	19.8	25.5	81.0	81.0	168.3	181.5
Reactor vessel	0.0	0.0	0.0	0.0	0.0	42.5	22.9
Total Energy Remaining	24.1	345.3	351.3	473.9	473.9	915.4	625.8
Initial energy	24.1	24.1	24.1	24.1	24.1	66.6	66.6
Energy added from primary system	0.0	321.0	327.4	448.6	448.6	842.8	3376.5
Energy added by sprays	0.0	0.0	0.0	1.9	1.9	39.7	87.2
Energy added by N_2 discharge	0.0	0.0	0.0	0.2	0.2	0.2	0.2
Heat removed by RHR	0.0	0.0	0.0	0.0	0.0	0.0	2003.0
Heat removed by air coolers	0.0	0.0	0.0	2.0	2.0	43.1	1094.1
Heat removed to outside atmosphere via heat sinks	0.0	~0.0	~0.0	~0.0	~0.0	~0.0	0.2
Total Energy Remaining	24.1	345.1	351.5	472.8	472.8	906.2	499.7

TABLE 6.2.1-9 (Sheet 2)

MASS BALANCE (X 10^3 lbm)

	Initial 0 sec	Blowdown Peak 18 sec	End of Blowdown 21 sec	End of Reflood 130 sec	Peak Pressure 130 sec	Beginning of Recirculation 1509 sec	1 Day into Recirculation 87,000 sec
Containment atmosphere	7.9	233.5	230.9	265.8	265.8	222.5	26.8
Containment sump	0.0	271.2	284.9	455.0	455.0	1864.8	2694.1
Reactor coolant	0.0	0.0	0.0	0.0	0.0	114.0	180.5
Total Mass	7.9	504.7	515.8	720.8	720.8	2201.3	2901.4
Initial mass	7.9	7.9	7.9	7.9	7.9	121.9	121.9
Mass released from primary system during injection phase	0.0	496.5	507.9	684.7	684.7	1492.9	1492.9
Mass added by sprays during injection phase	0.0	0.0	0.0	28.4	28.4	583.2	1283.0
Total Mass	7.9	504.4	515.8	721.0	721.0	2198.0	2897.8

TABLE 6.2.1-10

CONTAINMENT MASS AND ENERGY BALANCE DEPSG BREAK WITH MAXIMUM SAFETY INJECTION

ENERGY BALANCE (X 10^6 Btu)

	Initial 0 sec	Blowdown Peak 18 sec	End of Blowdown 21 sec	Peak Pressure 120 sec	End of Reflood 124 sec	Beginning of Recirculation 849 sec	1 Day into Recirculation 87,000 sec
Containment atmosphere	22.5	271.4	268.0	297.2	296.3	205.0	44.9
Containment sump	0.0	51.4	54.7	92.5	94.4	417.0	367.6
Heat sinks	0.0	20.9	26.9	80.9	81.9	136.7	189.9
Reactor vessel	0.0	0.0	0.0	0.0	0.0	41.2	17.8
Total Energy Remaining	22.5	343.7	349.6	470.6	472.6	799.9	620.2
Initial energy	22.5	22.5	22.5	22.5	22.5	63.7	63.7
Energy added from primary system	0.0	321.0	327.4	444.6	450.3	727.0	3283.1
Energy added by sprays	0.0	0.0	0.0	3.3	3.5	43.5	88.5
Energy added by N_2 discharge	0.0	0.0	0.0	0.2	0.2	0.2	0.2
Heat removed by RHR	0.0	0.0	0.0	0.0	0.0	0.0	2204.3
Heat removed by air coolers	0.0	0.0	0.0	1.3	1.4	18.1	574.9
Heat removed to outside atmosphere via heat sinks	0.0	~0.0	~0.0	~0.0	~0.0	0.1	9.8
Total Energy Remaining	22.5	343.5	350.0	469.3	475.1	816.2	646.5

TABLE 6.2.1-10 (Sheet 2)

MASS BALANCE (X 10^3 lbm)

	Initial 0 sec	Blowdown Peak 18 sec	End of Blowdown 21 sec	Peak Pressure 120 sec	End of Reflood 124 sec	Beginning of Recirculation 849 sec	1 Day into Recirculation 87,000 sec
Containment atmosphere	6.2	235.3	227.4	253.3	252.4	171.6	28.4
Containment sump	0.0	272.4	286.6	538.1	547.2	2174.8	2986.6
Reactor coolant	0.0	0.0	0.0	0.0	0.0	123.2	182.1
Total Mass	6.2	502.7	514.0	790.9	799.6	2469.6	3197.1
Initial mass	6.2	6.2	6.2	6.2	6.2	129.4	129.4
Mass released from primary system during injection phase	0.0	496.5	507.9	746.9	756.9	1772.2	1772.2
Mass added by sprays during injection phase	0.0	0.0	0.0	48.6	51.8	639.1	1301.7
Total Mass	6.2	502.7	514.1	801.7	814.9	2540.7	3203.3

TABLE 6.2.1-11

ADDITIONAL MASS AND ENERGY RELEASE-LOCA

Accumulator Nitrogen Release Following Accumulator Empty

Time (sec)	Mass (Lbs/sec)	Temp (F)
0	0	0
Accumulator empty	0	0
Accumulator empty	937	470
Accumulator empty +5	937	470
Accumulator empty +5	0	0
10^6	0	0

TABLE 6.2.1-12

REACTOR CAVITY
COLD LEG 150 SQUARE INCH BREAK
BREAK MASS FLOW AND ENERGY FLOW

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
0.00000	0.	0.	0.00
0.00251	1.2479195E+04	7.0036421E+06	561.23
0.00500	1.6637344E+04	9.3378033E+06	561.26
0.00751	1.9176510E+04	1.0762552E+07	561.24
0.01004	2.1386323E+04	1.2003236E+07	561.00
0.01253	2.2520092E+04	1.2626109E+07	560.66
0.01502	2.2352620E+04	1.2517510E+07	560.00
0.01751	2.4950199E+04	1.3983657E+07	560.46
0.02005	2.5459121E+04	1.4257657E+07	560.02
0.02252	2.4866287E+04	1.3909298E+07	559.36
0.02501	2.4633466E+04	1.3769194E+07	558.96
0.02754	2.5014356E+04	1.3978759E+07	558.83
0.03008	2.5119803E+04	1.4032344E+07	558.62
0.03257	2.5524819E+04	1.4258325E+07	558.61
0.03511	2.6140547E+04	1.4604555E+07	558.69
0.03761	2.6562706E+04	1.4841209E+07	558.72
0.04008	2.6938656E+04	1.5052055E+07	558.75
0.04253	2.7292354E+04	1.5250487E+07	558.78
0.04501	2.7388755E+04	1.5301809E+07	558.69
0.04756	2.7236107E+04	1.5211357E+07	558.50
0.05005	2.7085068E+04	1.5122646E+07	558.34
0.05257	2.6940928E+04	1.5038569E+07	558.21
0.05513	2.6836674E+04	1.4977666E+07	558.10
0.05760	2.6764042E+04	1.4935072E+07	558.03
0.06006	2.6614323E+04	1.4848672E+07	557.92
0.06253	2.6285228E+04	1.4660363E+07	557.74
0.06508	2.5851165E+04	1.4412680E+07	557.53
0.06750	2.5511843E+04	1.4219705E+07	557.38
0.07003	2.5402939E+04	1.4158179E+07	557.34
0.07254	2.5559335E+04	1.4247626E+07	557.43
0.07506	2.5806312E+04	1.4388536E+07	557.56
0.07750	2.5940979E+04	1.4465034E+07	557.61
0.08005	2.5870657E+04	1.4424514E+07	557.56
0.08253	2.5607302E+04	1.4274260E+07	557.43
0.08509	2.5192299E+04	1.4038094E+07	557.24
0.08752	2.4717011E+04	1.3768031E+07	557.03
0.09007	2.4223797E+04	1.3488405E+07	556.82
0.09254	2.3793468E+04	1.3244805E+07	556.66
0.09506	2.3440760E+04	1.3045481E+07	556.53
0.09756	2.3189290E+04	1.2903588E+07	556.45
0.10011	2.3013785E+04	1.2804787E+07	556.40

TABLE 6.2.1-12 (Sheet 2)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
0.10514	2.2833488E+04	1.2703935E+07	556.37
0.11003	2.2965013E+04	1.2779727E+07	556.49
0.11504	2.3456540E+04	1.3058989E+07	556.73
0.12013	2.3888539E+04	1.3304130E+07	556.93
0.12516	2.3987351E+04	1.3359886E+07	556.96
0.13001	2.3910924E+04	1.3315992E+07	556.90
0.13507	2.3636693E+04	1.3160000E+07	556.76
0.14013	2.3175308E+04	1.2898561E+07	556.56
0.14503	2.2889044E+04	1.2736857E+07	556.46
0.14502	2.2822906E+04	1.2699974E+07	556.46
0.15502	2.2774884E+04	1.2673177E+07	556.45
0.16000	2.2529730E+04	1.2534576E+07	556.36
0.16509	2.2238877E+04	1.2370534E+07	556.26
0.17012	2.2140066E+04	1.2315260E+07	556.24
0.17508	2.2176390E+04	1.2336414E+07	556.29
0.18013	2.2268559E+04	1.2389108E+07	556.35
0.18508	2.2406351E+04	1.2467322E+07	556.42
0.19006	2.2609861E+04	1.2582689E+07	556.51
0.19507	2.2289889E+04	1.2712888E+07	556.61
0.20010	2.2992641E+04	1.2799181E+07	556.66
0.21251	2.3099985E+04	1.2859073E+07	556.67
0.22515	2.2766403E+04	1.2669465E+07	556.50
0.23753	2.2665482E+04	1.2612627E+07	556.47
0.25008	2.2917330E+04	1.2755851E+07	556.60
0.26260	2.2788777E+04	1.2685208E+07	556.52
0.27509	2.2335385E+04	1.2425851E+07	556.33
0.28757	2.2347390E+04	1.2433610E+07	556.38
0.30001	2.2887445E+04	1.2739650E+07	556.62
0.31265	2.2969350E+04	1.2750924E+07	556.58
0.32507	2.2697713E+04	1.2630559E+07	556.47
0.33759	2.2741599E+04	1.2655926E+07	556.51
0.35022	2.2756910E+04	1.2665639E+07	556.51
0.36260	2.2730072E+04	1.2648997E+07	556.49
0.37513	2.2668840E+04	1.2614348E+07	556.46
0.38750	2.2657310E+04	1.2607927E+07	556.46
0.40029	2.2719561E+04	1.2643147E+07	556.49
0.41257	2.2702061E+04	1.2633128E+07	556.47
0.42524	2.2816315E+04	1.2697746E+07	556.52
0.43762	2.2857841E+04	1.2721116E+07	556.53
0.45010	2.2765073E+04	1.2668196E+07	556.48
0.46256	2.2711434E+04	1.2637794E+07	556.45
0.47585	2.2739781E+04	1.2654050E+07	556.47
0.48765	2.2789504E+04	1.2682156E+07	556.49
0.50002	2.2892916E+04	1.2739682E+07	556.54
0.52506	2.2783476E+04	1.2678118E+07	556.46
0.55003	2.2749255E+04	1.2659461E+07	556.48
0.57514	2.2873354E+04	1.2729382E+07	556.52
0.60018	2.2801817E+04	1.2688886E+07	556.49
0.62518	2.2913270E+04	1.2752101E+07	556.54

TABLE 6.2.1-12 (Sheet 3)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
0.65007	2.2870850E+04	1.2727855E+07	556.57
0.67513	2.2860966E+04	1.2722588E+07	556.52
0.70039	2.2933255E+04	1.2763494E+07	556.55
0.72501	2.2903970E+04	1.2746812E+07	556.53
0.75005	2.2969196E+04	1.2783878E+07	556.57
0.77512	2.2934406E+04	1.2764040E+07	556.55
0.80005	2.2951385E+04	1.2773815E+07	556.56
0.82505	2.2974247E+04	1.2786780E+07	556.57
0.85001	2.2994030E+04	1.2797983E+07	556.58
0.87510	2.2988790E+04	1.2794993E+07	556.58
0.90002	2.2996781E+04	1.2799550E+07	556.58
0.92524	2.3003880E+04	1.2803606E+07	556.58
0.95017	2.3022905E+04	1.2814416E+07	556.59
0.97514	2.3022883E+04	1.2814383E+07	556.59
1.00003	2.3021832E+04	1.2813804E+07	556.59

TABLE 6.2.1-13

HOT LEG LONGITUDINAL SPLIT BREAK
763 SQUARE INCHES
BREAK MASS FLOW AND ENERGY FLOW

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
.00000	0.	0.	0.00
.00101	8.1033415E+03	5.2479074E+06	647.62
.00202	1.4891822E+04	9.6436977E+06	647.58
.00300	3.3538763E+04	2.1729309E+07	647.89
.00402	4.3750401E+04	2.8341351E+07	647.80
.00502	4.8666372E+04	3.1512215E+07	647.52
.00601	5.0589146E+04	3.2737434E+07	647.12
.00702	5.1006945E+04	3.2992058E+07	646.82
.00803	5.0895242E+04	3.2914153E+07	646.70
.00902	5.0885216E+04	3.2910703E+07	646.76
.01001	5.1218730E+04	3.3131758E+07	646.87
.01100	5.1876999E+04	3.3560988E+07	646.93
.01202	5.2726932E+04	3.4110885E+07	646.93
.01303	5.3551829E+04	3.4641668E+07	646.88
.01403	5.4244736E+04	3.5085029E+07	646.79
.01503	5.4734699E+04	3.5395489E+07	646.67
.01600	5.4991203E+04	3.5553987E+07	646.54
.01700	5.5031540E+04	3.5572926E+07	646.41
.01802	5.4890352E+04	3.5475352E+07	646.29
.01900	5.4638748E+04	3.5308193E+07	646.21
.02003	5.4323329E+04	3.5101741E+07	646.16
.02101	5.4037895E+04	3.4917074E+07	646.16
.02201	5.3815910E+04	3.4775539E+07	646.19
.02304	5.3696178E+04	3.4701830E+07	646.26
.02400	5.3694077E+04	3.4704850E+07	646.34
.02500	5.3796572E+04	3.4775974E+07	646.43
.02602	5.3990369E+04	3.4906106E+07	646.52
.02702	5.4234465E+04	3.5068321E+07	646.61
.02805	5.4519544E+04	3.5256767E+07	646.68
.02904	5.4803890E+04	3.5444269E+07	646.75
.03003	5.5093564E+04	3.5634737E+07	646.80
.03105	5.5368834E+04	3.5815396E+07	646.85
.03204	5.5628834E+04	3.5985533E+07	646.90
.03301	5.5870866E+04	3.6144992E+07	646.94
.03403	5.6116586E+04	3.6306019E+07	646.97
.03504	5.6352566E+04	3.6460386E+07	647.00
.03604	5.6574044E+04	3.6605007E+07	647.03
.03705	5.6788352E+04	3.6744693E+07	647.05
.03801	5.6980592E+04	3.6869767E+07	647.06

TABLE 6.2.1-13 (Sheet 2)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
.03903	5.7166900E+04	3.6990763E+07	647.07
.04002	5.7333293E+04	3.7098501E+07	647.07
.04104	5.7482392E+04	3.7194704E+07	647.06
.04203	5.7606029E+04	3.7274227E+07	647.05
.04304	5.7708024E+04	3.7339466E+07	647.04
.04402	5.7784192E+04	3.7387841E+07	647.03
.04505	5.7840728E+04	3.7423358E+07	647.01
.04602	5.7873443E+04	3.7443488E+07	646.99
.04701	5.7889007E+04	3.7452485E+07	646.97
.04805	5.7888115E+04	3.7450818E+07	646.95
.04902	5.7873180E+04	3.7440175E+07	646.93
.05003	5.7845754E+04	3.7421521E+07	646.92
.05103	5.7807767E+04	3.7396135E+07	646.91
.05201	5.7759239E+04	3.7364084E+07	646.89
.05301	5.7703737E+04	3.7327910E+07	646.89
.05401	5.7642796E+04	3.7288847E+07	646.90
.05501	5.7580205E+04	3.7249159E+07	646.91
.05601	5.7520836E+04	3.7212224E+07	646.93
.05701	5.7470363E+04	3.7182530E+07	646.99
.05800	5.7459013E+04	3.7182770E+07	647.12
.05901	5.7519410E+04	3.7230371E+07	647.27
.06001	5.7665585E+04	3.7335873E+07	647.46
.06101	5.7877470E+04	3.7477569E+07	647.53
.06202	5.8086446E+04	3.7615994E+07	647.59
.06302	5.8243275E+04	3.7719911E+07	647.63
.06401	5.8331248E+04	3.7778611E+07	647.66
.06502	5.8345634E+04	3.7789282E+07	647.68
.06601	5.8292793E+04	3.7756256E+07	647.70
.06702	5.8186575E+04	3.7688681E+07	647.72
.06801	5.8048569E+04	3.7600591E+07	647.74
.06903	5.7887936E+04	3.7498055E+07	647.77
.07004	5.7725913E+04	3.7394812E+07	647.80
.07105	5.7577918E+04	3.7300713E+07	647.83
.07201	5.7442843E+04	3.7215231E+07	647.87
.07301	5.7328001E+04	3.7143113E+07	647.91
.07403	5.7229128E+04	3.7081251E+07	647.94
.07501	5.7145380E+04	3.7028937E+07	647.98
.07604	5.7061007E+04	3.6976103E+07	648.01
.07700	5.6975294E+04	3.6922210E+07	648.04
.07801	5.6874079E+04	3.6858249E+07	648.07
.07900	5.6755906E+04	3.6782928E+07	648.09
.08001	5.6604661E+04	3.6685846E+07	648.11
.08101	5.6411574E+04	3.6561466E+07	648.12
.08201	5.6177799E+04	3.6410684E+07	648.13
.08302	5.5901391E+04	3.6232262E+07	648.15
.08400	5.5597445E+04	3.6035854E+07	648.16
.08500	5.5257094E+04	3.5815753E+07	648.17

TABLE 6.2.1-13 (Sheet 3)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
.08601	5.4895819E+04	3.5581993E+07	648.17
.08702	5.4507445E+04	3.5330892E+07	648.18
.08802	5.4119131E+04	3.5079676E+07	648.19
.08902	5.3735948E+04	3.4832294E+07	648.21
.09001	5.3370360E+04	3.4596380E+07	648.23
.09100	5.3026446E+04	3.4374325E+07	648.25
.09203	5.2689097E+04	3.4156435E+07	648.26
.09302	5.2396247E+04	3.3967350E+07	648.28
.09402	5.2128103E+04	3.3794433E+07	648.30
.09502	5.1897012E+04	3.3645411E+07	648.31
.09602	5.1677805E+04	3.3504063E+07	648.33
.09705	5.1491386E+04	3.3384382E+07	648.35
.09802	5.1342918E+04	3.3288972E+07	648.37
.09905	5.1204513E+04	3.3200117E+07	648.38
.10002	5.1098817E+04	3.3132545E+07	648.40
.10506	5.0873716E+04	3.2993792E+07	648.54
.11003	5.1124634E+04	3.3166978E+07	648.75
.11503	5.1599480E+04	3.3486750E+07	648.97
.12004	5.2014096E+04	3.3765100E+07	649.15
.12512	5.2266069E+04	3.3934436E+07	649.26
.13006	5.2387018E+04	3.4016716E+07	649.33
.13501	5.2404864E+04	3.4031458E+07	649.40
.14008	5.2342945E+04	3.3994574E+07	649.46
.14506	5.2260398E+04	3.3944682E+07	649.53
.15008	5.2157685E+04	3.3881463E+07	649.60
.15513	5.2015304E+04	3.3791729E+07	649.65
.16005	5.1824647E+04	3.3670065E+07	649.69
.16504	5.1575205E+04	3.3510530E+07	649.74
.17013	5.1289450E+04	3.3328672E+07	649.82
.17508	5.1047575E+04	3.3176979E+07	649.92
.18008	5.0890714E+04	3.3082720E+07	650.07
.18507	5.0832171E+04	3.3053862E+07	650.25
.19015	5.0840397E+04	3.3069401E+07	650.46
.19509	5.0862614E+04	3.3094170E+07	650.66
.20005	5.0849271E+04	3.3095949E+07	650.86
.21009	5.0589926E+04	3.2947105E+07	651.26
.22007	5.0165355E+04	3.2684782E+07	651.54
.23008	5.0018470E+04	3.2597158E+07	651.70
.24008	5.0155702E+04	3.2690539E+07	651.78
.25002	5.0235222E+04	3.2744556E+07	651.82
.26002	5.0043009E+04	3.2623793E+07	651.92
.27007	4.9754984E+04	3.2443934E+07	652.07
.28008	4.9607409E+04	3.2356377E+07	652.25
.29011	4.9578057E+04	3.2344552E+07	652.40
.30002	4.9479037E+04	3.2285716E+07	652.51
.31006	4.9217645E+04	3.2120448E+07	652.62
.32005	4.8987294E+04	3.1974617E+07	652.71

WOLF CREEK

TABLE 6.2.1-13 (Sheet 4)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
.33009	4.8990341E+04	3.1979432E+07	652.77
.34003	4.9108943E+04	3.2058107E+07	652.80
.35006	4.9137581E+04	3.2078127E+07	652.82
.36003	4.9028820E+04	3.2009935E+07	652.88
.37003	4.8894983E+04	3.1926330E+07	652.96
.38013	4.8812191E+04	3.1875826E+07	653.03
.39002	4.8757250E+04	3.1842653E+07	653.09
.40009	4.8677019E+04	3.1792462E+07	653.13
.41012	4.8567941E+04	3.1723202E+07	653.17
.42004	4.8477201E+04	3.1665706E+07	653.21
.43007	4.8441687E+04	3.1643958E+07	653.24
.44007	4.8444420E+04	3.1646891E+07	653.26
.45003	4.8439546E+04	3.1644850E+07	653.29
.46008	4.8405455E+04	3.1623966E+07	653.31
.47000	4.8347220E+04	3.1587479E+07	653.35
.48004	4.8265944E+04	3.1536071E+07	653.38
.49008	4.8165418E+04	3.1472203E+07	653.42
.50010	4.8064286E+04	3.1407993E+07	653.46
.51011	4.7985748E+04	3.1358441E+07	653.49
.52004	4.7936044E+04	3.1327541E+07	653.53
.53009	4.7906127E+04	3.1309516E+07	653.56
.54006	4.7936807E+04	3.1330817E+07	653.59
.55015	4.8018455E+04	3.1384877E+07	653.60
.56014	4.8060735E+04	3.1413510E+07	653.62
.57009	4.8028295E+04	3.1393693E+07	653.65
.58002	4.7953157E+04	3.1346723E+07	653.69
.59011	4.7879057E+04	3.1300753E+07	653.75
.60001	4.7819109E+04	3.1264058E+07	653.80
.61011	4.7774294E+04	3.1237307E+07	653.85
.62005	4.7749312E+04	3.1223757E+07	653.90
.63010	4.7741022E+04	3.1220407E+07	653.95
.64009	4.7740675E+04	3.1222522E+07	654.00
.65011	4.7737632E+04	3.1222954E+07	654.05
.66005	4.7715946E+04	3.1211437E+07	654.11
.67007	4.7664669E+04	3.1181053E+07	654.18
.68012	4.7594828E+04	3.1138969E+07	654.25
.69012	4.7521882E+04	3.1095090E+07	654.33
.70002	4.7455716E+04	3.1055716E+07	654.41
.71008	4.7398427E+04	3.1022260E+07	654.50
.72007	4.7353041E+04	3.0996566E+07	654.58
.73011	4.7315200E+04	3.0975837E+07	654.67
.74005	4.7281012E+04	3.0957518E+07	654.76
.75013	4.7243509E+04	3.0937209E+07	654.85
.76002	4.7194671E+04	3.0909640E+07	654.94
.77008	4.7128901E+04	3.0871408E+07	655.04
.78009	4.7054137E+04	3.0827582E+07	655.15
.79009	4.6979598E+04	3.0784111E+07	655.27

WOLF CREEK

TABLE 6.2.1-13 (Sheet 5)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
.80009	4.6909670E+04	3.0743779E+07	655.38
.81012	4.6846184E+04	3.0707716E+07	655.50
.82004	4.6789900E+04	3.0676296E+07	655.62
.83013	4.6737041E+04	3.0647175E+07	655.74
.84011	4.6684891E+04	3.0618468E+07	655.85
.85009	4.6627681E+04	3.0586542E+07	655.97
.86004	4.6561116E+04	3.0548661E+07	656.10
.87010	4.6484743E+04	3.0504624E+07	656.23
.88003	4.6405813E+04	3.0458971E+07	656.36
.89011	4.6326865E+04	3.0413449E+07	656.50
.90009	4.6251629E+04	3.0370296E+07	656.63
.91010	4.6179916E+04	3.0329443E+07	656.77
.92002	4.6113085E+04	3.0291681E+07	656.90
.93010	4.6047783E+04	3.0254975E+07	657.03
.94007	4.5982134E+04	3.0217963E+07	657.17
.95003	4.5911172E+04	3.0177521E+07	657.30
.96010	4.5831557E+04	3.0131578E+07	657.44
.97003	4.5746802E+04	3.0082265E+07	657.58
.98011	4.5658511E+04	3.0030751E+07	657.73
.99008	4.5572130E+04	2.9980387E+07	657.87
1.00007	4.5488016E+04	2.9931454E+07	658.01
1.05012	4.5093621E+04	2.9702761E+07	658.69
1.10006	4.4639245E+04	2.9435833E+07	659.42
1.15004	4.4211852E+04	2.9186409E+07	660.15
1.20005	4.3751417E+04	2.8917926E+07	660.96
1.25007	4.3329589E+04	2.8672916E+07	661.74
1.30006	4.2799627E+04	2.8364827E+07	662.74
1.35007	4.2388735E+04	2.8129930E+07	663.62
1.40003	4.2008795E+04	2.7912315E+07	664.44
1.45009	4.1662480E+04	2.7710541E+07	665.12
1.50000	4.1333848E+04	2.7514553E+07	665.67
1.55010	4.1022218E+04	2.7324771E+07	666.10
1.60010	4.0719831E+04	2.7135783E+07	666.40
1.65004	4.0437624E+04	2.6953064E+07	666.53
1.70002	4.0164166E+04	2.6772580E+07	666.58
1.75006	3.9902789E+04	2.6598232E+07	666.58
1.80007	3.9647963E+04	2.6426705E+07	666.53
1.85005	3.9411803E+04	2.6267045E+07	666.48
1.90008	3.9183080E+04	2.6112873E+07	666.43
1.95010	3.8973644E+04	2.5969514E+07	666.34
2.00012	3.8777963E+04	2.5832984E+07	665.18
2.05001	3.8599076E+04	2.5703956E+07	665.92
2.10013	3.8433525E+04	2.5579363E+07	665.55
2.15013	3.8392287E+04	2.5526412E+07	664.88
2.20005	3.8406062E+04	2.5507508E+07	664.15
2.25003	3.8353069E+04	2.5449311E+07	663.55
2.30012	3.8231713E+04	2.5352190E+07	663.12

WOLF CREEK

TABLE 6.2.1-13 (Sheet 6)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
2.35007	3.8076095E+04	2.5237305E+07	662.81
2.40017	3.7893101E+04	2.5109325E+07	662.64
2.45012	3.7705570E+04	2.4979815E+07	662.50
2.50026	3.7523172E+04	2.4852799E+07	662.33
2.55018	3.7328598E+04	2.4719165E+07	662.20
2.60005	3.7137102E+04	2.4588828E+07	662.11
2.65002	3.6933419E+04	2.4452387E+07	662.07
2.70024	3.6747504E+04	2.4323077E+07	661.90
2.75032	3.6555254E+04	2.4187540E+07	661.67
2.80009	3.6373800E+04	2.4056056E+07	661.36
2.85014	3.6202085E+04	2.3928924E+07	660.98
2.90010	3.6007079E+04	2.3789049E+07	660.68
2.95007	3.5781539E+04	2.3639916E+07	660.67
3.00011	3.5594393E+04	2.3513164E+07	660.59

TABLE 6.2.1-14

LIMITED AREA CIRCUMFERENTIAL BREAK
PUMP SUCTION
436 SQUARE INCHES
BREAK MASS FLOW AND ENERGY FLOW

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
.00000	0.	0.	0.00
.00101	1.0612719E+04	5.9402813E+06	559.73
.00201	1.5477103E+04	8.6430425E+06	556.44
.00300	1.8715158E+04	1.0445304E+07	558.12
.00401	2.0587861E+04	1.1473286E+07	557.28
.00502	2.2870173E+04	1.2745422E+07	557.29
.00602	2.4323128E+04	1.3555706E+07	557.32
.00701	2.5284095E+04	1.4092159E+07	557.35
.00800	2.5934924E+04	1.4455438E+07	557.37
.00902	2.7097377E+04	1.5128925E+07	558.32
.01001	2.8648302E+04	1.5971766E+07	557.51
.01101	2.8321396E+04	1.5785820E+07	557.38
.01202	2.9178242E+04	1.6282400E+07	558.03
.01301	3.0337228E+04	1.6918747E+07	557.69
.01401	3.0532624E+04	1.7021447E+07	557.48
.01500	3.0638207E+04	1.7079211E+07	557.45
.01600	3.0530564E+04	1.7015821E+07	557.34
.01702	3.0637336E+04	1.7082704E+07	557.58
.01804	3.1491107E+04	1.7568886E+07	557.90
.01901	3.2718574E+04	1.8255835E+07	557.97
.02002	3.3697834E+04	1.8796276E+07	557.79
.02102	3.3990467E+04	1.8948289E+07	557.46
.02204	3.3051422E+04	1.8415925E+07	557.19
.02302	3.2317668E+04	1.8010469E+07	557.29
.02401	3.1893177E+04	1.7768510E+07	557.13
.02502	3.1159434E+04	1.7362933E+07	557.23
.02603	3.1058249E+04	1.7306350E+07	557.22
.02701	3.1162295E+04	1.7369362E+07	557.38
.02801	3.1354587E+04	1.7472001E+07	557.24
.02904	3.1163827E+04	1.7364131E+07	557.19
.03001	3.1162137E+04	1.7364544E+07	557.23
.03103	3.0910260E+04	1.7218121E+07	557.04
.03203	3.0335949E+04	1.6902309E+07	557.17
.03302	3.0473443E+04	1.6979848E+07	557.20
.03401	3.0381381E+04	1.6923743E+07	557.04
.03502	3.0151477E+04	1.6796567E+07	557.07
.03600	3.0013069E+04	1.6718224E+07	557.03
.03702	2.9768551E+04	1.6581642E+07	557.02
.03801	2.9739734E+04	1.6568611E+07	557.12

TABLE 6.2.1-14 (Sheet 2)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
.03901	2.9792727E+04	1.6596738E+07	557.07
.04001	2.9748776E+04	1.6572473E+07	557.08
.04101	2.9890995E+04	1.6655022E+07	557.19
.04200	3.0148218E+04	1.6796695E+07	557.14
.04300	3.0086983E+04	1.6757676E+07	556.97
.04402	2.9857969E+04	1.6631172E+07	557.01
.04501	2.9813962E+04	1.6607459E+07	557.04
.04602	2.9671708E+04	1.6525465E+07	556.94
.04702	2.9516248E+04	1.6443706E+07	557.11
.04801	3.0768840E+04	1.7173297E+07	558.14
.04901	3.4095683E+04	1.9046548E+07	558.62
.05000	3.6620754E+04	2.0436773E+07	558.07
.05102	3.8088803E+04	2.1256333E+07	558.07
.05202	3.9365211E+04	2.1960727E+07	557.87
.05304	3.9311114E+04	2.1903205E+07	557.18
.05401	3.8337268E+04	2.1356696E+07	557.07
.05503	3.7800104E+04	2.1067346E+07	557.34
.05600	3.7983737E+04	2.1180418E+07	557.62
.05703	3.8878146E+04	2.1692161E+07	557.95
.05802	4.0127890E+04	2.2391612E+07	558.01
.05901	4.0911763E+04	2.2819095E+07	557.76
.06004	4.1054620E+04	2.2890932E+07	557.57
.06102	4.1013622E+04	2.2869661E+07	557.61
.06201	4.1314329E+04	2.3046886E+07	557.84
.06303	4.2199537E+04	2.3552324E+07	558.12
.06405	4.3493146E+04	2.4283572E+07	558.33
.06506	4.4938720E+04	2.5097023E+07	558.47
.06605	4.6276930E+04	2.5844322E+07	558.47
.06703	4.7220224E+04	2.6365572E+07	558.35
.06806	4.7747552E+04	2.6653684E+07	558.22
.06904	4.7980823E+04	2.6781685E+07	558.17
.07002	4.8179997E+04	2.6893932E+07	558.20
.07103	4.8414892E+04	2.7025673E+07	558.21
.07206	4.8606537E+04	2.7130683E+07	558.17
.07303	4.8666339E+04	2.7161953E+07	558.13
.07406	4.8690461E+04	2.7176006E+07	558.14
.07506	4.8821441E+04	2.7252671E+07	558.21
.07601	4.9112729E+04	2.7419953E+07	558.31
.07706	4.9620229E+04	2.7708124E+07	558.40
.07803	5.0151290E+04	2.8006693E+07	558.44
.07905	5.0618710E+04	2.8266104E+07	558.41
.08003	5.0850883E+04	2.8390601E+07	558.31
.08102	5.0817457E+04	2.8366329E+07	558.20
.08203	5.0612968E+04	2.8248617E+07	558.13
.08307	5.0386212E+04	2.8121516E+07	558.12
.08406	5.0258532E+04	2.8051174E+07	558.14
.08508	5.0203870E+04	2.8020700E+07	558.14

TABLE 6.2.1-14 (Sheet 3)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
.08601	5.0145171E+04	2.7986129E+07	558.10
.08707	4.9971795E+04	2.7885479E+07	558.02
.08804	4.9707446E+04	2.7734628E+07	557.96
.08906	4.9388985E+04	2.7555369E+07	557.93
.09007	4.9149064E+04	2.7423039E+07	557.96
.09108	4.9102485E+04	2.7401129E+07	558.04
.09204	4.9254670E+04	2.7490224E+07	558.12
.09300	4.9535585E+04	2.7650217E+07	558.19
.09406	4.9890637E+04	2.7850104E+07	558.22
.09500	5.0168142E+04	2.8004932E+07	558.22
.09604	5.0390735E+04	2.8127887E+07	558.20
.09703	5.0494501E+04	2.8184059E+07	558.16
.09810	5.0512250E+04	2.8192052E+07	558.12
.09909	5.0461904E+04	2.8162069E+07	558.09
.10000	5.0365589E+04	2.8106397E+07	558.05
.10510	4.9565693E+04	2.7655238E+07	557.95
.11001	4.9462917E+04	2.7597334E+07	557.94
.11506	4.9112169E+04	2.7395046E+07	557.81
.12009	4.7947073E+04	2.6739988E+07	557.70
.12514	4.7822210E+04	2.6674141E+07	557.78
.13010	4.8192706E+04	2.6884750E+07	557.86
.13507	4.8521633E+04	2.7071479E+07	557.93
.14015	4.9035115E+04	2.7362858E+07	558.03
.14510	4.9372084E+04	2.7550667E+07	558.02
.15007	4.9301214E+04	2.7510682E+07	558.01
.15520	4.9434402E+04	2.7587019E+07	558.05
.16003	4.9576486E+04	2.7665767E+07	558.04
.16516	4.9299952E+04	2.7508317E+07	557.98
.17018	4.9058771E+04	2.7373159E+07	557.97
.17505	4.8910979E+04	2.7289827E+07	557.95
.18013	4.8626434E+04	2.7129924E+07	557.93
.18513	4.8635917E+04	2.7138547E+07	557.99
.19012	4.9085839E+04	2.7394609E+07	558.10
.19517	4.9648645E+04	2.7712952E+07	558.18
.20016	5.0073564E+04	2.7952642E+07	558.23
.21011	5.0191360E+04	2.8017063E+07	558.20
.22002	4.9667002E+04	2.7721259E+07	558.14
.23008	4.9087501E+04	2.7397055E+07	558.13
.24006	4.9041043E+04	2.7374860E+07	558.20
.25008	4.9219880E+04	2.7478666E+07	558.28
.26011	4.9140217E+04	2.7435036E+07	558.30
.27017	4.8667267E+04	2.7170814E+07	558.30
.28021	4.8455895E+04	2.7056505E+07	558.37
.29004	4.8824196E+04	2.7268675E+07	558.51
.30001	4.9234397E+04	2.7501876E+07	558.59
.31007	4.9184218E+04	2.7474483E+07	558.60
.32005	4.8928510E+04	2.7333010E+07	558.63

TABLE 6.2.1-14 (Sheet 4)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
.33019	4.8807988E+04	2.7269420E+07	558.71
.34006	4.8837616E+04	2.7290061E+07	558.79
.35008	4.8750832E+04	2.7243868E+07	558.84
.36005	4.8447244E+04	2.7075705E+07	558.87
.37009	4.8267095E+04	2.6979211E+07	558.96
.38017	4.8374968E+04	2.7045550E+07	559.08
.39018	4.8501796E+04	2.7121434E+07	559.18
.40003	4.8493322E+04	2.7120275E+07	559.26
.41017	4.8447865E+04	2.7098905E+07	559.34
.42010	4.8534561E+04	2.7152719E+07	559.45
.43018	4.8714184E+04	2.7258676E+07	559.56
.44000	4.8704108E+04	2.7256436E+07	559.63
.45002	4.8426303E+04	2.7103518E+07	559.69
.46004	4.8115803E+04	2.6933627E+07	559.77
.47013	4.7988548E+04	2.6868099E+07	559.89
.48007	4.8017445E+04	2.6890163E+07	560.01
.49010	4.8032671E+04	2.6904013E+07	560.12
.50006	4.7944911E+04	2.6859676E+07	560.22
.51004	4.7841510E+04	2.6807167E+07	560.33
.52005	4.7817261E+04	2.6799668E+07	560.46
.53016	4.7837500E+04	2.6816896E+07	560.58
.54004	4.7816839E+04	2.6810540E+07	560.69
.55004	4.7726210E+04	2.6764914E+07	560.80
.56007	4.7592712E+04	2.6695633E+07	560.92
.57008	4.7445915E+04	2.6619144E+07	561.04
.58006	4.7292450E+04	2.6538897E+07	561.17
.59008	4.7155691E+04	2.6468331E+07	561.30
.60008	4.7138608E+04	2.6465977E+07	561.45
.61000	4.7185043E+04	2.6499354E+07	561.60
.62008	4.7217354E+04	2.6524523E+07	561.75
.63020	4.7171530E+04	2.6505072E+07	561.89
.64010	4.7050159E+04	2.6442854E+07	562.01
.65008	4.6943185E+04	2.6389395E+07	562.16
.66015	4.6879717E+04	2.6360798E+07	562.31
.67016	4.6805880E+04	2.6326054E+07	562.45
.68024	4.6671712E+04	2.6257037E+07	562.59
.69021	4.6488324E+04	2.6160386E+07	562.73
.70004	4.6329886E+04	2.6078351E+07	562.88
.71004	4.6240897E+04	2.6035855E+07	563.05
.72006	4.6191780E+04	2.6015591E+07	563.21
.73031	4.6130742E+04	2.5988360E+07	563.36
.74018	4.6038465E+04	2.5943307E+07	563.51
.75006	4.5931516E+04	2.5889976E+07	563.66
.76006	4.5823546E+04	2.5836135E+07	563.82
.77004	4.5710748E+04	2.5779538E+07	563.97
.78009	4.5623139E+04	2.5737669E+07	564.14
.79010	4.5560045E+04	2.5709858E+07	564.31

TABLE 6.2.1-14 (Sheet 5)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
.80022	4.5489725E+04	2.5677850E+07	564.48
.81002	4.5413072E+04	2.5642185E+07	564.64
.82010	4.5327081E+04	2.5601209E+07	564.81
.83004	4.5260966E+04	2.5571549E+07	564.98
.84011	4.5209732E+04	2.5550368E+07	565.15
.85006	4.5159309E+04	2.5529469E+07	565.32
.86015	4.5089401E+04	2.5497327E+07	565.48
.87012	4.4994500E+04	2.5450746E+07	565.64
.88013	4.4886321E+04	2.5397036E+07	565.81
.89013	4.4780254E+04	2.5344589E+07	565.98
.90015	4.4682893E+04	2.5297033E+07	566.15
.91020	4.4589254E+04	2.5251457E+07	566.31
.92011	4.4494474E+04	2.5205284E+07	566.48
.93015	4.4403112E+04	2.5161086E+07	566.65
.94019	4.4318967E+04	2.5120874E+07	566.82
.95011	4.4241866E+04	2.5084499E+07	566.99
.96008	4.4166304E+04	2.5048726E+07	567.15
.97014	4.4081519E+04	2.5007956E+07	567.31
.98014	4.3990876E+04	2.4963692E+07	567.47
.99009	4.3895397E+04	2.4916558E+07	567.63
1.00004	4.3796575E+04	2.4867540E+07	567.80
1.05019	4.3461808E+04	2.4713931E+07	568.64
1.10027	4.3133378E+04	2.4561816E+07	569.44
1.15009	4.2739703E+04	2.4370168E+07	570.20
1.20010	4.2323008E+04	2.4161890E+07	570.89
1.25010	4.1895920E+04	2.3945093E+07	571.54
1.30004	4.1641428E+04	2.3825574E+07	572.16
1.35001	4.1275019E+04	2.3639530E+07	572.73
1.40013	4.0900745E+04	2.3446529E+07	573.25
1.45005	4.0510783E+04	2.3242466E+07	573.74
1.50012	4.0209646E+04	2.3088304E+07	574.20
1.55007	3.9977551E+04	2.2973632E+07	574.66
1.60020	3.9686581E+04	2.2823239E+07	575.09
1.65011	3.9367441E+04	2.2655369E+07	575.48
1.70009	3.9019099E+04	2.2468653E+07	575.84
1.75005	3.8650194E+04	2.2268489E+07	576.15
1.80004	3.8459410E+04	2.2171721E+07	576.50
1.85006	3.8205780E+04	2.2037365E+07	576.81
1.90018	3.7913564E+04	2.1879585E+07	577.09
1.95012	3.7624174E+04	2.1723045E+07	577.37
2.00011	3.7317209E+04	2.1555841E+07	577.64
2.05010	3.7002820E+04	2.1384087E+07	577.90
2.10009	3.6833263E+04	2.1297559E+07	578.22
2.15009	3.6549989E+04	2.1144677E+07	578.51
2.20015	3.6227378E+04	2.0967794E+07	578.78
2.25024	3.5847987E+04	2.0756612E+07	579.02
2.30012	3.5473524E+04	2.0547327E+07	579.23

TABLE 6.2.1-14 (Sheet 6)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
2.35014	3.5068678E+04	2.0318710E+07	579.40
2.40004	3.4845902E+04	2.0196771E+07	579.60
2.45001	3.4721634E+04	2.0133621E+07	579.86
2.50010	3.4519313E+04	2.0024657E+07	580.10
2.55021	3.4334784E+04	1.9925016E+07	580.33
2.60007	3.3939978E+04	1.9701369E+07	580.48
2.65009	3.3620292E+04	1.9520341E+07	580.61
2.70001	3.3325382E+04	1.9353676E+07	580.75
2.75018	3.3013720E+04	1.9176809E+07	580.87
2.80023	3.2709340E+04	1.9003776E+07	580.99
2.85022	3.2406780E+04	1.8830564E+07	581.07
2.90021	3.2076055E+04	1.8641111E+07	581.15
2.95021	3.1762886E+04	1.8460860E+07	581.21
3.00000	3.1438030E+04	1.8272828E+07	581.23

TABLE 6.2.1-15

LIMITED AREA CIRCUMFERENTIAL BREAK-
COLD LEG
236 SQUARE INCHES
BREAK MASS FLOW AND ENERGY FLOW

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (But/lb)
.00000	1.0572100E+04	5.9341197E+06	561.30
.00100	2.1707552E+04	1.2082083E+07	556.58
.00200	2.2095902E+04	1.2332674E+07	558.14
.00301	2.4453587E+04	1.3647396E+07	558.09
.00401	2.4614206E+04	1.3742704E+07	558.32
.00501	2.5073813E+04	1.4000423E+07	558.37
.00600	2.4968001E+04	1.3940432E+07	558.33
.00701	2.4799097E+04	1.3844457E+07	558.26
.00800	2.4521907E+04	1.3687502E+07	558.17
.00900	2.4235127E+04	1.3525275E+07	558.09
.01001	2.3956426E+04	1.3367745E+07	558.00
.01101	2.3712499E+04	1.3229957E+07	557.93
.01201	2.3509080E+04	1.3115107E+07	557.87
.01300	2.3348860E+04	1.3024663E+07	557.83
.01401	2.3224463E+04	1.2954460E+07	557.79
.01501	2.3136405E+04	1.2904766E+07	557.77
.01601	2.3078900E+04	1.2872302E+07	557.75
.01701	2.3045835E+04	1.2853614E+07	557.74
.01801	2.3031261E+04	1.2845346E+07	557.74
.01901	2.3031093E+04	1.2845199E+07	557.73
.02000	2.3042896E+04	1.2851798E+07	557.73
.02101	2.3062478E+04	1.2862774E+07	557.74
.02201	2.3085219E+04	1.2875528E+07	557.74
.02301	2.3112249E+04	1.2890722E+07	557.74
.02401	2.3154911E+04	1.2914784E+07	557.76
.02501	2.3232817E+04	1.2958803E+07	557.78
.02600	2.3363203E+04	1.3032514E+07	557.82
.02701	2.3560296E+04	1.3143944E+07	557.89
.02801	2.3815409E+04	1.3288187E+07	557.97
.02901	2.4108987E+04	1.3454219E+07	558.06
.03002	2.4416539E+04	1.3628203E+07	558.15
.03101	2.4702619E+04	1.3790082E+07	558.24
.03202	2.4956193E+04	1.3933591E+07	558.32
.03302	2.5153480E+04	1.4045262E+07	558.38
.03400	2.5295757E+04	1.4125764E+07	558.42
.03503	2.5393058E+04	1.4180785E+07	558.45
.03601	2.5445431E+04	1.4210337E+07	558.46
.03700	2.5469811E+04	1.4224050E+07	558.47
.03801	2.5485016E+04	1.4233333E+07	558.50

TABLE 6.2.1-15 (Sheet 2)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (But/lb)
.03900	2.5532165E+04	1.4260386E+07	558.53
.04001	2.5579295E+04	1.4286873E+07	558.53
.04100	3.1975101E+04	1.7928469E+07	560.70
.04201	3.8448314E+04	2.1502956E+07	559.27
.04300	3.9352140E+04	2.2033352E+07	559.90
.04401	3.9125641E+04	2.1906483E+07	559.90
.04501	3.9425222E+04	2.2073567E+07	559.88
.04600	3.9569449E+04	2.2156188E+07	559.93
.04701	3.9803243E+04	2.2290123E+07	560.01
.04801	4.0236633E+04	2.2536969E+07	560.11
.04901	4.0627082E+04	2.2759128E+07	560.20
.05002	4.0925012E+04	2.2928780E+07	560.26
.05102	4.1169127E+04	2.3067753E+07	560.32
.05201	4.1385789E+04	2.3191572E+07	560.38
.05300	4.1753771E+04	2.3402932E+07	560.50
.05401	4.2223803E+04	2.3671342E+07	560.62
.05503	4.2137045E+04	2.3618406E+07	560.51
.05603	4.1529382E+04	2.3270169E+07	560.33
.05701	4.1295423E+04	2.3138628E+07	560.32
.05801	4.1411429E+04	2.3204564E+07	560.34
.05901	4.1105545E+04	2.3027420E+07	560.20
.06001	4.0603325E+04	2.2741035E+07	560.08
.06103	4.0521101E+04	2.2695491E+07	560.09
.06201	4.0645395E+04	2.2766492E+07	560.12
.06304	4.0704550E+04	2.2799744E+07	560.13
.06404	4.0705829E+04	2.2800277E+07	560.12
.06507	4.0750515E+04	2.2825982E+07	560.14
.06608	4.0871065E+04	2.2895040E+07	560.18
.06708	4.0998964E+04	2.2967904E+07	560.21
.06803	4.1053073E+04	2.2998295E+07	560.21
.06902	4.1019766E+04	2.2978676E+07	560.19
.07001	4.0926484E+04	2.2924851E+07	560.15
.07108	4.0801842E+04	2.2853207E+07	560.10
.07211	4.0692741E+04	2.2790552E+07	560.06
.07309	4.0594318E+04	2.2734095E+07	560.03
.07409	4.0469378E+04	2.2662473E+07	559.99
.07504	4.0337650E+04	2.2586968E+07	559.95
.07608	4.0214347E+04	2.2516653E+07	559.92
.07709	4.0121581E+04	2.2463789E+07	559.89
.07804	4.0053713E+04	2.2425111E+07	559.88
.07908	4.0002239E+04	2.2395892E+07	559.87
.08009	3.9980392E+04	2.2383654E+07	559.87
.08108	3.9983680E+04	2.2385754E+07	559.87
.08208	3.9995601E+04	2.2392735E+07	559.88
.08304	3.9996317E+04	2.2393274E+07	559.88
.08405	3.9966032E+04	2.2376087E+07	559.88
.08504	3.9891651E+04	2.2333703E+07	559.86

TABLE 6.2.1-15 (Sheet 3)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (But/lb)
.08610	3.9750341E+04	2.2253151E+07	559.82
.08709	3.9568354E+04	2.2149429E+07	559.78
.08801	3.9364804E+04	2.2033483E+07	559.73
.08901	3.9131631E+04	2.1900720E+07	559.67
.09012	3.8871669E+04	2.1752747E+07	559.60
.09103	3.8662831E+04	2.1633870E+07	559.55
.09212	3.8430757E+04	2.1501990E+07	559.50
.09305	3.8228150E+04	2.1386925E+07	559.45
.09405	3.8028085E+04	2.1273173E+07	559.41
.09503	3.7840641E+04	2.1166762E+07	559.37
.09602	3.7653190E+04	2.1060321E+07	559.32
.09707	3.7460086E+04	2.0950587E+07	559.28
.09803	3.7314180E+04	2.0867701E+07	559.24
.09910	3.7157535E+04	2.0778860E+07	559.21
.10009	3.7027859E+04	2.0705323E+07	559.18
.10501	3.6632913E+04	2.0481815E+07	559.11
.11010	3.6501225E+04	2.0408199E+07	559.11
.11509	3.6282348E+04	2.0284419E+07	559.07
.12011	3.5914523E+04	2.0075865E+07	558.99
.12508	3.5368349E+04	1.9766474E+07	558.87
.13006	3.4928346E+04	1.9518017E+07	558.80
.13506	3.5003152E+04	1.9561727E+07	558.86
.14011	3.5387174E+04	1.9780616E+07	558.98
.14508	3.5790435E+04	2.0009865E+07	559.08
.15001	3.6094288E+04	2.0182489E+07	559.16
.15512	3.6303763E+04	2.0301364E+07	559.21
.16001	3.6531599E+04	2.0430727E+07	559.26
.16510	3.6764783E+04	2.0562948E+07	559.31
.17002	3.6887528E+04	2.0632243E+07	559.33
.17520	3.6876132E+04	2.0625015E+07	559.31
.18010	3.6792829E+04	2.0577088E+07	559.27
.18513	3.6751757E+04	2.0553520E+07	559.25
.19002	3.6796516E+04	2.0578936E+07	559.26
.19501	3.6827018E+04	2.0596085E+07	559.27
.20018	3.6769437E+04	2.0563047E+07	559.24
.21010	3.6573096E+04	2.0450930E+07	559.18
.22002	3.6391667E+04	2.0347573E+07	559.13
.23009	3.6096589E+04	2.0179782E+07	559.05
.24013	3.5990575E+04	2.0120049E+07	559.04
.25015	3.6081958E+04	2.0172127E+07	559.06
.26009	3.6088556E+04	2.0175920E+07	559.07
.27008	3.6400732E+04	2.0353382E+07	559.15
.28008	3.6757692E+04	2.0555821E+07	559.23
.29008	3.6832638E+04	2.0597661E+07	559.22
.30016	3.6764781E+04	2.0558426E+07	559.19
.31016	3.6608228E+04	2.0469086E+07	559.14
.32006	3.6501532E+04	2.0408435E+07	559.11

TABLE 6.2.1-15 (Sheet 4)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (But/lb)
.33008	3.6395300E+04	2.0348183E+07	559.09
.34007	3.6267729E+04	2.0275857E+07	559.06
.35002	3.6140651E+04	2.0203992E+07	559.04
.36013	3.6103086E+04	2.0183052E+07	559.04
.37010	3.6185810E+04	2.0230379E+07	559.07
.38005	3.6361709E+04	2.0330496E+07	559.12
.39012	3.6541541E+04	2.0432623E+07	559.16
.40007	3.6641160E+04	2.0489029E+07	559.18
.41006	3.6647514E+04	2.0492391E+07	559.18
.42009	3.6545798E+04	2.0434414E+07	559.15
.43001	3.6399205E+04	2.0351154E+07	559.11
.44001	3.6264088E+04	2.0274615E+07	559.08
.45005	3.6168431E+04	2.0220592E+07	559.07
.46013	3.6112827E+04	2.0189330E+07	559.06
.47004	3.6085029E+04	2.0173814E+07	559.06
.48008	3.6105125E+04	2.0185470E+07	559.07
.49008	3.6180307E+04	2.0228345E+07	559.10
.50010	3.6277334E+04	2.0283486E+07	559.12
.51014	3.6337432E+04	2.0317536E+07	559.14
.52006	3.6326079E+04	2.0310925E+07	559.13
.53012	3.6249658E+04	2.0267427E+07	559.11
.54016	3.6141407E+04	2.0205948E+07	559.08
.55012	3.6033220E+04	2.0144621E+07	559.06
.56001	3.5947203E+04	2.0095959E+07	559.04
.57005	3.5896821E+04	2.0067563E+07	559.03
.58009	3.5881727E+04	2.0059175E+07	559.04
.59017	3.5892773E+04	2.0065579E+07	559.04
.60002	3.5918369E+04	2.0080179E+07	559.05
.61005	3.5947401E+04	2.0096682E+07	559.06
.62004	3.5965029E+04	2.0106650E+07	559.06
.63005	3.5953838E+04	2.0100216E+07	559.06
.64001	3.5906058E+04	2.0073003E+07	559.04
.65006	3.5834052E+04	2.0032083E+07	559.02
.66010	3.5760760E+04	1.9990497E+07	559.01
.67009	3.5708143E+04	1.9960697E+07	559.00
.68003	3.5682226E+04	1.9946058E+07	558.99
.69001	3.5682166E+04	1.9946073E+07	558.99
.70001	3.5700880E+04	1.9956700E+07	559.00
.71006	3.5728117E+04	1.9972114E+07	559.00
.72011	3.5752752E+04	1.9986001E+07	559.01
.73006	3.5764762E+04	1.9992684E+07	559.01
.74005	3.5760249E+04	1.9989968E+07	559.00
.75006	3.5740351E+04	1.9978527E+07	558.99
.76001	3.5711821E+04	1.9962206E+07	558.98
.77007	3.5682869E+04	1.9945670E+07	558.97
.78006	3.5666198E+04	1.9936132E+07	558.96
.79009	3.5667682E+04	1.9936906E+07	558.96

TABLE 6.2.1-15 (Sheet 5)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (But/lb)
.80022	3.5687294E+04	1.9947954E+07	558.97
.81017	3.5718441E+04	1.9965520E+07	558.97
.82002	3.5751430E+04	1.9984084E+07	558.97
.83005	3.5779223E+04	1.9999675E+07	558.97
.84009	3.5796825E+04	2.0009453E+07	558.97
.85001	3.5801848E+04	2.0012090E+07	558.97
.86003	3.5796359E+04	2.0008764E+07	558.96
.87008	3.5786932E+04	2.0003223E+07	558.95
.88010	3.5779140E+04	1.9998615E+07	558.95
.89002	3.5778563E+04	1.9998114E+07	558.94
.90006	3.5788751E+04	2.0003723E+07	558.94
.91005	3.5809204E+04	2.0015144E+07	558.94
.92004	3.5835475E+04	2.0029846E+07	558.94
.93008	3.5861922E+04	2.0044622E+07	558.94
.94016	3.5882985E+04	2.0056325E+07	558.94
.95010	3.5903621E+04	2.0067778E+07	558.93
.96003	3.5921117E+04	2.0077436E+07	558.93
.97010	3.5924585E+04	2.0079130E+07	558.92
.98007	3.5921512E+04	2.0077130E+07	558.92
.99012	3.5918458E+04	2.0075157E+07	558.91
1.00005	3.5916499E+04	2.0073815E+07	558.90
1.05008	3.5969186E+04	2.0102519E+07	558.88
1.10005	3.5926821E+04	2.0077225E+07	558.84
1.15008	3.5938536E+04	2.0082736E+07	558.81
1.20007	3.5856088E+04	2.0034802E+07	558.76
1.25007	3.5768952E+04	1.9984414E+07	558.71
1.30007	3.5693161E+04	1.9940447E+07	558.66
1.35011	3.5622061E+04	1.9899206E+07	558.62
1.40004	3.5575341E+04	1.9871758E+07	558.58
1.45004	3.5527168E+04	1.9843508E+07	558.54
1.50013	3.5501810E+04	1.9828180E+07	558.51
1.55005	3.5461988E+04	1.9804676E+07	558.48
1.60000	3.5424567E+04	1.9782594E+07	558.44
1.65006	3.5369865E+04	1.9750777E+07	558.41
1.70012	3.5331137E+04	1.9728098E+07	558.38
1.75000	3.5307185E+04	1.9713660E+07	558.35
1.80012	3.5233397E+04	1.9671245E+07	558.31
1.85010	3.5205094E+04	1.9654588E+07	558.29
1.90000	3.5093505E+04	1.9590861E+07	558.25
1.95007	3.5000130E+04	1.9537568E+07	558.21
2.00000	3.4879758E+04	1.9469036E+07	558.18
2.05002	3.4793253E+04	1.9419705E+07	558.15
2.10004	3.4689036E+04	1.9360421E+07	558.11
2.15003	3.4615720E+04	1.9318672E+07	558.09
2.20007	3.4538643E+04	1.9274849E+07	558.07
2.25021	3.4464155E+04	1.9232569E+07	558.05
2.30004	3.4381216E+04	1.9185591E+07	558.03

TABLE 6.2.1-15 (Sheet 6)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (But/lb)
2.35008	3.4363178E+04	1.9175402E+07	558.02
2.40008	3.4252834E+04	1.9113112E+07	558.00
2.45015	3.4152419E+04	1.9056583E+07	557.99
2.50006	3.4056072E+04	1.9002467E+07	557.98
2.55005	3.3960401E+04	1.8948763E+07	557.97
2.60008	3.3798412E+04	1.8857833E+07	557.95
2.65015	3.3704717E+04	1.8805516E+07	557.95
2.70013	3.3560589E+04	1.8724864E+07	557.94
2.75010	3.3442746E+04	1.8659151E+07	557.94
2.80012	3.3327683E+04	1.8595164E+07	557.95
2.85002	3.3216236E+04	1.8533322E+07	557.96
2.90006	3.3172549E+04	1.8510071E+07	557.99
2.95015	3.3058421E+04	1.8447012E+07	558.01
3.00008	3.2942895E+04	1.8383423E+07	558.04

TABLE 6.2.1-16

PRESSURIZER SURGE LINE DOUBLE-ENDED GUILLOTINE BREAK BREAK MASS FLOW AND ENERGY FLOW

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
0.00000	0.	0.	0.00
0.00251	1.6681148E+04	1.1296008E+07	677.17
0.00501	1.6556361E+04	1.1212058E+07	677.21
0.00752	1.6699069E+04	1.1302997E+07	676.86
0.01002	1.9033506E+04	1.2830006E+07	674.07
0.01250	2.2089365E+04	1.4828262E+07	671.29
0.01501	2.1648161E+04	1.4533929E+07	671.37
0.01754	2.1247911E+04	1.4268193E+07	671.51
0.02002	2.0465838E+04	1.3752132E+07	671.96
0.02250	2.0393611E+04	1.3704347E+07	671.99
0.02505	2.0706044E+04	1.3907231E+07	671.65
0.02752	2.0931729E+04	1.4053966E+07	671.42
0.03001	2.0998600E+04	1.4096217E+07	671.29
0.03259	2.0967919E+04	1.4074876E+07	671.26
0.03507	2.0990414E+04	1.4088700E+07	671.20
0.03750	2.1019840E+04	1.4107187E+07	671.14
0.04009	2.1062241E+04	1.4134287E+07	671.07
0.04259	2.1156624E+04	1.4195514E+07	670.97
0.04512	2.1160405E+04	1.4197306E+07	670.94
0.04761	2.1098863E+04	1.4156324E+07	670.95
0.05009	2.1066994E+04	1.4134990E+07	670.95
0.05264	2.1095761E+04	1.4153509E+07	670.92
0.05505	2.1085426E+04	1.4146331E+07	670.91
0.05751	2.1000054E+04	1.4089897E+07	670.95
0.06008	2.0863697E+04	1.4000108E+07	671.03
0.06255	2.0694171E+04	1.3888722E+07	671.14
0.06512	2.0509657E+04	1.3767663E+07	671.28
0.06750	2.0407265E+04	1.3700589E+07	671.36
0.07002	2.0418448E+04	1.3708034E+07	671.36
0.07250	2.0481072E+04	1.3749121E+07	671.31
0.07507	2.0519777E+04	1.3774417E+07	671.28
0.07754	2.0521037E+04	1.3775092E+07	671.27
0.08003	2.0488129E+04	1.3753315E+07	671.28
0.08255	2.0410939E+04	1.3702503E+07	671.33
0.08504	2.0305825E+04	1.3633481E+07	671.41
0.08755	2.0203846E+04	1.3566573E+07	671.48
0.09006	2.0124810E+04	1.3514710E+07	671.54
0.09261	2.0067276E+04	1.3476990E+07	671.59
0.09501	2.0049927E+04	1.3465634E+07	671.61
0.09751	2.0091047E+04	1.3492584E+07	671.57
0.10011	2.0190095E+04	1.3557427E+07	671.49
0.10259	2.0322401E+04	1.3644022E+07	671.38
0.10513	2.0470869E+04	1.3741182E+07	671.26
0.10762	2.0613302E+04	1.3834228E+07	671.13

TABLE 6.2.1-16 (Sheet 2)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
0.11001	2.0698652E+04	1.3889843E+07	671.05
0.11251	2.0710177E+04	1.3896955E+07	671.02
0.11504	2.0648143E+04	1.3855823E+07	671.04
0.11753	2.0539220E+04	1.3783979E+07	671.11
0.12009	2.0392131E+04	1.3687301E+07	671.21
0.12255	2.0235027E+04	1.3584155E+07	671.32
0.12505	2.0076107E+04	1.3479844E+07	671.44
0.12762	1.9907452E+04	1.3369294E+07	671.57
0.13001	1.9721330E+04	1.3247406E+07	671.73
0.13253	1.9515669E+04	1.3112767E+07	671.91
0.13515	1.9325524E+04	1.2988402E+07	672.09
0.13760	1.9143891E+04	1.2869713E+07	672.26
0.14000	1.8989530E+04	1.2768843E+07	672.41
0.14263	1.8858030E+04	1.2682997E+07	672.55
0.14517	1.8757129E+04	1.2617164E+07	672.66
0.14757	1.8681814E+04	1.2568006E+07	672.74
0.15014	1.8626059E+04	1.2531659E+07	672.80
0.15265	1.8590127E+04	1.2508250E+07	672.84
0.15504	1.8569023E+04	1.2494497E+07	672.87
0.15764	1.8551204E+04	1.2482868E+07	672.89
0.16005	1.8525873E+04	1.2466307E+07	672.91
0.16250	1.8477290E+04	1.2434527E+07	672.96
0.16509	1.8394683E+04	1.2380511E+07	673.05
0.16765	1.8282083E+04	1.2306962E+07	673.17
0.17002	1.8146081E+04	1.2218190E+07	673.32
0.17253	1.7994507E+04	1.2119261E+07	673.50
0.17510	1.7851733E+04	1.2026175E+07	673.67
0.17754	1.7718757E+04	1.1939508E+07	673.83
0.18004	1.7607714E+04	1.1867137E+07	673.97
0.18257	1.7516255E+04	1.1807583E+07	674.09
0.18510	1.7440413E+04	1.1758207E+07	674.19
0.18753	1.7384799E+04	1.1721993E+07	674.27
0.19006	1.7331275E+04	1.1687159E+07	674.34
0.19258	1.7283259E+04	1.1655900E+07	674.40
0.19513	1.7239302E+04	1.1627267E+07	674.46
0.19757	1.7196585E+04	1.1599461E+07	674.52
0.20000	1.7153255E+04	1.1571232E+07	674.58
0.20257	1.7114304E+04	1.1545858E+07	674.63
0.20515	1.7075604E+04	1.1520650E+07	674.68
0.20764	1.7047204E+04	1.1502146E+07	674.72
0.21013	1.7030892E+04	1.1491517E+07	674.75
0.21262	1.7026041E+04	1.1488355E+07	674.75
0.21509	1.7031337E+04	1.1491802E+07	674.74
0.21755	1.7044630E+04	1.1500441E+07	674.73
0.22014	1.7064231E+04	1.1513204E+07	674.70
0.22261	1.7085144E+04	1.1526752E+07	674.67
0.22519	1.7104103E+04	1.1539031E+07	674.64

TABLE 6.2.1-16 (Sheet 3)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
0.22757	1.7120939E+04	1.1549913E+07	674.61
0.23002	1.7133999E+04	1.1558321E+07	674.58
0.23261	1.7139862E+04	1.1562022E+07	674.57
0.23511	1.7135943E+04	1.1559323E+07	674.57
0.23756	1.7121402E+04	1.1549700E+07	674.58
0.24007	1.7091493E+04	1.1530055E+07	674.61
0.24253	1.7044464E+04	1.1499260E+07	674.66
0.24509	1.6981075E+04	1.1457784E+07	674.74
0.24752	1.6909137E+04	1.1410815E+07	674.83
0.25000	1.6816993E+04	1.1350678E+07	674.95
0.25256	1.6725891E+04	1.1291225E+07	675.07
0.25505	1.6633374E+04	1.1230921E+07	675.20
0.25751	1.6542717E+04	1.1171824E+07	675.33
0.26005	1.6466594E+04	1.1122207E+07	675.44
0.26251	1.6403107E+04	1.1080847E+07	675.53
0.26504	1.6352876E+04	1.1048104E+07	675.61
0.26751	1.6321725E+04	1.1027787E+07	675.65
0.27009	1.6296620E+04	1.1011400E+07	675.69
0.27265	1.6276846E+04	1.0998473E+07	675.71
0.27509	1.6255893E+04	1.0984763E+07	675.74
0.27751	1.6228524E+04	1.0966874E+07	675.78
0.28003	1.6185426E+04	1.0938740E+07	675.84
0.28253	1.6127011E+04	1.0900616E+07	675.92
0.28512	1.6053276E+04	1.0852567E+07	676.03
0.28755	1.5970294E+04	1.0798521E+07	676.16
0.29001	1.5898962E+04	1.0752073E+07	676.28
0.29256	1.5832910E+04	1.0709102E+07	676.38
0.29509	1.5829868E+04	1.0707076E+07	676.38
0.29751	1.5825312E+04	1.0704075E+07	676.39
0.30009	1.5808551E+04	1.0693108E+07	676.41
0.30265	1.5808165E+04	1.0692807E+07	676.41
0.30517	1.5803688E+04	1.0689818E+07	676.41
0.30753	1.5753769E+04	1.0657243E+07	676.49
0.31006	1.5744724E+04	1.0651197E+07	676.47
0.31256	1.5753012E+04	1.0656385E+07	676.47
0.31501	1.5760820E+04	1.0661304E+07	676.44
0.31761	1.5737615E+04	1.0646068E+07	676.47
0.32014	1.5735895E+04	1.0644859E+07	676.47
0.32273	1.5734566E+04	1.0643956E+07	676.47
0.32509	1.5732595E+04	1.0642618E+07	676.47
0.32753	1.5729905E+04	1.0640794E+07	676.47
0.33024	1.5726744E+04	1.0638378E+07	676.47
0.33251	1.5723019E+04	1.0636121E+07	676.47
0.33526	1.5718891E+04	1.0633317E+07	676.47
0.33752	1.5715349E+04	1.0630912E+07	676.47
0.34003	1.5711537E+04	1.0628319E+07	676.47
0.34271	1.5707870E+04	1.0625820E+07	676.46
0.34506	1.5704632E+04	1.0623609E+07	676.46
0.34770	1.5701190E+04	1.0621254E+07	676.46

TABLE 6.2.1-16 (Sheet 4)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
0.35025	1.5698641E+04	1.0619896E+07	676.46
0.35261	1.5695247E+04	1.0617177E+07	676.46
0.35516	1.5692136E+04	1.0615038E+07	676.46
0.35762	1.5688914E+04	1.0612827E+07	676.45
0.36011	1.5685456E+04	1.0610463E+07	676.45
0.36259	1.5681810E+04	1.0607961E+07	676.45
0.36518	1.5677911E+04	1.0605294E+07	676.45
0.36758	1.5674219E+04	1.0602767E+07	676.45
0.37034	1.5670037E+04	1.0599906E+07	676.44
0.37267	1.5666639E+04	1.0597581E+07	676.44
0.37504	1.5663437E+04	1.0595386E+07	676.44
0.37757	1.5660250E+04	1.0593197E+07	676.44
0.38027	1.5657086E+04	1.0591016E+07	676.44
0.38277	1.5654322E+04	1.0589105E+07	676.43
0.38516	1.5651744E+04	1.0587321E+07	676.43
0.38754	1.5649144E+04	1.0585526E+07	676.43
0.39027	1.5646820E+04	1.0583914E+07	676.43
0.39262	1.5644725E+04	1.0582456E+07	676.42
0.39522	1.5642789E+04	1.0581100E+07	676.42
0.39760	1.5641070E+04	1.0579890E+07	676.42
0.40004	1.5639449E+04	1.0578741E+07	676.41
0.40257	1.5637925E+04	1.0577652E+07	676.41
0.40505	1.5636591E+04	1.0576689E+07	676.41
0.40763	1.5635413E+04	1.0575828E+07	676.40
0.41013	1.5634337E+04	1.0575027E+07	676.40
0.41251	1.5633562E+04	1.0574432E+07	676.39
0.41504	1.5632975E+04	1.0573960E+07	676.39
0.41775	1.5632551E+04	1.0573584E+07	676.38
0.42001	1.5632366E+04	1.0573381E+07	676.38
0.42268	1.5632315E+04	1.0573254E+07	676.37
0.42502	1.5632376E+04	1.0573212E+07	676.37
0.42781	1.5632537E+04	1.0573215E+07	676.36
0.43027	1.5632708E+04	1.0573240E+07	676.35
0.43267	1.5632877E+04	1.0573264E+07	676.35
0.43533	1.5633025E+04	1.0573264E+07	676.34
0.43752	1.5633896E+04	1.0573227E+07	676.34
0.44015	1.5633088E+04	1.0573125E+07	676.33
0.44257	1.5632964E+04	1.0572955E+07	676.32
0.44523	1.5632658E+04	1.0572657E+07	676.32
0.44756	1.5632172E+04	1.0572247E+07	676.31
0.45019	1.5631366E+04	1.0571613E+07	676.31
0.45287	1.5630249E+04	1.0570770E+07	676.30
0.45517	1.5629249E+04	1.0569885E+07	676.30
0.45757	1.5627623E+04	1.0568848E+07	676.29
0.46022	1.5635881E+04	1.0567590E+07	676.29
0.46289	1.5623874E+04	1.0566152E+07	676.28
0.46614	1.5622119E+04	1.0564900E+07	676.28
0.46777	1.5619955E+04	1.0563361E+07	676.27

TABLE 6.2.1-16 (Sheet 5)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
0.47036	1.5617741E+04	1.0561792E+07	676.27
0.47288	1.5615520E+04	1.0560223E+07	676.26
0.47503	1.5613565E+04	1.0558844E+07	676.26
0.47757	1.5611133E+04	1.0557133E+07	676.26
0.48011	1.5608643E+04	1.0555384E+07	676.25
0.48262	1.5606180E+04	1.0553588E+07	676.25
0.48512	1.5603492E+04	1.0551775E+07	676.24
0.48758	1.5600916E+04	1.0549973E+07	676.24
0.49009	1.5598319E+04	1.0548154E+07	676.24
0.49273	1.5595641E+04	1.0546276E+07	676.23
0.49505	1.5593323E+04	1.0544647E+07	676.23
0.49786	1.5590573E+04	1.0542711E+07	676.22
0.50029	1.5588315E+04	1.0541119E+07	676.22
0.51019	1.5579889E+04	1.0535146E+07	676.20
0.52041	1.5571914E+04	1.0529450E+07	676.18
0.53013	1.5564820E+04	1.0524389E+07	676.17
0.54025	1.5557270E+04	1.0518995E+07	676.15
0.55044	1.5550075E+04	1.0513839E+07	676.13
0.56029	1.5544285E+04	1.0509628E+07	676.11
0.57043	1.5539811E+04	1.0506279E+07	676.09
0.58035	1.5537036E+04	1.0504053E+07	676.07
0.59012	1.5535838E+04	1.0502863E+07	676.04
0.60013	1.5535793E+04	1.0502401E+07	676.01
0.61030	1.5536152E+04	1.0502172E+07	675.98
0.62023	1.5535777E+04	1.0501463E+07	675.95
0.63027	1.5533739E+04	1.0499646E+07	675.93
0.64028	1.5529494E+04	1.0496323E+07	675.90
0.65009	1.5523642E+04	1.0491943E+07	675.87
0.66010	1.5516674E+04	1.0486820E+07	675.84
0.67006	1.5509627E+04	1.0481657E+07	675.82
0.68002	1.5503246E+04	1.0476939E+07	675.79
0.69043	1.5497613E+04	1.0472703E+07	675.76
0.70003	1.5493333E+04	1.0469413E+07	675.74
0.71008	1.5489729E+04	1.0466564E+07	675.71
0.72062	1.5486462E+04	1.0463919E+07	675.68
0.73047	1.5483628E+04	1.0461579E+07	675.65
0.74006	1.5481145E+04	1.0459476E+07	675.63
0.75058	1.5478712E+04	1.0457353E+07	675.60
0.76039	1.5476578E+04	1.0456447E+07	675.57
0.77046	1.5474438E+04	1.0453521E+07	675.53
0.78003	1.5472213E+04	1.0451554E+07	675.50
0.79034	1.5469339E+04	1.0449119E+07	675.47
0.80022	1.5465740E+04	1.0446217E+07	675.44
0.81004	1.5461251E+04	1.0442584E+07	675.41
0.82013	1.5455070E+04	1.0478084E+07	675.38
0.83054	1.5447988E+04	1.0432852E+07	675.36
0.84013	1.5441170E+04	1.0427849E.07	675.33
0.85057	1.5433935E+04	1.0422535E+07	675.30

TABLE 6.2.1-16 (Sheet 6)

Time (sec)	Mass Flow (lb/sec)	Energy Flow (Btu/sec)	Average Enthalpy (Btu/lb)
0.86010	1.5427803E+04	1.0418005E+07	675.27
0.87064	1.5421686E+04	1.0413445E+07	675.25
0.88049	1.5416519E+04	1.0409555E+07	675.22
0.89029	1.5411736E+04	1.0405923E+07	675.19
0.90062	1.5496860E+04	1.0402204E+07	675.17
0.91043	1.5402219E+04	1.0398661E+07	675.14
0.92014	1.5397541E+04	1.0395092E+07	675.11
0.93032	1.5392543E+04	1.0391286E+07	675.09
0.94013	1.5387606E+04	1.0387534E+07	675.06
0.95020	1.5382356E+04	1.0383562E+07	675.03
0.96044	1.5376745E+04	1.0379341E+07	675.00
0.97022	1.5371025E+04	1.0375073E+07	674.98
0.98023	1.5364719E+04	1.0370408E+07	674.95
0.99000	1.5358118E+04	1.0365561E+07	674.92
1.00924	1.5350854E+04	1.0360257E+07	674.90
1.05009	1.5319038E+04	1.0336848E+07	674.77
1.10020	1.5296400E+04	1.0318842E+07	674.64
1.15027	1.5270563E+04	1.0299964E+07	674.50
1.20066	1.5244981E+04	1.0280607E+07	674.36
1.25022	1.5225611E+04	1.0265425E+07	674.22
1.30001	1.5284826E+04	1.0249226E+07	674.08
1.35009	1.5181682E+04	1.0231482E+07	673.94
1.40043	1.5158958E+04	1.0214058E+07	673.80
1.45008	1.5135654E+04	1.0196263E+07	673.66
1.50052	1.5108628E+04	1.0175997E+07	673.52
1.55021	1.5082453E+04	1.0156373E+07	673.39
1.60001	1.5056220E+04	1.0136713E+07	673.26
1.65041	1.5029192E+04	1.0116506E+07	673.12
1.70053	1.5003251E+04	1.0097044E+07	672.99
1.75042	1.4978791E+04	1.0078568E+07	672.86
1.80000	1.4954574E+04	1.0060259E+07	672.72
1.85004	1.4910174E+04	1.0027829E+07	672.55
1.90038	1.4937494E+04	1.0045448E+07	672.50
1.95060	1.4846071E+04	9.9803806E+06	672.26
2.00032	1.4821804E+04	9.9621501E+06	672.13

TABLE 6.2.1-17

REACTOR CAVITY PRESSURE-TEMPERATURE ANALYSIS SUBCOMPARTMENT NODAL DESCRIPTION

Node No.	Volume (ft3)	Initial Conditions			Peak Pressure Differential (psig)	Calculated Design Peak Pressure Differential (psig)	Design Margin %
		Temp. (F)	Press. (psia)	Humid. (%)			
1	55.5	120	14.7	100	101.95	131.5	22.5
2	55.8	120	14.7	100	98.88	131.5	24.8
3	57.2	120	14.7	100	46.36	131.5	64.7
4	56.0	120	14.7	100	24.86	131.5	81.1
5	55.6	120	14.7	100	20.70	131.5	84.3
6	56.0	120	14.7	100	20.89	131.5	84.1
7	57.2	120	14.7	100	23.16	131.5	82.4
8	56.0	120	14.7	100	39.00	131.5	70.3
9	174.9	120	14.7	100	81.70	131.5	37.9
10	172.7	120	14.7	100	80.89	131.5	38.5
11	171.8	120	14.7	100	43.97	131.5	66.6
12	173.0	120	14.7	100	25.21	131.5	80.8
13	175.0	120	14.7	100	20.74	131.5	84.2
14	173.0	120	14.7	100	20.91	131.5	84.1
15	171.8	120	14.7	100	23.49	131.5	82.1
16	173.0	120	14.7	100	38.66	131.5	70.6
17	48.3	120	14.7	100	30.59	104.7	70.8
18	66.2	120	14.7	100	30.70	104.7	70.7
19	48.3	120	14.7	100	20.29	104.7	80.6
20	66.2	120	14.7	100	18.79	104.7	82.1
21	48.3	120	14.7	100	17.89	104.7	82.9
22	66.2	120	14.7	100	18.54	104.7	82.3
23	48.3	120	14.7	100	20.19	104.7	80.7
24	66.2	120	14.7	100	30.23	104.7	71.1
25	57.2	120	14.7	100	19.42	87.9	77.9
26	57.3	120	14.7	100	19.13	87.9	78.2
27	57.2	120	14.7	100	16.59	87.9	81.1
28	57.3	120	14.7	100	15.22	87.9	82.7
29	57.2	120	14.7	100	15.06	87.9	82.9
30	57.3	120	14.7	100	15.32	87.9	82.6
31	57.2	120	14.7	100	16.59	87.9	81.1
32	57.3	120	14.7	100	19.13	87.9	78.2
33	1944.7	120	14.7	100	10.24	60.0	82.9
34	1802.7	120	14.7	100	7.86	60.0	86.9
35	1306.5	120	14.7	100	7.70	60.0	87.2
36	566.7	120	14.7	100	5.94	60.0	90.1
37	1291.1	120	14.7	100	2.86	60.0	95.2
38	252.4	120	14.7	100	3.88	60.0	93.5
39	252.4	120	14.7	100	3.15	60.0	94.8
40	252.4	120	14.7	100	2.81	60.0	95.3
41	3883.1	120	14.7	100	2.25	60.0	96.3

WOLF CREEK

TABLE 6.2.1-17 (Sheet 2)

Node No.	Volume (ft3)	Initial Conditions Temp. (F)	Press. (psia)	Humid. (%)	Peak Pressure Differential (psig)	Calculated Design Peak Pressure Differential (psig)	Design Margin %
42	12.3*	120	14.7	100	65.44	67.0	2.3
43	11.9*	120	14.7	100	64.94	67.0	3.1
44	11.6*	120	14.7	100	36.14	67.0	46.1
45	15.0*	120	14.7	100	20.64	67.0	69.2
46	12.4*	120	14.7	100	16.75	67.0	75.0
47	15.0*	120	14.7	100	18.06	67.0	73.0
48	11.6*	120	14.7	100	20.19	67.0	69.9
49	11.9*	120	14.7	100	32.50	67.0	51.5
50	2.486x106	120	14.7	100	1.97	60.0	96.7

*Initial volume of neutron shield compartment. See Table 6.2.1-19 for neutron shield bag compartment volume and vent area as a function of height.

TABLE 6.2.1-18

REACTOR CAVITY ANALYSIS
SUBCOMPARTMENT VENT PATH DESCRIPTION

Vent Path No.	From Node	To Node	Choked/time-Unchoked Flow	Vent Area (ft2)	L/A Term (ft-1)	Friction	HEAD LOSS--------K Turning	Expansion	Contraction	Total
1	1	2	unchoked	1.05	3.8327	0.1378	0.05	1.0	0.41	1.5978
2	1	9	choked/.007-.009	13.54	0.3663	0.0417	0.0	1.0	0.28	1.3217
3	2	3	choked/.003-1.00	4.00	1.2700	0.0944	0.05	1.0	0.33	1.4744
4	2	10	unchoked	14.26	0.3478	0.0289	0.0	1.0	0.27	1.2989
5	3	4	.095-1.00 choked/.017-.045	1.93	2.1629	0.0944	0.05	1.0	0.4	1.5444
6	3	11	unchoked	14.98	0.3311	0.0280	0.0	1.0	0.25	1.278
7	4	5	unchoked	2.65	1.7673	0.1378	0.05	1.0	0.375	1.5628
8	4	12	unchoked	14.43	0.3437	0.0286	0.0	1.0	0.26	1.2886
9	5	6	unchoked	1.05	3.8327	0.1378	0.05	1.0	0.41	1.5978
10	5	13	unchoked	13.20	0.3758	0.0417	0.0	1.0	0.29	1.3317
11	6	7	unchoked	4.00	1.2700	0.0944	0.05	1.0	0.33	1.4744
12	6	14	unchoked	14.43	0.3437	0.0286	0.0	1.0	0.26	1.2886
13	7	8	choked/.025-.045	1.93	2.1629	0.0944	0.05	1.0	0.4	1.5444
14	7	15	unchoked	14.98	0.3311	0.0280	0.0	1.0	0.25	1.278
15	8	16	unchoked	14.43	0.3437	0.0286	0.0	1.0	0.26	1.2886
16	8	23	choked/.023-.055	1.62	2.8460	0.1306	0.0	1.0	0.41	1.5406
17	8	24	unchoked	3.35	1.4319	0.0777	0.0	1.0	0.38	1.4577
18	9	10	unchoked	16.87	0.3847	0.0413	0.05	1.0	0.15	1.2413
19	9	16	choked/.005-1.00	16.87	0.3847	0.0413	0.05	1.0	0.15	1.2413
20	9	42	choked/.035-1.00	19.73	0.3041	0.0802	0.0	1.0	0.025	1.1052
21	10	11	choked/.005-1.00	18.21	0.3654	0.0388	0.05	1.0	0.11	1.1988
22	10	43	choked/.055-1.00	19.26	0.3155	0.0822	0.0	1.0	0.025	1.1072
23	11	12	.095-1.00 choked/.023-.045	18.21	0.3654	0.0388	0.05	1.0	0.11	1.1988
24	11	44	choked/.055-1.00	18.80	0.3191	0.0842	0.0	1.0	0.03	1.1142
25	12	13	unchoked	16.87	0.3847	0.0413	0.05	1.0	0.15	1.2413
26	12	45	choked/.065-.075	19.26	0.3115	0.0822	0.0	1.0	0.025	1.1072
27	13	14	unchoked	16.87	0.3847	0.0413	0.05	1.0	0.15	1.2413
28	13	46	choked/.075-.085	19.73	0.3041	0.0802	0.0	1.0	0.025	1.1052
29	14	15	unchoked	18.21	0.3654	0.0388	0.05	1.0	0.11	1.1988
30	14	47	choked/.075-.085	19.26	0.3115	0.0822	0.0	1.0	0.025	1.1072
31	15	16	choked/.03-.055	18.21	0.3654	0.0388	0.05	1.0	0.11	1.1988
32	15	48	unchoked	18.80	0.3191	0.0842	0.0	1.0	0.03	1.1142
33	16	49	choked/.055-1.00	19.26	0.3115	0.0822	0.0	1.0	0.025	1.1072
34	17	18	unchoked	4.44	0.7656	0.1433	0.05	1.0	0.31	1.5033
35	17	24	unchoked	4.44	0.7656	0.1433	0.05	1.0	0.31	1.5033
36	17	25	unchoked	7.44	1.1008	0.0875	0.0	1.0	0.0	1.0875
37	18	19	unchoked	4.44	0.7656	0.1433	0.05	1.0	0.31	1.5033
38	18	26	unchoked	7.44	1.1008	0.0875	0.0	1.0	0.0	1.0875
39	19	20	unchoked	4.44	0.7656	0.1433	0.05	1.0	0.31	1.5033
40	19	27	unchoked	7.44	1.1008	0.0875	0.0	1.0	0.0	1.0875
41	20	21	unchoked	4.44	0.7656	0.1433	0.05	1.0	0.31	1.5033
42	20	28	unchoked	7.44	1.1008	0.0875	0.0	1.0	0.0	1.0875

WOLF CREEK

TABLE 6.2.1-18 (Sheet 2)

Vent Path No.	From Node	To Node	Choked/time-Unchoked Flow	Vent Area (ft2)	L/A Term (ft-1)	HEAD LOSS--------K Friction	Turning	Expansion	Contraction	Total
43	21	22	unchoked	4.44	0.7656	0.1433	0.05	1.0	0.31	1.5033
44	21	29	unchoked	7.44	1.1008	0.0875	0.0	1.0	0.0	1.0875
45	22	23	unchoked	4.44	0.7656	0.1433	0.05	1.0	0.31	1.5033
46	22	30	unchoked	7.44	1.1008	0.0875	0.0	1.0	0.0	1.0875
47	23	24	unchoked	4.44	0.7656	0.1433	0.05	1.0	0.31	1.5033
48	23	31	unchoked	7.44	1.1008	0.0875	0.0	1.0	0.0	1.0875
49	24	32	unchoked	7.44	1.1008	0.0875	0.0	1.0	0.0	1.0875
50	25	26	unchoked	5.05	0.9344	0.1115	0.05	1.0	0.22	1.3815
51	25	32	unchoked	5.05	0.9344	0.1115	0.05	1.0	0.22	1.3815
52	25	33	unchoked	8.02	1.1721	0.0932	0.0	1.0	0.0	1.0932
53	26	27	unchoked	5.05	0.9344	0.1115	0.05	1.0	0.22	1.3815
54	26	33	unchoked	8.02	1.1721	0.0932	0.0	1.0	0.0	1.0932
55	27	28	unchoked	5.05	0.9344	0.1115	0.05	1.0	0.22	1.3815
56	27	33	unchoked	8.02	1.1721	0.0932	0.0	1.0	0.0	1.0932
57	28	29	unchoked	5.05	0.9344	0.1115	0.05	1.0	0.22	1.3815
58	28	33	unchoked	8.02	1.1721	0.0932	0.0	1.0	0.0	1.0932
59	29	30	unchoked	5.05	0.9344	0.1115	0.05	1.0	0.22	1.3815
60	29	33	unchoked	8.02	1.1721	0.0932	0.0	1.0	0.0	1.0932
61	30	31	unchoked	5.05	0.9344	0.1115	0.05	1.0	0.22	1.3815
62	30	33	unchoked	8.02	1.1721	0.0932	0.0	1.0	0.0	1.0932
63	31	32	unchoked	5.05	0.9344	0.1115	0.05	1.0	0.22	1.3815
64	31	33	unchoked	8.02	1.1721	0.0932	0.0	1.0	0.0	0.0932
65	32	33	unchoked	8.02	1.1721	0.0932	0.0	1.0	0.0	0.0932
66	33	34	unchoked	116.95	0.3091	0.0	0.0	1.0	0.3	1.3
67	33	37	unchoked	17.42	1.1005	0.0	0.17	1.0	0.33	1.505
68	34	35	unchoked	233.05	0.0386	0.0	0.0	1.0	0.075	1.075
69	35	36	unchoked	79.88	0.0792	0.0	0.0	1.0	0.22	1.22
70	36	37	unchoked	74.25	0.2349	----------	----------	---ORIFICE---	----------	----------
71	36	38	unchoked	29.18	0.1839	0.0	0.0	1.0	0.1	1.1
72	37	38	unchoked	39.25	0.1529	----------	----------	---ORIFICE---	----------	----------
73	37	39	unchoked	39.25	0.1529	----------	----------	---ORIFICE---	----------	----------
74	37	40	unchoked	39.25	0.1529	----------	----------	---ORIFICE---	----------	----------
75	37	41	unchoked	71.50	0.2098	0.037	0.0	1.0	0.0	1.037
76	37	50	unchoked	82.66	0.2329	0.078	0.0	1.0	0.03	1.108
77	38	39	unchoked	29.18	0.1714	0.0	0.0	1.0	0.1	1.1
78	39	40	unchoked	29.18	0.1714	0.0	0.0	1.0	0.1	1.1
79	40	41	unchoked	29.18	0.3312	0.0	0.0	1.0	0.1	1.1
80	41	50	unchoked	98.68	0.1621	0.045	0.0	1.0	0.18	1.225
81	42	43	unchoked		*	0.032	0.032	1.0	0.5	1.564
82	42	49	.095-.645 .055-.065 choked/.007-.035		*	0.032	0.032	1.0	0.5	1.564
83	42	50	choked/.007-1.000		*	0.0	0.0	1.0	0.0	1.0
84	43	44	choked/.007-.03		*	0.032	0.032	1.0	0.5	1.564
85	43	50	choked/.007-.1000		*	0.0	0.0	1.0	0.0	1.0
86	44	45	choked/.065-.075		*	0.032	0.032	1.0	0.5	1.564
87	44	50	choked/.017-.095		*	0.0	0.0	1.0	0.0	1.0

TABLE 6.2.1-18 (Sheet 3)

Vent Path No.	From Node	To Node	Choked/time-Unchoked Flow	Vent Area (ft2)	L/A Term (ft-1)	HEAD LOSS--------K Friction	Turning	Expansion	Contraction	Total
88	45	46	unchoked		*	0.032	0.032	1.0	0.5	1.564
89	45	50	choked/.03-.075		*	0.0	0.0	1.0	0.0	1.0
90	46	47	unchoked		*	0.032	0.032	1.0	0.5	1.564
91	46	50	choked/.045-.075		*	0.0	0.0	1.0	0.0	1.0
92	47	48	choked/.075-.085		*	0.032	0.032	1.0	0.5	1.564
93	47	50	choked/.045-.075		*	0.0	0.0	1.0	0.0	1.0
94	48	49	unchoked		*	0.032	0.032	1.0	0.5	1.564
95	48	50	choked/.035-.075		*	0.0	0.0	1.0	0.0	1.0
96	49	50	choked/.017-.055		*	0.0	0.0	1.0	0.0	1.0
97	1	8	choked/.003-1.00	2.65	1.7673	0.1378	0.05	1.0	0.375	1.5628
98	1	17	choked/.003-1.06	1.62	2.8460	0.1306	0.0	1.0	0.41	1.5406
99	1	24	choked/.003-1.00	3.52	1.3633	0.0764	0.0	1.0	0.38	1.4564
100	2	17	choked/.003-1.00	1.46	3.1515	0.1547	0.0	1.0	0.41	1.5647
101	2	18	choked/.003-1.00	3.52	1.3633	0.0764	0.0	1.0	0.38	1.4564
102	3	18	unchoked	3.35	1.4319	0.0777	0.0	1.0	0.38	1.4577
103	3	19	.145-1.00 choked/.021-0.55	1.46	3.1515	0.1547	0.0	1.0	0.41	1.5647
104	4	19	unchoked	1.62	2.8460	0.1306	0.0	1.0	0.41	1.5406
105	4	20	unchoked	3.35	1.4319	0.0777	0.0	1.0	0.38	1.4577
106	5	20	unchoked	3.52	1.3633	0.0764	0.0	1.0	0.38	1.4564
107	5	21	unchoked	1.62	2.8460	0.1306	0.0	1.0	0.41	1.5406
108	6	21	unchoked	1.46	3.1515	0.1547	0.0	1.0	0.41	1.5647
109	6	22	unchoked	3.52	1.3633	0.0764	0.0	1.0	0.38	1.4564
110	7	22	unchoked	3.35	1.4319	0.0777	0.0	1.0	0.38	1.4577
111	7	23	unchoked	1.46	3.1515	0.1547	0.0	1.0	0.41	1.5647

See Tables of Volumes and Vent Areas of "Waterbag Compartments" and Vent Areas and L/As for "Waterbag Compartments" (Tables 6.2.1-19 and 6.2.1-20)

* See Table of Vent Areas and L/As for "Waterbag Compartments" (Table 6.2.1-20)

TABLE 6.2.1-19

VOLUMES AND VENT AREAS OF WATERBAG COMPARTMENTS

Height (ft)	Cmpt No.	Vent Area to Containment (ft^2)	Volume (ft^3)
0.0	42	4.705	12.30
	43	4.5927	11.90
	44	4.493	11.60
	45	3.740	15.00
	46	4.691	12.40
	47	3.740	15.00
	48	4.493	11.60
	49	4.5927	11.90
1.0	42	6.190	50.96
	43	5.886	49.55
	44	5.583	48.24
	45	9.324	62.40
	46	15.691	51.06
	47	8.324	62.40
	48	5.583	48.24
	49	5.886	49.55
1.001	42	38.660	147.61
	43	37.650	143.68
	44	36.640	139.84
	45	47.400	180.90
	46	38.660	147.71
	47	47.400	180.90
	48	36.640	139.84
	49	37.650	143.68
1.100	42	38.660	147.61
	43	37.650	143.68
	44	36.640	139.84
	45	47.400	180.90
	46	38.660	147.71
	47	47.400	180.90
	48	36.640	139.84
	49	37.650	143.68

WOLF CREEK

TABLE 6.2.1-20

VENT AREAS AND L/As FOR WATERBAG COMPARTMENTS

Flowpath	42 to 50		42 to 43		42 to 49		43 to 50		43 to 44	
Time (sec)	Vent Area (ft^2)	L/A (ft^{-1})	Vent Area (ft^2)	L/A (ft^{-1})	Vent Area (ft^2)	L/A (ft^{-1})	Vent Area (ft^2)	L/A (ft^{-1})	Vent Area (ft^2)	L/A (ft^{-1})
0.0	4.705 + 00	5.356 - 01	0.0		0.0		4.593 + 00	5.487 - 01	0.0	
0.0025	4.705 + 00	5.356 - 01	1.174 - 06	6.629 + 06	0.0		4.593 + 00	5.487 - 01	0.0	
0.0060	4.709 + 00	5.352 - 01	4.935 - 03	1.577 + 03	0.0		4.596 + 00	5.483 - 01	0.0	
0.0120	4.780 + 00	5.251 - 01	1.273 - 01	6.115 + 01	6.196 - 03	1.256 + 03	4.679 + 00	5.386 - 01	6.970 - 03	1.117 + 03
0.0180	5.147 + 00	4.896 - 01	5.947 - 01	1.309 + 01	6.953 - 02	1.120 + 02	4.992 + 00	5.049 - 01	7.797 - 02	9.983 + 01
0.0290	6.190 + 00	4.071 - 01	2.914 + 00	2.672 + 00	6.375 - 01	1.221 + 01	5.886 + 00	4.281 - 01	7.162 - 01	1.087 + 01
0.0350	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	1.334 + 00	5.835 + 00	3.765 + 01	6.693 - 02	1.500 + 00	5.189 + 00
0.0580	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02	4.314 + 00	1.804 + 00
0.0800	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02	4.314 + 00	1.804 + 00
0.1000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02	4.314 + 00	1.804 + 00
0.2000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02	4.314 + 00	1.804 + 00
0.3000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02	4.314 + 00	1.804 + 00
0.4000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02	4.314 + 00	1.804 + 00
0.5000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02	4.314 + 00	1.804 + 00
0.6000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02	4.314 + 00	1.804 + 00
0.7000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02	4.314 + 00	1.804 + 00
0.8000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02	4.314 + 00	1.804 + 00
0.9000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02	4.314 + 00	1.804 + 00
1.0000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02	4.314 + 00	1.804 + 00

Flowpath	44 to 50		44 to 45		45 to 50		45 to 46	
Time (sec)	Vent Area (ft^2)	L/A (ft^{-1})	Vent Area (ft^2)	L/A (ft^{-1})	Vent Area (ft^2)	L/A (ft^{-1})	Vent Area (ft^2)	L/A (ft^{-1})
0.0	4.493 + 00	5.609 - 01	0.0		3.740 + 00	8.262 - 01	0.0	
0.0025	4.493 + 00	5.609 - 01	0.0		3.740 + 00	8.262 - 01	0.0	
0.0060	4.493 + 00	5.609 - 01	0.0		3.740 + 00	8.262 - 01	0.0	
0.0120	4.497 + 00	5.604 - 01	4.534 - 06	1.717 + 06	3.740 + 00	8.262 - 01	0.0	
0.0180	4.538 + 00	5.553 - 01	5.440 - 03	1.431 + 03	3.748 + 00	8.245 - 01	2.227 - 06	3.419 + 06
0.0290	4.909 + 00	5.134 - 01	1.490 - 01	5.224 + 01	3.952 + 00	7.819 - 01	2.168 - 02	3.591 + 02
0.0350	5.364 + 00	4.698 - 01	3.840 - 01	2.027 + 01	4.287 + 00	7.208 - 01	9.657 - 02	8.061 + 01
0.0580	3.664 + 01	6.878 - 02	2.994 + 00	2.600 + 00	8.003 + 00	3.861 - 01	1.594 + 00	4.882 + 00
0.0800	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.192 + 00	1.897 + 00
0.1000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.2000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.3000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.5000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.5000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.6000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.7000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.8000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.9000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
1.0000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00

L/A term is not applicable when vent area = 0.0

TABLE 6.2.1-20 (Sheet 2)

Flowpath	46 to 50		46 to 47		47 to 50		47 to 48	
Time (sec)	Vent Area (ft^2)	L/A (ft^{-1})	Vent Area (ft^2)	L/A (ft^{-1})	Vent Area (ft^2)	L/A (ft^{-1})	Vent Area (ft^2)	L/A (ft^{-1})
0.0	4.691 + 00	5.372 - 01	0.0		3.740 + 00	8.262 - 01	0.0	
0.0025	4.691 + 00	5.372 - 01	0.0		3.740 + 00	8.262 - 01	0.0	
0.0060	4.691 + 00	5.372 - 01	0.0		3.740 + 00	8.262 - 01	0.0	
0.0120	4.691 + 00	5.372 - 01	0.0		3.740 + 00	8.262 - 01	4.331 - 06	1.797 + 06
0.0180	4.691 + 00	5.372 - 01	2.277 - 06	3.419 + 06	3.740 + 00	8.262 - 01	2.355 - 02	3.305 + 02
0.0290	4.752 + 00	5.303 - 01	2.168 - 02	3.591 + 02	3.774 + 00	8.189 - 01	1.034 - 01	7.532 + 01
0.0350	4.962 + 00	5.079 - 01	9.657 - 02	8.061 + 01	3.887 + 00	7.949 - 01	1.657 + 00	4.698 + 00
0.0580	9.163 + 00	2.750 - 01	1.594 + 00	4.882 + 00	6.099 + 00	5.066 - 01	4.314 + 00	1.804 + 00
0.0800	3.866 + 01	6.518 - 02	4.192 + 00	1.857 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.1000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.2000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.3000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.4000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.5000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.6000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.7000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.8000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
0.9000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00
1.0000	3.866 + 01	6.518 - 02	4.314 + 00	1.804 + 00	4.740 + 01	6.519 - 02	4.314 + 00	1.804 + 00

Flowpath	48 to 50		48 to 49		49 to 50	
Time (sec)	Vent Area (ft^2)	L/A (ft^{-1})	Vent Area (ft^2)	L/A (ft^{-1})	Vent Area (ft^2)	L/A (ft^{-1})
0.0	4.493 + 00	5.609 - 01	0.0		4.593 + 00	5.487 - 01
0.0025	4.493 + 00	5.609 - 01	0.0		4.593 + 00	5.487 - 01
0.0060	4.493 + 00	5.609 - 01	0.0		4.593 + 00	5.487 - 01
0.0120	4.493 + 00	5.609 - 01	1.788 - 06	4.354 + 06	4.597 + 00	5.482 - 01
0.0180	4.496 + 00	5.606 - 01	4.226 - 03	1.842 + 03	4.639 + 00	5.432 - 01
0.0290	4.563 + 00	5.522 - 01	1.210 - 01	6.436 + 01	5.017 + 00	5.023 - 01
0.0350	4.678 + 00	5.387 - 01	3.181 - 01	2.447 + 01	5.481 + 00	4.598 - 01
0.0580	5.583 + 00	4.514 - 01	2.651 + 00	2.936 + 00	3.765 + 01	6.693 - 02
0.0800	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02
0.1000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02
0.2000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02
0.3000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02
0.4000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02
0.5000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02
0.6000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02
0.7000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02
0.8000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02
0.9000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02
1.0000	3.664 + 01	6.878 - 02	4.314 + 00	1.804 + 00	3.765 + 01	6.693 - 02

L/A term is not applicable when vent area = 0.0

TABLE 6.2.1-21

REACTOR CAVITY ANALYSIS
COEFFICIENTS FOR DETERMINATION OF FORCES AND MOMENTS ON THE REACTOR PRESSURE VESSEL

Level No.	Cmpt. No.	X - Force ($in.^2$)	Y - Force ($in.^2$)	Uplift Force ($in.^2$)	Moment About X-axis ($ft\text{-}in.^2$)	Moment About Y-axis ($ft\text{-}in.^2$)
1	42 *	Ao = 289.91	Ao =-289.91	0.0	See note below	See note below
		Av = 869.74	Av =-869.74	0.0	See note below	See note below
	43 *	Ao = 289.91	Ao = 289.91	0.0	See note below	See note below
		Av = 869.74	Av = 869.74	0.0	See note below	See note below
	44 *	Ao = 120.08	Ao = 120.08	0.0	See note below	See note below
		Av = 360.24	Av = 360.24	0.0	See note below	See note below
	45 *	Ao =-120.08	Ao = 120.08	0.0	See note below	See note below
		Av =-360.24	Av = 360.24	0.0	See note below	See note below
	46 *	Ao =-289.91	Ao = 289.91	0.0	See note below	See note below
		Av =-869.74	Av = 869.74	0.0	See note below	See note below
	47 *	Ao =-289.91	Ao =-289.91	0.0	See note below	See note below
		Av =-869.74	Av =-869.74	0.0	See note below	See note below
	48 *	Ao =-120.08	Ao =-120.08	0.0	See note below	See note below
		Av =-360.24	Av =-360.24	0.0	See note below	See note below
	49 *	Ao = 120.08	Ao =-120.08	0.0	See note below	See note below
		Av = 360.24	Av =-360.24	0.0	See note below	See note below
2	9	6305.84	-2611.97	-946.98	-12,689.83	12,332.62
	10	6222.55	2662.99	-852.00	12,383.83	12,934.18
	11	2568.01	6199.73	-757.02	28,926.32	5722.57
	12	-2516.99	6283.03	-852.00	29,800.40	-5116.21
	13	-6305.84	2611.97	-946.98	12,689.83	-12,332.62
	14	-6222.55	-2662.99	-852.00	-12,383.83	-12,934.18
	15	-2568.01	-6199.73	-757.02	-28,926.32	-5722.57
	16	2516.99	-6283.03	-852.00	-29,800.40	5116.21
3	1	3058.33	-1266.81	1715.18	4668.55	20,128.92
	2	3017.94	1291.55	1620.20	-4062.19	19,254.93
	3	1245.48	3006.87	1525.22	-7859.04	8428.51
	4	-1220.74	3047.27	1620.20	-8460.69	-8823.62
	5	-3058.33	1266.81	1715.18	-4668.55	-20,128.92
	6	-3017.94	-1291.55	1620.20	4062.19	-19,254.93
	7	-1245.48	-3006.87	1525.22	7859.04	-8428.51
	8	1220.74	-3047.27	1620.20	8460.69	8823.62

TABLE 6.2.1-21 (Sheet 2)

Level No.	Cmpt. No.	X - Force ($in.^2$)	Y - Force ($in.^2$)	Uplift Force ($in.^2$)	Moment About X-axis ($ft\text{-}in.^2$)	Moment About Y-axis ($ft\text{-}in.^2$)
4	17	7869.41	-68.68	82.2	-305.63	35,018.87
	18	5613.08	5515.96	82.2	24,546.02	24,978.21
	19	-68.68	7869.42	82.2	35,018.92	-305.63
	20	-5515.96	5613.08	82.2	24,978.21	-24,546.02
	21	-7869.41	68.68	82.2	305.63	-35,018.87
	22	-5613.08	-5515.96	82.2	-24,546.02	-24,978.21
	23	68.68	-7869.42	82.2	-35,018.92	305.63
	24	5515.96	-5613.08	82.2	-24,978.21	24,546.02
	25	6633.91	-57.90	0.0	-257.65	29,520.91
	26	4731.83	4649.95	0.0	20,692.29	21,056.63
	27	-57.90	6633.92	0.0	29,520.95	-257.65
	28	-4649.95	4731.83	0.0	21,056.62	-20,692.30
	29	-6633.91	57.90	0.0	257.65	-29,520.91
	30	-4731.83	-4649.95	0.0	-20,692.29	-21,056.63
	31	57.90	-6633.92	0.0	-29,520.95	257.65
	32	4649.95	-4731.83	0.0	-21,056.62	20,692.30
	33	0.0	0.0	28,727.17	0.0	0.0
	34	0.0	0.0	0.0	0.0	0.0
	35	0.0	0.0	0.0	0.0	0.0
	36	0.0	0.0	0.0	0.0	0.0
	37	0.0	0.0	0.0	0.0	0.0
	38	0.0	0.0	0.0	0.0	0.0
	39	0.0	0.0	0.0	0.0	0.0
	40	0.0	0.0	0.0	0.0	0.0
	41	0.0	0.0	0.0	0.0	0.0
Containment	50	-	-	-37,627.21	-	-

TABLE 6.2.1-21 (Sheet 3)

Note: In general, the force on the reactor pressure vessel due to pressure in compartment i at any time is given by $F_i(t) = P_i(t)A_i$,

where $F_i(t)$ = force on RPV due to compartment i at time t(lb_f),

$P_i(t)$ = pressure in compartment i at t($lb_f/in.^2$), from Figures 6.2.1-34 through 6.2.1-39

and A_i = area of projection of compartment i on RPV perpendicular to the direction of force, obtained from the appropriate column above ($in.^2$).

For compartments denoted by *, the force is function of the height of water-filled neutron shield bags. Prior to disintegration of a neutron shield bag, the force is given by

$$F_i(t) = P_i(t) \times [A_i o + A_i v \times \frac{h_i(t)}{1.0'}] + P_c(t) \times [A_i v \times (H - h_i(t) - T)] ,$$

where $A_i o$ = initial projected area of compartment i on RPV; not a function of shield bag height (in.2)

$A_i v$ = variable projected area of compartment i, based on a 1.0 ft maximum bag travel distance prior to disintegration of bag ($in.^2$)

$h_i(t)$ = distance traveled by shield bag at time t, (ft), determined by the equations of rigid body mechanics

$P_c(t)$ = containment pressure (compartment 50) in $lb_F/in.^2$ at time t, obtained from Figure 6.2.1-39

H = maximum height of compartment projection of RPV after bag disintegration; this height represents the distance from the top of the neutron shield support platform to the top of the RPV head bolts (3.5 ft),

and T = shield bag thickness (1.0 ft).

Following disintegration of a shield bag, the force is given by

$$F_i(t) = P_i(t) \times [A_i o + (A_i v \times H)]$$

where all parameters were defined above.

TABLE 6.2.1-21 (Sheet 4)

Moments are taken about the nozzle centerline at El. 2014'-6", with direction shown in Figures 6.2.1-28 through 6.2.1-32. In general, the moment about the axis of rotation due to pressure in compartment i is given by $M_i(t) = P_i(t)C_i$,

where $M_i(t)$ = moment due to compartment i at time t (ft-lb_f),

$P_i(t)$ was defined above,

and C_i = projected area of compartment i on RPV times appropriate moment arm (ft-in.2)

For compartments denoted by *, the moment is a function of neutron shield bag height. Prior to disintegration of a shield bag, the moment due to compartment i is

given by $$M_i(t) = P_i(t) \text{ x } [A_i o + A_i v \text{ x } \frac{h_i(t)}{1.0}] \text{ x } [7.1' + \frac{h(t)}{2}]$$

$$+ P_c(t) \text{ x } [A_i v \text{ x } (H - h_i(t) - T)] \text{ x } [7.1' + \frac{(h(t) + T + H)}{2}],$$

where all parameters were defined above. Moments about X-axis are due to the y-direction force. Therefore, the appropriate values of Ao and Av should be used.

Following disintegration of a shield bag, the moments due to compartments denoted by * are given by

$$M_i(t) = P_i(t) \text{ x } [A_i o + (A_i v \text{ x } H)] \text{ x } [7.1' + \frac{H}{2}]$$

where all parameters were defined above.

TABLE 6.2.1-22

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS

Node[a]	Net Volume (ft^3)	Peak Pressure[c] (psig)	Time to Peak Pressure (sec)	Break Case[b]	Design Pressure[c] (psig)
1	3962.5	8.911	9.800 x 10-2	1	24.53
2	545.9	9.368	9.550 x 10-2	1	24.53
3	828.1	9.895	5.550 x 10-2	1	24.53
4	2452.8	7.522	5.500 x 10-2	1	24.53
5	1957.1	15.864	3.700 x 10-2	1	24.53
6	826.8	12.746	8.300 x 10-2	2	24.53
7	231.7	27.321[e]	5.700 x 10-3	3	24.53
8	2299.5	17.463	1.800 x 10-2	1	24.53
9	4075.4	10.903	9.450 x 10-2	1	24.53/13.03[f]
10	3452.2	13.219	1.600 x 10-2	1	24.53/13.03
11	3294.4	8.868	4.800 x 10-2	1	13.03
12	8144.3	8.397	1.000 x 10-1	1	13.03
13	7912.9	3.475	1.000 x 10-1	1	13.03
14	17788.0	-	1.000 x 10-1	1	-[d]
15	23994.0	1.532	1.000 x 10-1	1	24.53/13.03
16	2.5 x 10^6	-	1.000 x 10-1	1	-
17	1677.5	8.667	9.950 x 10-2	1	24.53
18	295.2	9.407	5.550 x 10-2	1	24.53
19	184.7	9.058	7.400 x 10-2	1	24.53
20	78.1	10.385	6.000 x 10-2	1	24.53
21	734.4	10.754	5.950 x 10-2	1	24.53
22	278.6	10.231	8.650 x 10-2	1	24.53
23	639.0	12.078	3.300 x 10-2	1	24.53
24	1303.4	10.202	3.000 x 10-2	1	24.53/13 03
25	1165.1	9.984	9.200 x 10-2	1	24.53/13.03
26	1167.7	8.464	1.000 x 10-1	1	13.03
27	2976.2	8.282	1.000 x 10-1	1	13.03
28	1385.1	6.160	8.700 x 10-2	1	13.03
29	10860.2	1.638	1.000 x 10-1	1	24.53/13.03
30	865.3	8.047	9.600 x 10-2	1	17.96
31	2208.9	7.218	9.750 x 10-2	1	17.96
32	1679.5	12.049	6.600 x 10-2	1	17.60
33	3152.0	10.210	8.050 x 10-2	1	17.60
34	7706.7	9.307	9.300 x 10-2	1	17.60
35	12006.6	8.987	9.300 x 10-2	1	11.79
36	4206.6	6.765	9.850 x 10-2	1	11.79
37	25571.4	1.792	1.000 x 10-1	1	17.60
38	1578.0	5.610	9.150 x 10-2	1	14.63
39	1862.0	8.236	9.550 x 10-2	1	17.60
40	1920.6	8.254	8.500 x 10-2	1	17.60
41	1920.6	7.723	9.750 x 10-2	1	17.60
42	1862.0	8.054	9.150 x 10-2	1	17.60
43	4008.7	1.154	1.000 x 10-1	1	17.60
44	3824.0	1.150	1.000 x 10-1	1	17.60
45	1621.8	4.662	8.650 x 10-2	1	14.63

TABLE 6.2.1-22 (Sheet 2)

Node[a]	Net Volume (ft3)	Peak Pressure[c] (psig)	Time to Peak Pressure (sec)	Break Case[b]	Design Pressure[c] (psia)
46	896.9	5.650	8.700×10^{-2}	1	11.79
47	979.4	5.520	8.050×10^{-2}	1	11.79
48	979.4	5.562	8.050×10^{-2}	1	11.79
49	896.9	5.489	8.100×10^{-2}	1	11.79
50	2011.7	0.702	1.000×10^{-1}	1	11.79
51	1904.3	0.705	1.000×10^{-1}	1	11.79
52	4543.7	1.842	9.900×10^{-2}	1	14.63
53	2234.9	-	7.550×10^{-2}	1	-[d]
54	2305.4	-	7.900×10^{-2}	1	-[d]
55	2305.4	-	7.900×10^{-2}	1	-[d]
56	2234.9	-	8.200×10^{-2}	1	-[d]
57	4811.4	-	1.000×10^{-1}	1	-[d]
58	4595.6	-	1.000×10^{-1}	1	-[d]
59	2601.5	9.825	8.750×10^{-2}	1	17.60

NOTES:

a. Initial conditions for all nodes are identical: Temp = 120°F, press. = 14.7 psia, and relative humidity = 50%

b. Break cases:
1 = 763 in.^{2} hot leg split
2 = 436 in.^{2} double-ended pump suction line break
3 = 236 in.^{2} double-ended cold leg break

c. These are diffential pressures between the compartment and the remainder of the containment (Node 16).

d. The compartments where no peak or design pressure is given are considered to be part of the containment with no walls between them and the containment on which a pressure differential could be exerted.

e. Structural model considered average pressure load over element (see nodes 3 and 7, Figure 6.2.1-43). Hence, resultant pressure on effected element does not exceed design pressure of 24.53 psig.

f. Structural model divided at this node. Design pressure higher on effected half (24.53 psig), lower on noneffected half (13.03 psig).

TABLE 6.2.1-23

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS

Nodes		Vent Area	Head Loss Coefficients			Flow	
From	To	(Ft^2)	$K_{contraction}$	$K_{expansion}$	$K_{friction}$	Coefficient	λ/a
1	2	205.87	0.32	1.0	0.0158	0.870	0.0447
1	3	80.75	0.40	1.0	0.052	0.830	0.2238
1	16	21.00	0.44	1.0	0.000	0.830	0.3667
1	17	207.00	0.05	1.0	0.0228	0.966	0.0476
2	3	126.23	0.09	1.0	0.01	0.950	0.0454
2	6	105.0	0.12	1.0	0.0142	0.938	0.0819
2	19	17.35	0.32	1.0	0.105	0.838	0.6821
3	4	42.00	0 00	1.0	0.08	0.980	0.500
3	7	65.00	0.20	1.0	0.025	0.903	0.0779
3	18	33.96	0.28	1.0	0.055	0.870	0.3485
4	7	26.30	0.00	1.0	0.103	0.950	0.9290
4	8	18.30	0.44	1.0	0.087	0.809	0.3128
4	15	86.60	0.00	1.0	0.087	0.960	0.2944
5	6	270.70	0.02	1.0	0.010	0.985	0.0516
5	9	177.20	0.02	1.0	0.027	0.980	0.0960
5	23	100.62	0.08	1.0	0.029	0.950	0.094
6	8	224.91	0.10	1.0	0.011	0.950	0.0322
6	22	41.91	0.20	1.0	0.060	0.891	0.2824
7	8	103.60	0.125	1.0	0.024	0.933	0.0736
7	20	6.2	0.35	1.0	0.202	0.800	1.909
8	10	189.0	0.050	1.0	0.025	0.960	0.0792
8	21	91.84	0.22	1.0	0.0352	0.890	0.1289
9	10	382.73	0.02	1.0	0.011	0.985	0.0286
9	11	177.20	0.02	1.0	0.027	0.980	0.1096
9	24	210.00	0.08	1.0	0.019	0.954	0.0455
10	12	190.00	0.05	1.0	0.037	0.960	0.0987
10	25	168.13	0.08	1.0	0.022	0.953	0.0704
11	12	266.50	0.02	1.0	0.019	0.980	0.0492
11	26	182.76	0.04	1.0	0.015	0.974	0.0571
12	13	247.30	0.27	1.0	0.066	0.865	0.056
12	16	102.00	0.38	1.0	0.0243	0.843	0.1862
12	27	477.66	0.05	1.0	0.012	0.970	0.0209
13	14	127.225	0.15	1.0	0.128	0.885	0.3868
13	15	131.00	0.17	1.0	0.066	0.865	0.1764
13	28	46.25	0.41	1.0	0.115	0.810	0.2560
15	16	204.00	0.38	1.0	0.216	0.790	0.1155
15	29	1334.00	0.05	1.0	0.009	0.970	0.009
17	18	31.68	0.40	1.0	0.084	0.820	0.125
17	19	59.85	0.42	1.0	0.041	0.845	0.1118
17	30	187.70	0.03	1.0	0.011	0.980	0.0298
18	19	37.34	0.22	1.0	0.019	0.898	0.1156
18	20	13.00	0.36	1.0	0.0246	0.850	0.1986
18	32	45.67	0.10	1.0	0.047	0.933	0.2976
19	32	17.35	0.32	1.0	0.105	0.838	0.7883
20	21	30.20	0.40	1.0	0.0425	0.833	0.2615
20	59	19.03	0.17	1.0	0.075	0.896	0.7141
21	22	50.88	0.28	1.0	0.021	0.877	0.0822

TABLE 6.2.1-23 (Sheet 2)

Nodes		Vent Area	Head Loss Coefficients			Flow	
From	To	(Ft^2)	$K_{contraction}$	$K_{expansion}$	$K_{friction}$	Coefficient	λ/a
21	25	82.90	0.03	1.0	0.036	0.969	0.2015
21	59	64.45	0.08	1.0	0.040	0.940	0.2109
22	23	72.30	0.15	1.0	0.013	0.927	0.1316
22	59	16.16	0.20	1.0	0.098	0.877	0.8410
22	23	34.34	0.08	1.0	0.111	0.916	0.3957
24	25	150.84	0.03	1.0	0.012	0.979	0.1086
24	26	35.15	0.28	1.0	0.047	0.868	0.2895
24	34	210.00	0.08	1.0	0.019	0.954	0.065
25	27	82.90	0.03	1.0	0.036	0.970	0.2516
25	34	207.55	0.08	1.0	0.022	0.960	0.0655
26	27	70.62	0.15	1.0	0.050	0.913	0.1250
26	35	182.76	0.04	1.0	0.974	0.974	0.0744
27	16	40.20	0.38	1.0	0.843	0.836	0.4747
27	28	99.39	0.27	1.0	0.066	0.865	0.1430
27	35	477.60	0.05	1.0	0.012	0.970	0.0285
28	29	98.94	0.17	1.0	0.066	0.865	0.4061
28	36	216.00	0.00	1.0	0.00	1.0	0.0629
29	16	80.40	0.38	1.0	0.207	0.794	0.2944
29	37	1334.00	0.05	1.0	0.009	0.970	0.0102
30	16	10.5	0.44	1.0	0.00	0.833	0.9606
30	31	147.00	0.10	1.0	0.023	0.944	0.0663
31	16	21.00	0.44	1.0	0.00	0.833	0.3939
31	38	102.00	0.12	1.0	0.0353	0.930	0.1489
32	59	215.30	0.12	1.0	0.043	0.927	0.0456
33	34	248.00	0.27	1.0	0.0224	0.880	0.0366
33	39	147.86	0.14	1.0	0.03	0.925	0.1185
33	59	415.12	0.00	1.0	0.00	1.00	0.0284
34	35	248.00	0.27	1.0	0.0224	0.880	0.064
34	40	149.30	0.08	1.0	0.028	0.950	0.1172
34	41	149.30	0.08	1.0	0.028	0.950	0.1172
35	16	0.00	-	-	-	-	-
35	36	300.30	0.02	1.0	0.0161	0.980	0.075
35	42	147.86	0.37	1.0	0.0379	0.843	0.1185
36	37	300.30	0.02	1.0	0.054	0.965	0.132
37	43	313.60	0.10	1.0	0.0137	0.948	0.0558
37	44	300.60	0.10	1.0	0.023	0.944	0.0582
38	45	102.00	0.00	1.0	0.0266	0.987	0.113
39	40	131.30	0.30	1.0	0.0253	0.869	0.0233
39	46	109.10	0.23	1.0	0.034	0.890	0.1062
40	47	119.00	0.20	1.0	0.0285	0.903	0.0974
41	42	131.30	0.30	1.0	0.0253	0.869	0.2330
41	48	119.00	0.20	1.0	0.0285	0.903	0.0974
42	49	109.10	0.23	1.0	0.034	0.890	0.1062
43	50	244.50	0.20	1.0	0.020	0.905	0.0474
44	51	231.50	0.23	1.0	0.020	0.894	0.0501
45	52	102.00	0.00	1.0	0.0361	0.982	0.1481
46	47	60.00	0.35	1.0	0.050	0.845	0.055
46	53	109.10	0.23	1.0	0.034	0.888	0.1195

TABLE 6.2.1-23 (Sheet 3)

Nodes		Vent Area	Head Loss Coefficients			Flow	
From	To	(Ft^2)	$K_{contraction}$	$K_{expansion}$	$K_{friction}$	Coefficient	λ/a
47	48	125.90	0.12	1.0	0.0418	0.928	0.1896
47	54	119.00	0.20	1.0	0.0285	0.903	0.1096
48	49	60.00	0.35	1.0	0.050	0.845	0.055
48	55	119.00	0.20	1.0	0.0285	0.903	0.1096
49	56	109.10	0.23	1.0	0.034	0.888	0.1195
50	51	125.90	0.12	1.0	0.0418	0.928	0.1876
50	57	244.50	0.20	1.0	0.0534	0.904	0.0533
51	58	231.45	0.23	1.0	0.023	0.893	0.0563
53	54	160.85	0.30	1.0	0.026	0.868	0.0274
54	55	405.42	0.00	1.0	0.00	1.00	0.0344
55	56	160.85	0.30	1.0	0.026	0.868	0.0274
57	58	405.42	0.00	1.0	0.00	1.00	0.0632
19	22	29.00	0.27	1.0	0.031	0.877	0.2093
23	24	35.15	0.28	1.0	0.047	0.868	0.2895
23	33	100.62	0.08	1.0	0.029	0.950	0.1351
52	16	219.43	0.00	1.0	0.0	1.0	0.0494
53	16	183.56	0.00	1.0	0.0	1.0	0.0474
54	16	173.92	0.00	1.0	0.0	1.0	0.0500
55	16	173.92	0.00	1.0	0.0	1.0	0.0500
56	16	183.56	0.00	1.0	0.0	1.0	0.0474
57	16	372.24	0.00	1.0	0.0	1.0	0.0234
58	16	360.496	0.00	1.0	0.0	1.0	0.0241

TABLE 6.2.1-24

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS

FORCE COEFFICIENTS

FOR STEAM GENERATOR

Node	Force in E-W Direction	Force in N-S Direction	Uplift Force
5	-2251.36	-2141.19	3593.4
6	265.60	-1179.78	1283.6
8	2830.43	-1023.38	3454.85
9	-2254.31	2254.31	3712.23
10	1409.97	2090.03	2804.8
21	6905.60	-2496.80	------
22	648.00	-2878.40	------
23	-5492.80	-5224.00	------
24	-5500.00	5500.00	------
25	3440.00	5099.20	------
34	6206.70	-32208.78	------
35	-6206.70	32208.78	------
39	5075.58	-26115.66	5612.84
40	-5075.58	26115.66	4390.24
46	3430.96	-17651.92	------
47	-3430.96	17651.92	------
53	5781.17	-29743.49	-13689.8
54	-5781.17	29743.49	-10707.7

TABLE 6.2.1-25

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS FORCE COEFFICIENTS ON REACTOR COOLANT PUMP

Node	Force in E-W Direction	Force in N-S Direction	Uplift Force
2	-9311.58	-10347.0	1929.33
3	10404.0	-10404.0	2042.82
6	-10273.7	5519.62	1543.45
7	7356.74	3048.37	1021.41
8	1829.44	12241.12	1663.76
18	4082.04	-4082.04	
19	-3653.86	-4060.16	
20	2886.78	1196.04	
21	717.79	4803.0	
22	-4031.0	2165.90	
32	1311.4	-25029.30	-3949.45
59	-1311.4	25023.27	-4221.82

TABLE 6.2.1-26

PRESSURIZER COMPARTMENT ANALYSIS

Node[a]	Net Volume (ft^3)	Peak Pressure (psig)	Time to Peak Pressure (sec)	Design Pressure (psig)
1	3962	8.9	0.056	24.53
2	1374	6.7	0.04	24.53
3	2453	0.9	0.5	24.53
4	1677	13.6	0.014	24.53
5	480	5.7	0.055	24.53
6	865	14.7	0.016	17.96
7	2209	12.0	0.028	17.96
8	1578	9.7	0.067	14.63
9	1622	7.9	0.055	14.63
10	4544	1.1	0.5	14.63
11	2.6×10^6		0.5	

[a] Initial conditions for all nodes are identical. Temp = 120°F, press. = 14.7 psia, and relative humidity = 50%.

TABLE 6.2.1-27

PRESSURIZER COMPARTMENT ANALYSIS

Nodes		Vent Area	Head Loss Coefficients			Flow	
From	To	(Ft^2)	$K_{contraction}$	$K_{expansion}$	$K_{friction}$	Coefficient	l/a
1	2	286.62	0.25	1.0	0.0134	0.89	0.034
1	4	207.00	0.05	1.0	0.0228	0.966	0.0476
2	3	42.00	0.25	1.0	0.080	0.0828	0.500
2	5	51.31	0.27	1.0	0.160	0.838	0.5153
2	11	170.00	0.28	1.0	0.039	0.8707	0.001
3	11	131.2	0.00	1.0	0.00	1.00	0.001
4	5	91.53	0.30	1.0	0.0253	0.869	0.0866
4	6	187.70	0.03	1.0	0.011	0.980	0.0298
5	11	105.02	0.00	1.0	0.00	1.00	0.001
6	7	147.00	0.10	1.0	0.023	0.944	0.0663
6	11	10.5	0.44	1.0	0.00	0.833	0.9606
7	8	102.00	0.12	1.0	0.0353	0.93	0.1489
7	11	21.00	0.44	1.0	0.00	0.833	0.3939
8	9	102.00	0.00	1.0	0.0266	0.987	0.113
9	10	102.00	0.00	1.0	0.0361	0.982	0.1481
10	11	219.43	0.00	1.0	0.00	1.00	0.001

TABLE 6.2.1-28

BLOWDOWN MASS AND ENERGY RELEASE DOUBLE - ENDED PUMP SUCTION GUILLOTINE

Time (seconds)	Mass (1000 lbm)	Energy (1,000,000 Btu)
0.000	0.00	0.00
0.050	3.89	2.21
0.200	15.45	8.80
0.300	23.50	13.41
0.400	30.84	17.64
0.500	37.83	21.71
0.650	47.98	27.66
0.750	54.58	31.57
0.900	64.22	37.32
1.000	70.49	41.08
1.301	88.46	51.91
1.600	105.29	62.17
1.800	115.68	68.58
2.500	148.11	88.87
3.500	189.17	114.99
5.000	242.34	149.32
6.500	290.88	180.66
8.001	334.86	209.02
9.501	374.62	234.81
10.502	396.87	250.31
12.500	433.77	276.59
14.001	455.47	292.88
15.001	467.12	302.00
16.501	482.94	312.84
18.000	495.37	320.34
19.000	502.43	323.85
20.500	506.67	325.89
20.856	506.70	325.92

TABLE 6.2.1-28 (Sheet 2)

Time (seconds)	Mass Rate (1000 lbm/sec)	Energy Rate (1,000,000 Btu/sec)
0.000	77.721	44.213
0.025	77.721	44.213
0.125	76.910	43.836
0.250	80.602	46.180
0.350	73.541	42.382
0.450	69.901	40.642
0.575	67.632	39.687
0.700	65.960	39.051
0.825	64.333	38.357
0.950	62.499	37.464
1.150	59.848	36.093
1.451	56.148	34.217
1.700	51.976	32.042
2.150	46.334	28.997
3.000	41.064	26.123
4.250	35.443	22.881
5.750	32.360	20.895
7.251	29.303	18.895
8.751	26.501	17.191
10.002	22.231	15.493
11.501	18.465	13.148
13.251	14.462	10.857
14.501	11.653	9.126
15.751	10.550	7.229
17.250	8.286	4.996
18.500	7.059	3.509
19.750	2.833	1.364
20.678	0.061	0.079
20.857	0.000	0.000

TABLE 6.2.1-29

BLOWDOWN MASS AND ENERGY RELEASE
0.6 DOUBLE-ENDED PUMP SUCTION GUILLOTINE

Time (seconds)	Mass (1000 lbm)	Energy (1,000,000 btu)
0.000	0.00	0.00
0.050	2.64	1.50
0.200	11.94	6.82
0.300	18.23	10.42
0.450	27.31	15.65
0.550	33.14	19.04
0.700	41.65	24.00
0.850	49.62	28.69
0.950	54.74	31.71
1.200	66.91	38.93
1.500	81.33	47.53
1.800	95.68	56.12
2.000	105.11	61.80
3.500	168.31	100.71
5.000	218.08	132.35
6.500	262.48	160.66
8.000	302.91	186.42
9.500	339.96	210.03
11.002	372.70	231.78
12.501	399.88	250.49
14.501	430.39	271.98
16.002	448.91	285.58
17.501	464.12	297.17
19.500	481.91	309.26
21.000	493.72	315.95
22.500	504.40	320.93
24.000	508.24	322.75
24.500	508.26	322.78

Table 6.2.1-29 (Sheet 2)

Time (seconds)	Mass Rate (1000 lbm/sec)	Energy Rate (1,000,000 Btu/sec)
0.000	52.706	30.041
0.025	52.706	30.041
0.125	61.889	35.346
0.250	62.832	36.018
0.375	60.661	34.952
0.500	58.277	33.807
0.625	56.712	33.117
0.775	53.237	31.304
0.900	51.123	30.192
1.075	48.653	28.854
1.350	48.081	28.661
1.650	47.811	28.636
1.900	47.151	28.375
2.750	42.138	25.941
4.250	33.174	21.093
5.750	29.602	18.873
7.250	26.955	17.174
8.750	24.698	15.741
10.251	21.802	14.480
11.752	18.129	12.481
13.501	15.258	10.745
15.252	12.334	9.062
16.752	10.149	7.734
18.501	8.901	6.048
20.250	7.871	4.455
21.750	7.118	3.323
23.250	2.561	1.211
24.250	0.051	0.066
24.500	0.000	0.000

TABLE 6.2.1-30

BLOWDOWN MASS AND ENERGY RELEASE THREE FOOT SQUARED PUMP SUCTION SPLIT

Time (seconds)	Mass (1000 lbm)	Energy (1,000,000 Btu)
0.000	0.00	0.00
0.050	1.44	0.81
0.250	10.23	5.81
0.400	16.73	9.52
0.550	23.10	13.19
0.750	31.27	17.94
0.900	37.10	21.36
1.200	48.16	27.90
1.600	62.01	36.15
1.900	71.79	42.02
3.500	115.59	68.71
5.500	162.29	97.73
7.500	204.87	124.00
9.500	245.37	148.78
11.503	283.46	172.28
13.500	316.82	193.59
15.503	348.83	213.88
18.502	390.06	240.86
21.002	417.60	259.87
23.002	435.91	273.06
26.000	458.29	290.02
28.000	469.29	299.10
30.000	478.16	306.00
32.001	484.84	310.84
34.000	491.97	314.50
35.500	494.67	315.91
37.228	497.25	316.89
38.000	497.86	317.10

TABLE 6.2.1-30 (Sheet 2)

Time (seconds)	Mass Rate (1000 lbm/sec)	Energy Rate (1,000,000 btu/sec)
0.000	28.734	16.260
0.025	28.234	16.260
0.150	43.918	24.949
0.325	43.298	24.751
0.475	42.500	24.472
0.650	40.841	23.738
0.825	38.872	22.790
1.050	35.874	21.799
1.400	34.648	20.647
1.750	32.577	19.528
2.700	27.374	16.684
4.500	32.352	14.513
6.500	21.292	13.136
8.500	20.248	12.390
10.501	19.022	11.733
12.501	16.696	10.668
14.501	15.989	10.131
17.002	13.746	8.998
19.752	11.019	7.604
22.002	9.154	6.593
24.501	7.462	5.65s
27.000	5.504	4.540
29.000	4.433	3.451
31.000	3.341	2.419
33.000	3.567	1.831
34.750	1.800	0.939
36.364	1.489	0.568
37.614	0.793	0.272
38.000	0.000	0.000

TABLE 6.2.1-31

BLOWDOWN MASS AND EMERGY RELEASE DOUBLE-ENDED HOT LEG GUILLOTINE

Time (seconds)	Mass (1000 lbm)	Energy (1,000,000 Btu)
0.000	0.00	0.00
0.050	3.87	2.55
0.150	12.43	8.21
0.250	20.03	13.1
0.350	27.27	17.89
0.500	37.64	24.58
0.600	44.25	28.83
0.700	50.67	32.95
0.850	60.01	38.96
0.951	66.09	42.87
1.201	80.83	52.37
1.400	92.29	59.76
1.700	108.82	70.43
1.900	119.30	77.22
3.000	169.93	110.34
4.000	209.60	136.42
5.500	265.32	172.74
6.500	302.15	196.29
8.001	354.04	229.45
9.002	382.82	248.74
10.502	419.34	273.82
12.001	447.87	294.31
13.500	467.98	310.12
15.001	480.26	320.28
16.000	485.24	324.53
17.501	488.67	327.88
18.500	488.91	328.12
18.766	488.92	328.12

TABLE 6.2.1-31 (Sheet 2)

Time (seconds)	Mass Rate (1000 lbm/sec)	Energy Rate (1,000,000 btu/sec)
0.000	77.091	50.876
0.025	77.091	50.876
0.100	85.600	56.509
0.200	76.042	49.828
0.300	72.530	47.124
0.425	68.980	44.489
0.550	66.167	42.541
0.650	64.308	41.333
0.775	62.173	39.989
0.901	60.483	38.951
1.076	58.967	37.985
1.300	57.472	37.033
1.550	55.117	35.591
1.800	52.350	33.945
2.450	46.032	30.103
3.500	39.659	26.077
4.750	37.150	24.215
6.000	36.829	23.552
7.251	34.585	22.101
8.502	28.723	19.257
9.752	24.358	16.727
11.251	19.038	13.669
12.750	13.408	10.546
14.251	8.186	6.771
15.501	4.983	4.249
16.751	2.287	2.233
18.000	0.240	0.238
18.633	0.011	0.000
18.766	0.000	

TABLE 6.2.1-32

BLOWDOWN MASS AND ENERGY RELEASE DOUBLE-ENDED COLD LEG GUILLOTINE

Time (seconds)	Mass (1000 lbm)	Energy (1,000,000 Btu)
0.000	0.00	0.00
0.050	3.04	1.73
0.150	11.05	6.30
0.300	24.42	13.93
0.400	33.25	18.97
0.500	41.94	23.93
0.650	54.77	31.26
0.750	63.17	36.06
0.850	71.40	40.77
1.000	83.57	47.74
1.200	99.53	56.90
1.500	122.47	70.13
1.700	137.07	78.59
2.000	157.54	90.49
3.000	214.71	123.92
4.000	261.31	151.63
5.501	323.53	189.31
6.501	360.97	212.45
8.000	408.12	242.38
9.000	432.94	258.46
10.500	462.97	278.96
12.001	480.65	294.01
13.000	486.89	300.70
14.500	495.37	307.84
15.500	502.88	311.89
17.000	512.50	316.19
18.500	516.71	317.84
19.000	516.71	317.84

TABLE 6.2.1-32 (Sheet 2)

Time (seconds)	Mass Rate (1000 lbm/sec)	Energy Rate (1,000,000 Btu/sec)
0.000	60.513	34.397
0.025	60.513	34.397
0.100	80.298	45.819
0.225	89.099	50.870
0.350	88.175	50.338
0.450	86.994	49.665
0.575	85.587	48.880
0.700	83.923	47.962
0.800	82.340	47.096
0.925	81.101	46.451
1.100	79.780	45.805
1.350	76.476	44.091
1.600	72.950	42.250
1.850	68.292	39.698
2.500	57.165	33.435
3.500	46.596	27.704
4.751	41.447	25.102
6.001	37.435	23.132
7.251	31.460	19.970
8.500	24.820	16.087
9.750	20.017	13.664
11.251	11.784	10.029
12.501	6.241	6.598
13.750	5.658	4.756
15.000	7.511	4.052
16.250	6.414	2.866
17.750	2.802	1.100
18.750	0.006	0.008
19.000	0.000	0.000

TABE 6.2.1-33

REFLOOD MASS AND ENERGY RELEASE DOUBLE-ENDED PUMP SUCTION GUILLOTINE (MINIMUM SAFETY INJECTION)

		Steam Release		Water Release
(seconds)	(lbm/sec)	(1000 Btu/sec)	(lbm/sec)	(1000 Btu/sec)
20.9	0.0	0.0	0.0	0.0
21.2	0.1	0.1	0.0	0.0
21.8	336.8	438.1	0.0	0.0
22.4	417.8	543.4	0.0	0.0
25.5	812.7	1055.8	0.0	0.0
29 9	1135.7	1471.0	0.0	0.0
30 9	1181.6	1529.3	3377.7	297.2
39.6	1091.8	1402.7	2420.1	713.0
45.0	1088.2	1392.1	1951.8	171.8
50.0	1050.5	1338.2	1736.7	152.8
67.8	916.4	1151.8	995.6	87.6
74.5	914.1	1143.7	805.7	70.9
94.6	771.7	953.0	0.0	0.0
100.0	696.7	857.5	0.0	0.0
110.7	565.0	692.2	0.0	0.0
130.7	445.5	541.9	0.0	0.0

TABLE 6.2.1-34

REFLOOD MASS AND ENERGY RELEASE
DOUBLE-ENDED PUMP SUCTION GUILLOTINE (MAXIMUM SAFETY INJECTION)

Time	Steam Release		Water Release	
(seconds)	(lbm/sec)	(1000 Btu/sec)	(lbm/sec)	(1000 Btu/sec)
20.9	0.0	0.0	0.0	0.0
21.2	0.2	0.2	0.0	0.0
21.7	383.2	498.5	0.0	0.0
22.3	417.1	542.5	0.0	0.0
25.2	876.0	1138.0	0.0	0.0
29.4	1151.0	1490.8	4321.4	380.3
34.0	1164.3	1502.1	3693.0	325.0
44.5	1052.6	1346.5	2733.2	240.5
50.0	1027.5	1308.6	2476.5	217.9
67.8	950.4	1194.6	1715.4	151.0
74.0	881.8	1103.4	1574.3	138.5
87.2	840.2	1042.0	1430.7	125.9
92.1	785.2	970.7	264.4	23.3
94.1	798.5	986.2	233.2	20.5
100.0	771.6	949.5	278.0	24.5
124.3	632.0	376.4	457.0	40.2

TABLE 6.2.1-35

POST-BLOWDOWN MASS AND ENERGY RELEASE 0.6 DOUBLE-ENDED PUMP SUCTION GUILLOTINE

Time (seconds)	Steam Release (lbm/sec)	Steam Release (1000 Btu/sec)	Water Release (lbm/sec)	Water Release (1000 Btu/sec)
24.5	0.0	0.0	0.0	0.0
24.8	0.1	0.1	0.0	0.0
25.4	384.2	499.0	0.0	0.0
25.9	386.4	501.8	0.0	0.0
28.9	890.7	1155.4	0.0	0.0
33.1	1118.9	1446.9	0.0	0.0
33.5	1120.8	1448.9	4148.3	365.1
37.7	1181.7	1522.3	3624.8	319.0
42.7	1060.1	1359.7	3115.3	274.2
50.0	1072.1	1366.8	2590.1	227.9
53.4	1076.8	1369.0	2360.7	207.7
77.0	858.8	1072.5	1596.3	140.5
89.8	864.3	1069.5	1433.4	126.1
96.6	762.9	940.1	344.2	30.3
100.0	746.3	917.6	254.3	22.4
126.2	679.8	462.2	448.9	39.5
126.2	163.6	198.8	455.7	40.1
200.0	143.8	174.8	1155.2	101.7
500.0	104.1	126.4	1194.9	105.2
1000.0	81.1	98.5	1217.9	107.2
1500.0	72.0	87.4	1227.0	108.0
1500.0	86.9	105.5	1212.1	336.1
2000.0	80.6	97.8	1218.5	337.9
5000.0	61.7	74.8	1237.3	343.1
10000.0	50.5	61.2	1248.5	346.2
20000.0	41.5	50.1	1257.5	348.7
50000.0	32.1	38.6	1266.9	351.3
100000.0	25.3	31.5	1272.7	352.9
1000000.0	12.6	14.9	1286.4	356.7

Entrainment ends at 125.16 seconds.

TABLE 6.2.1-36

POST-BLOWDOWN MASS AND ENERGY RELEASE THREE FOOT SQUARED PUMP SUCTION SPLIT

Time	Steam Release		Water Release	
(seconds)	(lbm/sec)	(1000 Btu/sec)	(lbm/sec)	(1000 Btu/sec)
38.0	0.0	0.0	0.0	0.0
38.4	0.1	0.1	0.0	0.0
39.0	322.0	418.2	0.0	0.0
39.4	358.6	465.7	0.0	0.0
42.7	795.0	1031.4	0.0	0.0
47.1	1055.8	1365.8	0.0	0.0
48.0	1118.2	1445.4	3651.5	321.3
50.0	1102.3	1422.4	3461.1	304.6
56.6	1030.8	1323.0	2880.0	253.4
78.6	937.5	1183.3	1819.0	160.1
84.5	875.9	1101.0	1683.0	148.1
96.8	838.6	1045.3	1496.2	131.7
100.0	808.3	1005.4	897.2	79.0
103.3	776.3	963.5	235.5	20.7
131.3	668.5	816.6	425.0	37.4
139.0	615.0	748.3	479.0	42.2
139.0	160.9	195.7	485.8	42.8
200.0	144.9	176.2	1160.5	102.1
500.0	104.6	127.2	1200.8	105.7
1000.0	81.3	98.9	1224.1	107.7
1500.0	71.9	87.4	1233.6	108.6
1500.0	86.9	105.6	1218.5	337.9
2000.0	80.6	97.9	1224.9	339.6
5000.0	61.6	74.7	1243.9	344.9
10000.0	50.4	61.0	1255.1	348.0
20000.0	41.5	50.2	1263.9	350.5
50000.0	32.1	38.6	1273.4	353.1
100000.0	26.1	31.5	1279.2	354.7
1000000.0	12.6	14.9	1292.9	358.5

Entrainment ends at 138.99 seconds.

TABLE 6.2.1-37

POST-BLOWDOWN MASS AND ENERGY RELEASE: DOUBLE-ENDED HOT LEG GUILLOTINE

Time	Steam Release		Water Release	
(seconds)	(lbm/sec)	(1000 Btu/sec)	(lbm/sec)	(1000 Btu/sec)
18.8	0.0	0.0	0.0	0.0
19.1	.2	.0	0.0	0.0
19.3	1255.0	250.1	0.0	0.0
19.5	649.5	329.4	0.0	0.0
20.0	801.3	359.5	0.0	0.0
24.9	3175.5	952.4	0.0	0.0
28.3	2515.2	624.7	0.0	0.0
29.6	3809.9	1068.2	0.0	0.0
35.1	2527.0	624.2	1783.7	157.0
50.0	2699.4	755.2	1419.7	124.9
65.3	2726.8	839.9	1045.8	92.0
68.8	1717.4	490.5	1032.6	90.9
69.5	2313.0	709.7	0.0	0.0
74.1	1373.9	446.6	0.0	0.0
79.3	1707.1	636.5	0.0	0.0
85.1	850.4	363.7	0.0	0.0
85.1	178.8	213.0	0.0	0.0
100.0	173.1	206.1	1188.9	104.6
200.0	143.3	170.6	1218.7	107.2
500.0	103.9	123.7	1258.1	110.7
1000.0	81.2	96.7	1280.8	112.7
1500.0	71.9	85.7	1290.1	113.5
1500.0	86.9	103.5	1275.1	353.6
2000.0	80.5	93.9	1281.5	355.3
5000.0	61.6	73.4	1300.3	360.6
10000.0	50.5	60.1	1311.5	363.6
20000.0	41.5	49.4	1320.5	366.1
50000.0	32.1	38.2	1329.9	368.8
1000000.0	12.5	14.9	1349.4	374.2

Entrainment ends at 85-11 seconds.

TABLE 6.2.1-38

POST-BLOWDOWN MASS AND ENERGY RELEASE DOUBLE-ENDED COLD LEG GUILLOTINE

Time	Steam Release		Water Release	
(seconds)	(lbm/sec)	(1000 Btu/sec)	(lbm/sec)	(1000 Btu/sec)
19.0	0.0	0.0	0.0	0.0
19.4	0.5	0.7	0.0	0.0
19.4	0.5	0.7	0.0	0.0
20.0	183.6	239.7	0.0	0.0
20.8	215.4	281.2	0.0	0.0
22.0	263.5	344.0	0.0	0.0
27.0	463.4	604.9	0.0	0.0
29.0	420.3	548.5	0.0	0.0
30.0	446.5	582.6	4791.3	421.6
36.6	457.5	596.5	4340.6	382.0
48.6	430.3	560.4	3772.1	331.9
50.0	430.5	560.5	3496.6	307.7
61.7	433.5	563.8	845.0	74.4
100.0	391.8	507.6	871.2	76.7
116.9	373.5	483.2	888.8	78.2
131.2	376.1	485.9	899.5	79.2
200.0	312.2	401.1	968.9	85.3
252.9	267.0	342.0	1020.3	89.8
252.9	132.6	169.9	1022.1	89.9
500.0	104.0	133.0	1284.3	113.0
1000.0	81.2	103.7	1307.1	115.0
1500.0	71.9	91.7	1316.3	115.8
1500.0	86.9	110.8	1301.4	360.8
2000.0	80.5	102.5	1307.7	362.6
5000.0	61.6	77.9	1326.6	367.8
10000.0	50.5	63.3	1337.8	370.9
20000.0	41.5	51.4	1346.8	373.4
50000.0	32.1	38.9	1356.2	376.0
1000000.0	12.6	14.9	137s.7	381.4

Entrainment ends at 252.91 seconds.

TABLE 6.2.1-39

Post-Reflood Mass and Energy Release Double-Ended Pump Suction Guillotine (Minimum Safety Injection)

Time	Steam Release		Water Release	
(seconds)	(lbm/sec)	(1000 Btu/sec)	(lbm/sec)	(1000 Btu/sec)
130.7	330.7	390.5	255.6	72.3
174.6	330.7	390.5	255.6	72.3
174.6	209.8	247.8	376.5	104.6
185.7	204.6	241.7	381.7	106.1
210.7	198.9	235.0	387.4	107.7
240.7	192.7	227.7	393.6	109.4
265.7	188.0	222.1	398.3	110.7
295.7	176.9	209.0	409.4	113.8
325.7	172.2	203.4	414.1	115.1
355.7	167.7	198.1	418.6	116.3
380.7	164.1	193.9	422.2	117.3
410.7	160.0	189.0	426.3	118.5
435.7	156.7	185.1	429.6	119.4
465.7	152.8	180.5	433.5	120.5
490.7	149.6	176.7	436.7	121.3
520.7	145.9	172.3	440.4	122.4
550.7	142.2	168.0	444.1	123.4
580.7	138.6	163.7	447.7	124.4
605.7	135.6	160.2	450.7	125.2
635.7	132.1	156.0	454.2	126.2
660.7	134.2	158.5	452.1	125.6
690.7	130.5	154.2	455.8	126.6
715.7	127.5	150.5	458.8	127.5
745.7	123.8	146.2	462.5	128.5
775.7	124.8	147.4	461.5	128.2
805.7	120.9	142.8	465.4	129.3
830.7	117.6	138.9	468.7	130.2
860.7	118.0	139.4	468.3	130.1
920.7	113.6	134.2	472.7	131.3
975.7	108.9	128.7	477.4	132.6
1035.7	105.8	124.9	480.5	133.5
1323.7	105.8	124.9	480.5	133.5
1323.7	109.1	127.2	477.2	132.5
1400.0	107.7	125.5	478.6	132.9
1509.0	106.3	123.9	480.0	133.3

TABLE 6.2.1-39 (Sheet 2)

Time	Steam Release		Water Release	
(seconds)	(lbm/sec)	(1000 Btu/sec)	(lbm/sec)	(1000 Btu/sec)
1509.0	See note below	102.1	See note below	
2000.0	See note below	92.1	See note below	
3775.0	See note below	79.7	See note below	
3775.0	See note below	54.0	See note below	
5000.0	See note below	49.2	See note below	
10000.0	See note below	40.0	See note below	
20000.0	See note below	33.2	See note below	
50000.0	See note below	24.5	See note below	
100000.0	See note below	19.8	See note below	
200000.0	See note below	16.0	See note below	
500000.0	See note below	11.1	See note below	
1000000.0	See note below	8.2	See note below	

NOTE: Following switchover to recirculation mode at 1509.0 seconds, the releases are a function of the reactor decay heat, the safety injection system flowrate (4800 gpm), the steam generator depressurization energy releases, and the containment saturation pressure. The energy releases above represent the rate of addition of energy to the primary system during recirculation from decay heat and depressurization. Steam and water releases to the containment are calculated as functions of time using the procedure outlined in section 3.2.4 of BN-TOP-3, Rev. 4 (Ref. 1)

TABLE 6.2.1-40

POST-REFLOOD MASS AND ENERGY RELEASE DOUBLE-ENDED PUMP SUCTION GUILLOTINE (MAXIMUM SAFETY INJECTION)

Time	Steam Release		Water Release	
(seconds)	(lbm/sec)	(1000 Btu/sec)	(lbm/sec)	(1000 Btu/sec)
124.3	257.3	303.7	1143.7	231.2
172.4	257.3	303.7	1143.7	231.2
172.4	142.3	168.2	1258.7	254.1
179.3	141.0	166.6	1260.0	252.7
204.3	137.0	161.9	1264.0	252.2
234.3	132.9	157.0	1268.1	251.3
259.3	129.9	153.5	1271.1	245.2
289.3	126.8	149.8	1274.2	244.2
319.3	124.1	146.5	1276.9	243.1
349.3	121.6	143.6	1279.4	241.9
374.3	119.7	141.4	1281.3	240.9
404.3	117.7	139.0	1283.3	239.6
434.3	115.8	136.8	1285.2	238.2
464.3	114.0	134.7	1287.0	236.7
489.3	112.7	133.1	1288.3	235.5
519.3	111.1	131.3	1289.9	233.9
549.3	109.7	129.6	1291.3	232.3
579.3	108.4	128.0	1292.6	230.6
604.3	107.4	126.8	1293.6	229.1
634.3	106.2	125.4	1294.8	227.3
659.3	105.2	124.3	1295.8	225.8
689.3	104.2	123.0	1296.8	223.9
714.3	103.3	122.0	1297.7	226.6
744.3	102.3	120.9	1298.7	224.5
774.3	101.4	119.8	1299.6	222.3
804.3	100.5	118.7	1300.5	224.1
829.3	99.8	117.9	1301.2	222.0
849.0	99.3	117.2	1301.7	220.3

TABLE 6.2.1-40 (Sheet 2)

Time	Steam Release		Water Release	
(seconds)	(lbm/sec)	(1000 Btu/sec)	(lbm/sec)	(1000 Btu/sec)
849.0	See note below	93.5	See note below	
1000.0	See note below	90.5	See note below	
1489.9	See note below	80.5	See note below	
1489.9	See note below	95.5	See note below	
2000.0	See note below	85.8	See note below	
3772.0	See note below	73.5	See note below	
3772.0	See note below	54.0	See note below	
5000.0	See note below	49.2	See note below	
10000.0	See note below	40.0	See note below	
20000.0	See note below	33.2	See note below	
50000.0	See note below	24.5	See note below	
100000.0	See note below	19.8	See note below	
200000.0	See note below	16.0	See note below	
500000.0	See note below	11.1	See note below	
1000000.0	See note below	8.2	See note below	

NOTE: Following switchover to recirculation mode at 849.0 seconds, the releases are a function of the reactor decay heat, the safety injection flowrate (9600 gpm), the steam generator depressurization energy releases, and the containment saturation pressure. The energy releases above represent the rate of addition of energy to the primary system during recirculation from decay heat and depressurization. Steam and water releases to the containment are calculated as functions of time using the procedure outlined in section 3.2.4 of BN-TOP-3, Rev. 4 (Ref. 1).

TABLE 6.2.1-41

DEPRESSURIZATION ENERGY
DOUBLE-ENDED PUMP SUCTION GUILLOTINE
(MINIMUM SAFETY INJECTION)

Depressurization Output

The post-reflood energy release from the steam generators is terminated when the steam generators are in equilibrium with the referenced containment design pressure (74.7 psia, 60.0 psig or 307.3°F). This leaves the following energy stored in the system (above 14.7 psia or 212.0°F):

	Energy Remaining (1,000,000 Btu)
Broken loop steam generator	20.9
Unbroken loop steam generator	62.8
Metal energy (thin and thick)	20.8
Core stored	1.8
Total available energy	106.3

TABLE 6.2.1-42

DEPRESSURIZATION ENERGY
DOUBLE-ENDED PUMP SUCTION GUILLOTINE
(MAXIMUM SAFETY INJECTION)

Depressurization Output

The post-reflood energy release from the steam generators is terminated when the steam generators are in equilibrium with the referenced containment design pressure (74.7 psia, 60.0 psig or 307.3°F). This leaves the following energy stored in the system (above 14.7 psia or 212.0°F):

Energy Remaining (1,000,000 Btu)	
Broken loop steam generator	20.9
Unbroken loop steam generator	62.8
Metal energy (thin and thick)	21.1
Core stored	1.8
Total available energy	106.6

TABLE 6.2.1-43

REACTOR COOLANT SYSTEM MASS AND ENERGY BALANCE DOUBLE-ENDED PUMP SUCTION GUILLOTINE (MINIMUM SAFETY INJECTION)

Mass Balance

Time (seconds)	0.00	20.86	130.69	130.69	1035.69
	Mass (1000 lb)				
Available					
Initial RCS and accumulator	739.54	739.54	739.54	739.54	739.54
Added Mass					
Pumped injection	0.00	0.00	54.77	54.77	585.37
Total added	0.00	0.00	54.77	54.77	585.37
Total available	739.54	739.54	794.31	794.31	1324.91
Distribution					
Reactor coolant	504.52	40.00	113.99	113.99	113.99
Accumulator	235.02	192.84	0.00	0.00	0.00
Total contents	739.54	232.84	113.99	113.99	113.99
Effluent					
Break flow	0.00	506.70	597.00	597.00	725.51
ECCS spill	0.00	0.00	83.32	83.32	485.51
Total effluent	0.00	506.70	680.32	680.32	1210.92
Total Accountable	739.54	739.54	794.31	794.31	1324.81

TABLE 6.2.1-43 (Sheet 2)

Energy Balance

Time (seconds)	0.00	20.86	130.69	130.69	1035.69
Energy (1,000,000 Btu)					
Available					
In RCS, accumulator, and steam generator	874.50	874.50	874.50	874.50	874.50
Added Energy					
Pumped injection	0.00	0.00	4.82	4.82	51.51
Decay heat	0.00	7.06	24.53	24.53	117.15
Heat from secondary	0.00	-0.61	-0.61	-0.61	16.91
Total added	0.00	6.45	28.73	28.73	185.57
Total available	874.50	880.95	903.24	903.24	1060.08
Distribution					
Reactor coolant	304.90	11.02	22.91	22.91	22.91
Accumulator	20.68	16.97	0.00	0.00	0.00
Core stored	26.97	6.03	5.09	5.09	5.09
Thin metal	19.97	16.78	9.84	9.84	9.84
Thick metal	33.03	33.03	28.06	28.06	28.06
Steam generator	468.96	471.21	390.46	390.46	283.94
Total contents	874.50	555.03	456.35	456.35	349.82
Effluent					
Break flow	0.00	325.92	439.56	439.56	591.43
ECCS spill	0.00	0.00	7.33	7.33	118.82
Total effluent	0.00	325.92	446.89	446.89	710.25
Total Accountable	874.50	880.95	903.24	903.24	1060.08

TABLE 6.2.1-44

REACTOR COOLANT SYSTEM MASS AND ENERGY BALANCE DOUBLE-ENDED PUMP SUCTION GUILLOTINE (MAXIMUM SAFETY INJECTION)

Mass Balance

Time (seconds)	0.00	20.86	124.30	124.30	1034.30
	Mass (1000 lb)				
Available					
Initial RCS and accumulator	739.54	739.54	739.54	739.54	739.54
Added Mass					
Pumped injection	0.00	0.00	131.19	131.19	1406.10
Total added	0.00	0.00	131.19	131.19	1406.10
Total available	739.54	739.54	870.73	870.73	2145.64
Distribution					
Reactor coolant	504.52	40.00	123.16	123.16	123.16
Accumulator	235.02	192.84	0.00	0.00	0.00
Total contents	739.54	232.84	123.16	123.16	123.16
Effluent					
Break flow	0.00	506.70	597.78	597.78	695.89
ECCS spill	0.00	0.00	149.79	149.79	1326.59
Total effluent	0.00	506.70	747.57	747.57	2022.48
Total Accountable	739.54	739.54	870.73	870.73	2145.64

TABLE 6.2.1-44 (Sheet 2)

Energy Balance

Time (seconds)	0.00	20.86	124.30	124.30	1034.30
	Energy (1,000,000 Btu)				
Available					
In RCS, accumulator, and steam generator	874.50	874.50	874.50	874.50	874.50
Added Energy					
Pumped injection	0.00	0.00	11.54	11.54	123.74
Decay heat	0.00	7.06	23.63	23.63	117.04
Heat from secondary	0.00	-0.61	-0.61	-0.61	16.91
Total added	0.00	6.45	34.56	34.56	257.68
Total available	874.50	880.95	909.06	909.06	1132.18
Distribution					
Reactor coolant	304.90	11.02	23.69	23.69	23.69
Accumulator	20.68	16.97	0.00	0.00	0.00
Core stored	26.97	6.03	5.09	5.09	5.09
Thin metal	19.97	16.78	9.84	9.84	9.84
Thick metal	33.03	33.03	28.30	28.30	28.30
Steam generator	468.96	471.21	389.63	389.63	284.07
Total contents	874.50	555.03	456.55	456.55	350.99
Effluent					
Break flow	0.00	325.92	439.33	439.33	555.27
ECCS spill	0.00	0.00	13.18	13.18	225.93
Total effluent	0.00	325.92	452.51	452.51	781.20
Total Accountable	874.50	880.95	909.06	909.06	1132.18

TABLE 6.2.1-45

PRIMARY COOLANT SYSTEM MASS AND ENERGY BALANCE
0.6 DOUBLE-EMDED PUMP SUCTION GUILLOTINE

Mass Balance

Time (seconds)	0.00	20.86	126.16	1500.00
Mass (1000 lb)				
Available				
Initial RCS and accumulator	739.54	739.54	739.54	739.54
Added Mass				
Pumped injection	0.00	0.00	130.40	1915.04
Total added	0.00	0.00	130.40	1915.04
Total available	739.54	739.54	869.94	2654.58
Distribution				
Reactor coolant	504.52	43.19	126.36	123.36
Accumulator	235.02	188.09	0.00	0.00
Total contents	739.54	231.27	126.36	126.36
Effluent				
Break flow	0.00	508.26	597.65	728.47
ECCS spill	0.00	0.00	145.92	1799.74
Total effluent	0.00	508.26	743.57	2528.21
Total Accountable	739.54	739.54	869.94	2654.57

TABLE 6.2.1-45 (Sheet 2)

Energy Balance

Time (seconds)	0.00	24.50	126.16	1500.00
Energy (1,000,000 Btu)				
Available				
In RCS, accumulator, and steam geneeator	874.50	874.50	874.50	874.50
Pumped injection	0.00	8.11	24.23	155.29
Heat from secondary	0.00	-20.26	-20.26	-20.26
Total added	0.00	-12.15	15.44	303.55
Total available	874.50	862.35	889.94	1178.05
Reactor coolant	304.90	11.73	24.40	24.40
Accumulator	20.68	16.55	0.00	0.00
Core stored	26.97	5.09	5.09	5.09
Thin metal	19.97	16.52	9.84	9.84
Thick metal	33.03	33.03	28.37	16.34
Steam generator	468.96	456.65	376.89	372.62
Total contents	874.50	539.57	444.59	428.29
Break flow	0.00	322.78	432.51	591.38
ECCS spill	0.00	0.00	12.84	158.38
Total effluent	0.00	322.78	445.35	749.76
Total Accountable	874.50	862.35	889.94	1178.05

TABLE 6.2.1-46

REACTOR COOLANT SYSTEM MASS AND ENERGY BALANCE
THREE-FOOT-SQUARED PUMP SUCTION SPLIT

Mass Balance

Time (seconds)	0.00	38.00	138.99	1500.00
Mass (1000 lb)				
Available				
Initial RCS and accumulator	739.54	739.54	739.54	739.54
Added Mass				
Pumped injection	0.00	0.00	131.09	1907.83
Total added	0.00	0.00	131.09	1907.83
Total available	739.54	739.54	870.63	2647.37
Distribution				
Reactor coolant	504.52	75.42	158.58	158.58
Accumulator	235.02	166.26	0.00	0.00
Total contents	739.54	241.68	158.58	158.58
Effluent				
Break flow	0.00	497.86	582.35	711.55
ECCS spill	0.00	0.00	129.71	1777.24
Total effluent	0.00	497.86	712.05	2488.79
Total Accountable	739.54	739.54	870.63	2647.37

TABLE 6.2.1-46 (Sheet 2)

Energy Balance

Time (seconds)	0.00	38.00	138.99	1500.00
Energy (1,000,000 Btu)				
Available				
In RCS, accumulator, and steam generator	874.50	874.50	874.50	874.50
Added Energy				
Pumped injection	0.00	0.00	11.54	167.89
Decay heat	0.00	13.21	28.65	157.92
Heat from secondary	0.00	-30.26	-30.26	-30.26
Total added	0.00	-17.04	9.93	295.55
Total available	874.50	857.46	884.43	1170.05
Distribution				
Reactor coolant	304.90	17.58	30.26	30.26
Accumulator	20.68	14.63	0.00	0.00
Core stored	26.97	6.32	5.09	5.09
Thin metal	19.97	15.66	9.84	9.84
Thick metal	33.03	33.03	28.40	16.35
Steam generator	468.96	453.14	376.02	371.64
Total contents	874.50	540.36	449.61	433.18
Effluent				
Break flow	0.00	317.10	423.40	580.48
ECCS spill	0.00	0.00	11.41	156.40
Total effluent	0.00	317.10	434.82	736.87
Total Accountable	874.50	857.46	884.43	1170.05

WOLF CREEK

TABLE 6.2.1-47

REACTOR COOLANT SYSTEM MASS AND ENERGY BALANCE DOUBLE-ENDED HOT LEG GUILLOTINE

Mass Balance

Time (seconds)	0.00	18.77	85.11	1500.00
	Mass (1000 lb)			
Available				
Initial RCS and accumulator	739.54	739.54	739.54	739.54
Added Mass				
Pumped injection	0.00	0.00	96.32	2023.39
Total added	0.00	0.00	96.32	2023.39
Total available	739.54	739.54	835.86	2762.93
Distribution				
Reactor coolant	504.52	59.29	135.07	143.18
Accumulator	235.02	191.33	0.00	0.00
Total contents	739.54	250.62	135.07	143.18
Effluent				
Break flow	0.00	488.92	644.63	782.27
ECCS spill	0.00	0.00	56.16	1837.48
Total effluent	0.00	488.92	700.79	2619.75
Total Accountable	739.54	739.54	835.86	2762.93

TABLE 6.2.1-47 (Sheet 2)

Energy Balance

Time (seconds)	0.00	18.77	85.11	1500.00
	Energy (1,000,000 Btu)			
Available				
In RCS, accumulator, and steam generator	874.50	874.50	874.50	874.50
Added Energy				
Pumped injection	0.00	0.00	8.48	178.06
Decay heat	0.00	7.31	18.56	155.62
Heat from secondary	0.00	-.61	-.61	-.61
Total added	0.00	6.70	26.42	333.07
Total available	874.50	881.20	900.92	1207.57
Distribution				
Reactor coolant	304.90	15.02	26.94	27.66
Accumulator	20.68	16.84	0.00	0.00
Core stored	26.97	7.01	5.09	5.09
Thin metal	19.97	16.93	9.84	9.84
Thick metal	33.03	33.03	29.82	16.34
Steam generator	468.96	464.26	450.49	449.23
Total contents	874.50	553.08	522.18	508.15
Effluent				
Break flow	0.00	328.12	373.80	537.72
ECCS spill	0.00	0.00	4.94	161.70
Total effluent	0.00	328.12	378.74	699.42
Total Accountable	874.50	881.20	900.92	1207.57

TABLE 6.2.1-48

REACTOR COOLANT SYSTEM MASS AND ENERGY BALANCE
DOUBLE-ENDED COLD LEG GUILLOTINE

Mass Balance

Time (seconds)	0.00	19.00	252.91	1500.00
Mass (1000 lb)				
Available				
Initial RCS and accumulator	739.54	739.54	739.54	739.54
Added Mass				
Pumped injection	0.00	0.00	321.43	2052.74
Total added	0.00	0.00	321.43	2052.74
Total available	739.54	739.54	1060.97	2792.27
Distribution				
Reactor coolant	504.52	26.70	113.74	113.74
Accumulator	235.02	137.37	0.00	0.00
Total contents	739.54	164.07	113.74	113.74
Effluent				
Break flow	0.00	516.71	600.98	713.06
ECCS spill	0.00	58.75	346.25	1965.48
Total effluent	0.00	575.46	947.21	2678.54
Total Accountable	739.54	739.54	1060.97	2792.27

TABLE 6.2.1-48 (Sheet 2)

Energy Balance

Time (seconds)	0.00	19.00	252.91	1500.00
	Energy (1,000,000 Btu)			
Available				
In RCS, accumulator, and steam generator	874.50	874.50	874.50	874.50
Added Energy				
Pumped injection	0.00	0.00	28.29	180.64
Decay heat	0.00	5.58	39.09	153.84
Heat from secondary	0.00	-0.61	-0.61	-0.61
Total added	0.00	4.97	66.77	333.87
Total available	874.50	879.47	941.27	1208.37
Distribution				
Reactor coolant	304.90	7.33	20.46	20.46
Accumulator	20.68	12.09	0.00	0.00
Core stored	26.97	13.60	5.09	5.09
Thin metal	19.97	16.91	9.84	9.84
Thick metal	33.03	33.03	24.18	16.34
Steam generator	468.96	473.50	424.42	413.67
Total contents	874.50	556.46	484.00	465.40
Effluent				
Break flow	0.00	317.84	426.80	570.01
ECCS spill	0.00	5.17	30.47	172.96
Total effluent	0.00	323.01	457.27	742.97
Total Accountable	874.50	879.47	941.27	1208.37

WOLF CREEK

TABLE 6.2.1-49

PRINCIPAL REFLOOD PARAMETERS TRANSIENTS DOUBLE-ENDED PUMP SUCTION (MINIMUM SAFETY INJECTION)

	Flooding						Injection			
Time (seconds)	Temperature (F)	Rate (in/sec)	Carryover Fraction	Core Height (ft)	Downcomer Height (ft)	Flow Fraction	Total (ft^3/sec)	Accumulator (ft^3/sec)	Spill (ft^3/sec)	Enthalpy (Btu/lbm)
0.00	307.89	0.000	0.000	0.00	0.00	0.250	0.0	0.0	0.0	88.00
0.26	301.81	52.823	0.000	0.62	0.12	0.267	146.6	137.1	0.0	88.00
0.34	298.62	62.208	0.000	1.01	-0.03	0.419	146.1	136.6	0.0	88.00
0.92	294.72	3.552	0.347	1.50	0.97	0.655	140.2	131.0	0.0	88.00
1.31	294.17	3.467	0.422	1.57	1.89	0.659	137.0	127.9	0.0	88.00
1.41	294.03	3.467	0.438	1.59	2.13	0.660	136.2	127.1	0.0	88.00
1.51	293.90	3.467	0.454	1.60	2.36	0.661	135.4	126.3	0.0	88.00
4.61	289.07	4.339	0.681	2.00	8.74	0.673	112.3	104.2	0.0	88.00
9.02	279.87	5.696	0.759	2.50	15.17	0.678	83.8	77.2	0.0	88.00
10.01	277.59	5.798	0.766	2.61	16.00	0.678	79.3	73.0	54.6	88.00
13.64	270.02	5.562	0.780	3.00	16.00	0.679	71.0	64.4	47.3	88.00
18.74	261.18	5.347	0.787	3.50	16.00	0.680	61.6	54.8	38.8	88.00
24.11	253.51	5.167	0.788	4.00	16.00	0.682	53.9	46.9	31.9	88.00
29.68	246.86	4.999	0.788	4.50	16.00	0.683	47.6	40.3	26.2	88.00
35.43	241.05	4.835	0.787	5.00	16.00	0.684	42.3	34.9	21.7	88.00
41.33	235.95	4.672	0.786	5.50	16.00	0.685	38.1	30.5	18.1	88.00
47.41	231.39	4.509	0.784	6.00	16.00	0.686	34.6	26.9	15.4	88.00
53.67	227.28	4.346	0.783	6.50	16.00	0.688	31.9	24.1	13.4	88.00
60.13	223.52	4.182	0.781	7.00	16.00	0.689	29.8	21.8	11.9	88.00
66.79	220.07	4.018	0.780	7.50	16.00	0.690	28.1	20.0	11.0	88.00
70.01	218.53	3.940	0.779	7.74	16.00	0.690	27.5	19.3	10.7	88.00
71.60	217.80	3.902	0.778	7.85	16.00	0.691	8.2	0.0	0.0	88.00
73.70	216.88	3.748	0.777	8.00	15.67	0.690	8.3	0.0	0.0	88.00
81.32	214.07	3.257	0.772	8.50	14.73	0.690	8.6	0.0	0.0	88.00
89.86	211.68	2.840	0.766	9.00	14.04	0.689	8.8	0.0	0.0	88.00
99.36	209.67	2.498	0.760	9.50	13.59	0.688	9.0	0.0	0.0	88.00
109.83	207.99	2.229	0.754	10.00	13.38	0.687	9.1	0.0	0.0	88.00

TABLE 6.2.1-50

PRINCIPAL REFLOOD PARAMETERS TRANSIENTS
DOUBLE-ENDED PUMP SUCTION (MINIMUM SAFETY INJECTION)

	Flooding						Injection			
Time (seconds)	Temperature (F)	Rate (in/sec)	Carryover Fraction	Core Height (ft)	Downcomer Height (ft)	Flow Fraction	Total (ft3/sec)	Accumulator (ft3/sec)	Spill (ft3/sec)	Enthalpy (Btu/lbm)
0.00	307.09	0.000	0.000	0.0	0.00	0.250	0.0	0.0	0.0	88.00
0.25	301.79	55.252	0.000	0.62	0.16	0.267	159.8	137.2	0.0	88.00
0.33	298.43	65.797	0.000	1.03	0.00	0.507	159.3	136.7	0.0	88.00
0.86	294.64	3.764	0.350	1.50	1.01	0.656	153.1	131.1	0.0	88.00
1.41	293.80	3.643	0.454	1.60	2.43	0.662	148.3	126.6	0.0	88.00
4.37	288.84	4.554	0.681	2.00	9.18	0.674	124.2	104.4	0.0	88.00
8.57	279.45	5.897	0.759	2.50	16.00	0.678	94.6	77.6	69.4	88.00
13.17	269.59	5.564	0.780	3.00	16.00	0.679	83.4	66.0	59.7	88.00
18.27	260.74	5.348	0.786	3.50	16.00	0.680	73.9	56.1	51.0	88.00
23.63	253.10	5.168	0.788	4.00	16.00	0.682	66.0	48.0	44.0	88.00
29.20	246.48	4.999	0.788	4.50	16.00	0.683	59.6	41.2	38.3	88.00
34.94	240.72	4.835	0.787	5.00	16.00	0.684	54.4	35.7	33.7	88.00
40.84	235.65	4.671	0.786	5.50	16.00	0.685	50.1	31.1	30.2	88.00
46.92	231.14	4.508	0.784	6.00	16.00	0.686	46.7	27.4	27.5	88.00
53.18	227.07	4.345	0.783	6.50	16.00	0.688	44.0	24.5	25.4	88.00
59.64	223.36	4.180	0.781	7.00	16.00	0.689	41.9	22.1	24.0	88.00
66.30	219.95	4.016	0.779	7.50	16.00	0.690	40.2	20.2	23.1	88.00
71.28	217.63	3.895	0.778	7.86	16.00	0.690	20.2	0.0	3.6	88.00
73.19	216.78	3.850	0.778	8.00	16.00	0.691	20.2	0.0	3.8	88.00
80.33	213.84	3.682	0.776	8.50	16.00	0.692	20.5	0.0	4.7	88.00
87.73	211.09	3.514	0.774	9.00	16.00	0.693	20.7	0.0	5.7	88.00
95.42	208.51	3.344	0.771	9.50	16.00	0.693	20.9	0.0	6.6	88.00
103.44	206.10	3.171	0.769	10.00	16.00	0.694	21.0	0.0	7.5	88.00

TABLE 6.2.1-51
BASES FOR ANALYSIS

Plant model	4 loop, 12 ft core
Core power, license application, MWt	3411
Ultimate core power rating, MWt	3565
Nominal inlet temperature, F	560.0
Nominal outlet temperature, F	618.6
Steam pressure, psia	1000
Rod array	17 x 17
Total accumulator mass, lbm	235,020
Accumulator temperature, F	120
Assumed containment design pressure, psia	74.7
Assumed RWST temperature, F	120
Pumped injection (assumed for froth)	
Minimum, lb/sec	586.3
Maximum, lb/sec	1401
RPV volume below break, ft^3	2959

TABLE 6.2.1-52

SAFETY INJECTION FLOW RATE VERSUS BACKPRESSURE

Pressure (psia)	Minimum Flow Rate (ft^3/sec)	Maximum Flow Rate (ft^3/sec)
14.7	11.26	26.13
114.7	8.035	19.84
214.7	2.257	7.741
1014.7	1.530	2.730

TABLE 6.2.1-53

19-ELEMENT REFLOOD MODEL(a)

Element	Broken Loop Area (ft^2)	Unbroken Loop Area (ft^2)	Form Factor (K)	Equivalent Length (ft)	Hydraulic Diameter (ft)
1. Hot leg nozzle	4.59	13.77	0.2116	0.0	2.42
2. Hot leg piping	4.59	13.77	0.0530	0.0	2.42
3. Steam generator inlet plenum	19.90	59.70	9.298	0.0	2.58
4. Steam generator tubes	11.343	34.03	2.981	57.82	0.05067
5. Steam generator outlet plenum	19.90	59.70	4.142	0.0	2.58
6. Crossover leg piping	5.24	15.72	0.0529	0.0	2.58
7. Pump (forward)	4.125	12.3	(b)	0.0	2.292
8. Cold leg piping	4.12	12.3	0.0332	0.0	2.29
9. Cold leg inlet nozzle (c)	-	12.3	0.6068	0.0	2.29
10. Around downcomer (estimate)	-	10.00	0.01	10.0	4.00
11. Cold leg inlet nozzle	-	4.12	0.6068	0.0	2.29
12. Cold leg piping	-	4.12	0.0332	0.0	2.29
13. Pump (reverse)	-	4.125	(b)	0.0	2.292
14. Crossover leg piping	-	5.24	0.0529	0.0	2.58
15. Steam generator outlet plenum	-	19.90	4.142	0.0	2.58
16. Steam generator tubes	-	11.343	2.981	57.82	0.05067
17. Steam generator inlet plenum	-	19.90	9.928	0.0	2.58
18. Hot leg piping	-	4.59	0.0530	0.0	2.42

(a) The 19-element model includes elements for both the broken and unbroken (as an example if there is 1 broken loop element there are 18 unbroken loop elements, for a total of 19 elements).

(b) The analysis accounts for transient pump resistances due to pump coastdown.

(c) The path around the downcomer is specified only to provide a loop reference point for pressure at top of downcomer. The frictional pressure drop data are estimated and provide negligible pressure drop.

TABLE 6.2.1-54

MASS AND ENERGY RELEASE HYDRAULIC CHARACTERISTICS FOR POST-REFLOOD (ONE INTACT LOOP) AT 130.7 SECONDS

Item Number	Description	Steam Mass Flow (lb/sec)	Area (ft^2)	Steam Velocity (ft/sec)		Density (lb/ft^3)	Height (ft)	K	$\Delta P_{Elevation}$ (psf)	$\Delta P_{Friction}$ (psf)
1	Downcomer	-	-	-	-	57.1	16.0	-	913.0	-
2	Core	154.0	51.2	8.78	0.73	15.7	12.0	-	-187.9	-
3	Upper plenum	154.0	152.1	5.91	0.60	22.7	4.0	-	-90.7	-
4	Steam generator inlet plenum	2.6	20.5	0.73	0.22	44.3	8.0	-	-354.4	-
	Available P								280.0	
5	Steam generator tubes	58.8	11.3	-	-	0.327*	1.5	-	0.5	-
6	Loop ΔP (steam generator plus pump)	58.8	4.5	-	-	0.130	-	13.9	-	283.5
	$\Delta P_{Loop} + \Delta P_{Tubes}$								284.0	

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* Density in tubes based on mass balanced quality instead of void fraction correlation.

TABLE 6.2.1-55

MASS AND ENERGY RELEASE
HYDRAULIC CHARACTERISTICS FOR
POST-REFLOOD (BROKEN LOOP) AT 130.7 SECONDS

Item Number	Description	Steam Mass Flow (lb/sec)	Liquid Mass Flow (lb/sec)	Area (ft^2)	Steam Velocity (ft/sec)		Density (lb/ft^3)	Height (ft)	K	ΔPElevation (psf)	ΔPFriction (psf)
1	Cold leg (pump)	75.0	365.0	4.5	-	-	1.0	-	14.0	-	2095.7
2	Downcomer	-	-	-	-	-	57.1	16.0	-	913.0	-
3	Core	154.0	-	51.2	8.78	0.73	15.7	12.0	-	-187.9	-
4	Upper plenum	154.0	-	152.1	5.91	0.60	22.7	4.0	-	-90.7	-
5	Steam generator inlet plenum	146.3	-	20.5	41.66	1.00	0.2	8.0	-	-1.4	-
	Available ΔP										2728.7
6	Steam generator tubes	146.3	0.0	11.3	-	-	0.171(a)	57.8(b)	-	0.0	-
7	Hot leg (steam generator)	146.3	0.0	4.5	-	-	0.171	-	4.5	-	431.1
	$\Delta P_{\text{Hot Leg}} + \Delta P_{\text{Tubes}}$										431.1

(a) Density based on a mass balanced quality and includes effect of negative head (H = 1/2 average length of tubes).

(b) Steam generator tube height is assumed equal to the heat transfer length (since the effective head is negligible and is a reasonble assumption).

TABLE 6.2.1-56

Spectrum of Main Steamline Ruptures Analyzed

Case #	Power Level (%)*	Break Size (ft^2)	Break Type	Remarks
1	102	Full	Double-ended	***
2	102	0.6	Double-ended	
3	102	0.8	Split	
4	75	Full	Double-ended	***
5	75	0.55	Double-ended	
6	75	0.84	Split	
7	50	Full	Double-ended	***
8	50	0.45	Double-ended	
9	50	0.80	Split	
10	25	Full	Double-ended	***
11	25	0.33	Double-ended	
12	25	0.66	Split	
13	0	full	Double-ended	***
14	0	0.20	Double-ended	
15	0	0.40	Split	
16**	0	0.40	Split	MSIV Failure

* The power % is scaled to reference the re-rated power of 3579 MWt

** Same as Case 15, except additional failure of the MSIV on faulted loop has been taken into consideration.

*** An MSIV failure is conservatively accounted for by combining the LOFTRAN results with the hand-calculated initial blowdown.

TABLE 6.2.1-56A

Time Sequence of Events for the Steamline Break Mass and Energy Releases to Containment

Case	Rx Trip Signal	SI Signal	Steamline Isolation Signal	SI Actuation (sec)	Feedwater Isolation (sec)	Steamline Isolation (sec)	SG Tube Uncovery (sec)	SG Dryout (sec)
1	SI	LSP	LSP	1.389	18.389	18.389	188.0	276.6
2	SI	LSP	LSP	1.991	8.991	18.991	290.8	580.2
3	OPDT	Hi-1 Cont P	Hi-2 Cont P	18.7	35.7	86.7	280.2	473.6
4	SI	LSP	LSP	1.209	18.209	18.209	158.4	300.7
5	SI	LSP	LSP	2.800	19.800	19.800	330.2	911.2
6	SI	Hi-1 Cont P	Hi-2 Cont P	16.8	33.8	84.7	285.0	600.8
7	SI	LSP	LSP	1.133	18.133	18.133	164.2	396.7
8	SI	Hi-1 Cont P	Hi-2 Cont P	14.7	31.7	79.5	481.2	545.7
9	SI	Hi-1 Cont P	Hi-2 Cont P	16.7	33.7	89.3	315.6	337.4
10	SI	LSP	LSP	1.115	18.115	18.115	175.2	192.0
11	SI	Hi-1 Cont P	Hi-2 Cont P	18.8	35.8	125.5	698.2	788.7
12	SI	Hi-1 Cont P	Hi-2 Cont P	19.1	36.1	108.2	402.8	443.2
13	SI	LSP	LSp	1.168	18.168	18.168	200.0	217.0
14	SI	Hi-1 Cont P	Hi-2 Cont P	29.7	46.7	219.9	1480.2	1744.0
15	SI	Hi-1 Cont P	Hi-2 Cont P	30.7	47.7	192.7	761.0	832.5
16	SI	Hi-1 Cont P	Hi-2 Cont P	30.7	47.7	192.7	824.0	895.0

SI - Safety Injection
LSP - Low Steamline Pressure
OPΔT - Overpower Delta T
Hi-1 Cont P - Hi-1 (6 psig) Containment Pressure
Hi-2 Cont P - Hi-2 (20 psig) Containment Pressure

TABLE 6.2.1-57

Specific Plant Design Input for MSLB Mass & Energy Release Analysis

Case	1	2	3	4	5	6	7	8
Initial steam generator inventory[1], lbm	117728	119532	117728	130632	130632	132494	144079	144079
Initial average temperature, °F	595.53	595.53	595.53	587.05	587.05	587.05	579.20	579.20
Initial pressurizer water volume, ft^3	1026.63	1026.63	1026.63	891.68	891.68	891.68	766.72	766.72
Initial feedwater enthalpy, Btu/lbm	428.32	428.32	428.32	390.00	390.00	390.00	349.42	349.42
Safety injection water enthalpy[2], Btu/lbm	555.918	555.918	555.918	555.918	555.918	555.918	555.918	555.918
Break area, ft^2	1.4	0.6	0.80	1.4	0.55	0.84	1.4	0.45
Feedwater isolation time, sec	18.389	18.991	35.7	18.209	19.8	33.8	18.133	31.7
Steamline isolation time, sec	18.389	18.991	86.7	18.209	19.8	84.7	18.133	79.5
Maximum AFW flow rate to the affected SG[3], gpm	1360	1360	1360	1360	1360	1360	1360	1360
Termination of AFW addition, sec	1200	1200	1200	1200	1200	1200	1200	1200

TABLE 6.2.1-57
(sheet 2)

Case	9	10	11	12	13	14	15	16
Initial steam generator inventory[1], lbm	146008	161098	161098	163106	188398	188398	190497	210702
Initial average temperature, °F	579.20	571.35	371.35	571.35	563.5	563.5	563.5	563.5
Initial pressurizer water volume, ft^3	766.72	641.76	641.76	641.76	516.81	516.81	516.81	516.81
Initial feedwater enthalpy, Btu/lbm	349.42	300.43	300.43	300.43	76.98	76.98	76.98	76.98
Safety injection water enthalpy[2], Btu/lbm	555.918	555.918	555.918	555.918	555.918	555.918	555.918	555.918
Break area, ft^2	0.80	1.4	0.33	0.66	1.4	0.20	0.40	0.40
Feedwater isolation time, sec	33.7	18.115	35.8	36.1	18.168	46.7	47.7	47.7
Steamline isolation time, sec	89.3	18.115	125.5	108.2	18.168	219.9	192.7	192.7
Maximum AFW flow rate to the affected SG[3], gpm	1360	1360	1360	1360	1360	1360	1360	1360
Termination of AFW addition, sec	1200	1200	1200	1200	1200	1200	1200	1200

TABLE 6.2.1-57
(sheet 3)

Note:

1) For split breaks, the initial mass of the unisolable portion of the steamline is added to the initial mass of the faulted steam generator.

2) Represents the enthalpy at the regions downstream of the boron injection tank (BIT) instead of the water source from the refueling water storage tank (RWST). Mixing of the relatively colder water from the RWST with the hotter water residing in the BIT has been accounted for.

3) Corresponds to the situation that the faulted steam generator depressurizes to atmospheric condition and the intact steam generators are maintained at 1200 psia.

TABLE 6.2.1-57A

Steamline Break Mass and Energy Release Rates, Case 1, 102% Power, Full Double-Ended Break

Time (sec)	Mass Release Rate (lbm/sec)	Energy Release Rate (E+6 Btu/sec)	Enthalpy (Btu/lbm)
0	0	0	0
0.2	8857	10.56	1192
0.4	8710	10.39	1192
0.6	8632	10.3	1193
0.8	8515	10.16	1193
1	8443	10.08	1194
1.4	8258	9.862	1194
1.8	8122	9.704	1195
2	8051	9.622	1195
3.2	7633	9.133	1197
3.4	8378	10.03	1197
3.6	8356	10	1197
3.8	8337	9.979	1197
4	8317	9.957	1197
5	8107	9.71	1198
6	7935	9.508	1198
8	7645	9.166	1199
10	7351	8.82	1200
14	6564	7.888	1202
15	6359	7.645	1202
18	5847	7.035	1203
18.4	5783	6.959	1203
18.6	1625	1.956	1204
18.8	1616	1.946	1204
19	1608	1.936	1204
20	1568	1.888	1204
25	1380	1.662	1204
30	1228	1.479	1204
35	1128	1.358	1204
40	1065	1.282	1204
50	998.5	1.202	1204
60	965.4	1.162	1204
70	944.7	1.137	1204
75	936.7	1.127	1203
100	913.5	1.099	1203
125	904	1.088	1203
150	899.4	1.082	1203
175	897.2	1.079	1203
180	897	1.079	1203
185	896.7	1.079	1203
188	896.6	1.079	1203
190	875.4	1.053	1203
195	787.5	0.9466	1202
200	696.9	0.8369	1201
205	611.8	0.7337	1199

TABLE 6.2.1-57A (sheet 2)

Steamline Break Mass and Energy Release Rates, Case 1, 102% Power, Full Double-Ended Break

Time (sec)	Mass Release Rate (lbm/sec)	Energy Release Rate (E+6 Btu/sec)	Enthalpy (Btu/lbm)
210	525.7	0.6294	1197
215	442.8	0.5288	1194
220	369.3	0.4399	1191
225	310.6	0.369	1188
230	266	0.3153	1185
240	215.2	0.2542	1181
250	194.6	0.2295	1179
260	187.2	0.2207	1178
275	184.2	0.217	1178
300	183.5	0.2162	1178
450.2	183.5	0.2162	1178
600.2	183.5	0.2162	1178
900.2	183.5	0.2162	1178
1200	183.5	0.2162	1178

TABLE 6.2.1-57B

Steamline Break Mass and Energy Release Rates, Case 16, Hot Zero Power, 0.40 ft^2 Split Break With MSIV Failure

Time (sec)	Mass Release Rate (lbm/sec)	Energy Release Rate (E+6 Btu/sec)	Enthalpy (Btu/lbm)
0	0	0	0
0.2	957.8	1.136	1186
0.6	954.3	1.132	1186
1	951.1	1.128	1186
2	943.4	1.119	1186
4	929	1.103	1187
6	916.2	1.088	1188
8	904.6	1.075	1188
10	894	1.063	1189
15	870.1	1.035	1190
20	848.8	1.011	1191
25	830.4	0.9896	1192
30	816.4	0.9733	1192
32	811	0.9671	1193
32.6	809.3	0.9651	1193
32.8	808.8	0.9646	1193
35	804.9	0.9601	1193
40	802.8	0.9576	1193
50	782.3	0.9339	1194
60	759.6	0.9076	1195
75	726.6	0.869	1196
100	676.3	0.8102	1198
125	635.2	0.7618	1199
150	616.6	0.7399	1200
175	612.4	0.7349	1200
190	612.2	0.7346	1200
192.6	612.2	0.7347	1200
192.8	612.2	0.7347	1200
195	598.3	0.7183	1201
200	569.9	0.6847	1201
205	547.8	0.6585	1202
210	530.1	0.6374	1202
220	503.8	0.6061	1203
225	494.1	0.5945	1203
230	486.2	0.5851	1203
240	474.5	0.571	1204
250	466.6	0.5616	1204
275	456.4	0.5494	1204
300	452.6	0.5449	1204
450	450	0.5418	1204
600	451.4	0.5435	1204
750	453	0.5453	1204
800	453.4	0.5458	1204
824	453.5	0.546	1204
830	440.2	0.53	1204

TABLE 6.2.1-57B (sheet 2)

Steamline Break Mass and Energy Release Rates, Case 16, Hot Zero Power, 0.40 ft^2 Split Break With MSIV Failure

Time (sec)	Mass Release Rate (lbm/sec)	Energy Release Rate (E+6 Btu/sec)	Enthalpy (Btu/lbm)
835	418.4	0.5038	1204
840	387.1	0.4662	1204
845	349.3	0.4207	1204
850	310.4	0.3738	1204
855	276	0.3322	1204
860	248.5	0.2989	1203
865	227.8	0.2738	1202
870	212.5	0.2553	1202
875	201.4	0.2418	1201
880	193.2	0.232	1200
885	187.4	0.2249	1200
890	183.2	0.2198	1200
900	178.1	0.2136	1199
1200	173.1	0.2076	1199

TABLE 6.2.1-57C

Containment Fan Cooler Performance Data: Based on 69400 CFM Air Flow with ESW Flowrate =1000 GPM per Cooler and 95°F ESW Water Temperature

Inlet Gas Temperature	Actual Heat Removal Rate	Actual Heat Removal Rate	20% Degradation (See Note)
(°F)	(Btu/hr)	(Btu/sec)	(Btu/sec)
125	8,606,664	2,390.74	1,923.99
131	10,653,612	2,959.34	2,368.74
153	18,851,040	5,236.40	4,180.52
190	34,021,272	9,450.35	7,594.62
220	46,670,472	12,964.02	10,417.78
253	60,678,684	16,855.19	13,519.12
277	70,891,380	19,692.05	15,701.33
288	75,580,104	20,994.47	15,701.33

Note: The actual heat removal rates are based on AL-6XN replacement coils. The 20% degradation values are from the original CAC equipment specifications, reduced by 20%.

TABLE 6.2.1-58

MSLB Peak Pressure and Temperature Results

Case	Power Level/Break Type	Peak Pressure (psig)	Time of Peak Pressure (sec)	Peak Temperature (°F)	Time of Peak Temperature (sec)
1	102%/Full DER	50.59	1202	364.9	18
2	102%/0.60 ft^2 DER	38.86	1202	296.6	298
3	102%/0.80 ft^2 Split	46.59	1202	303.8	186
4	75%/Full DER	48.66	1202	357.0	18
5	75%/0.55 ft^2 DER	39.50	1202	295.3	322
6	75%/0.84 ft^2 Split	45.57	1202	304.1	192
7	50%/Full DER	49.41	1202	356.8	18
8	50%/0.45 ft^2 DER	42.22	1202	293.4	62
9	50%/0.80 ft^2 Split	46.83	1202	303.4	202
10	25%/Full DER	52.85	1202	362.4	18
11	25%/0.33 ft^2 DER	43.61	1202	272.2	62
12	25%/0.66 ft^2 Split	44.34	1202	299.3	242
13	0%/Full DER	50.98	1202	363.8	18
14	0%/0.20 ft^2 DER	39.82	1204	263.3	1202
15	0%/0.40 ft^2 Split	48.69	1202	289.5	384
16	0%/0.40 ft^2 Split w/MSIV Failure	52.69	1200	293.8	364

TABLE 6.2.1-59

Sequence of Events for Case 10
Peak Calculated Containment Pressure Case for MSLB

Time (sec)	Event
0.0	Break occurs, blowdown from all four steam generators
1.1	Steamline pressure setpoint for isolation of main feedwater lines and main steam lines reached (360 psig)
14.6	Containment pressure setpoint for actuation of containment sprays reaches (30 psig)
18.0	Peak containment vapor tenmperature of 362.4°F is reached
18.1	Main feedwater line isolation valves closed
18.1	Main steam line isolation valves closed, blowdown from broken loop steam generator and unisolated steam piping only
60.0*	Containment sprays start
175.2	Steam generator tube uncovery occurs
192.0	Dryout occurs, blowdown equals auxiliary feedwater addition rate
225.0**	Containment air coolers are assumed to begin removing heat.
1200.0	Auxiliary feedwater addition is terminated
1202.0	Peak containment pressure of 52.85 psig is reached

* The containment pressure reaches the containment Hi-3 pressure setpoint (30 psig, including uncertainty) before 27 seconds. Therefore, full flow containment spray is conservatively assumed to occur at 60 seconds, accounting for time to attain operating speed and design flow of the containment spray pump and fill up the spray lines.

** This response time considered an extended time interval between the time of steamline break initiation/LOOP and the time full containment cooling system air and safety grade cooling water flow is establiished. The delay was increased to bound all potential water hammer modification designs. Following the completion of the water hammer modification design, the actual delay time is less than 70 seconds; however, the use of the 225 second delay time results in conservative results.

TABLE 6.2.1-60

Sequence of Events for Case 1
Peak Calculated Containment Temperature Case for MSLB

Time (sec)	Event
0.0	Break occurs, blowdown from all four steam generators
1.4	Low steamline pressure setpoint for isolation of main steam lines and main feedwater lines reached
14.9	Containment pressure setpoint for actuation of containment sprays reaches (30 psig)
18.0	Peak containment vapor temperature of 364.9°F is reached
18.4	Main steam line isolation valves closed, blowdown from broken loop steam generator and unisolated steam piping only
18.4	Main feedwater line isolation valves closed
60.0*	Containment sprays start
188.0	Steam Generator tube uncovery occurs
225.0**	Containment air coolers are assumed to begin removing heat
276.6	Dryout occurs, blowdown equals auxiliary feedwater addition rate
1200.0	Auxiliary feedwater addition is terminated
1202.0	Peak containment pressure of 50.59 psig is reached

* The containment pressure reaches the containment Hi-3 pressure setpoint (30 psig, including uncertainty) before 27 seconds. Therefore, full flow containment spray is conservatively assumed to occur at 60 seconds, accounting for time to attain operating speed and design flow of the containment spray pump and fill up the spray lines.

** This response time considered an extended time interval between the time of steamline break initiation/LOOP and the time full containment cooling system air and safety grade cooling water flow is established. The delay was increased to bound all potential water hammer modification designs. Following te completion of the water hammer modification design, the actual delay time is less tan 70 seconds; however, the use of the 225 second delay time results in conservative results.

TABLE 6.2.1-61

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TABLE 6.2.1-62

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TABLE 6.2.1-63

BELOCA Mass & Energy Release Data Used for COCO Calculations

Time (s)	RCP Side Mass Flow Rate (lb/s)	RCP Side Energy Flow (BTU/s)	Vessel Side Mass Flow Rate (lb/s)	Vessel Side Energy Flow (BTU/s)
0.0	9408.2	5207067	-9.1	0
0.5	25172.1	13846789	53074.0	29215435
1	24638.8	13749897	48465.2	26653226
2	19413.5	11344687	34907.8	19207958
3	13086.7	8113011	28349.9	15669619
4	9175.6	6485948	25311.3	14108456
5	6978.9	5595382	23164.5	13075017
6	6359.8	5279076	21123.0	12184754
7	6005.0	5033120	19415.4	11397310
8	5676.4	4758261	17638.7	10547493
9	5447.0	4483483	16415.4	9776754
10	5393.8	4274180	13807.0	8618746
15	2438.7	2241777	8577.4	4531724
20	474.6	572078	6000.7	1682727
25	67.8	86101	134.2	34519
30	28.9	37264	-29.8	0
35	45.9	59001	6.5	6154
40	94.1	119331	1043.0	136641
45	95.4	121295	5296.1	786287
50	157.0	195982	1056.9	585688
55	95.9	121869	948.4	382474
60	68.6	87743	405.6	259988
65	60.7	77789	344.5	222160
70	55.8	71421	143.3	113647
75	53.7	68810	120.2	99563
80	56.0	71753	125.7	101808
85	54.3	69502	116.4	96356
90	55.2	70574	123.4	101204

TABLE 6.2.1-63 (Sheet 2)

BELOCA Mass & Energy Release Data Used for COCO Calculations

95	58.9	74926	137.5	109960
100	65.8	83084	201.2	138477
110	65.4	82633	200.1	138558
120	61.3	77626	177.1	119744
130	75.7	93618	459.3	213458
140	80.5	97380	444.1	200998
150	61.9	77554	243.3	116303
160	66.9	83458	370.5	172567
170	71.3	88216	338.8	183997
180	68.2	84812	566.5	198845
190	70.1	86088	576.8	209728
200	66.0	82585	438.0	188509
210	75.3	89834	444.0	205182
220	67.1	82774	719.9	228167
230	58.7	73455	386.2	157530
240	62.9	76765	376.8	176575
250	48.1	60381	290.1	142306
260	60.8	72829	308.5	152940
270	56.0	69259	876.4	237684
280	51.7	64261	499.9	174101
290	53.0	65427	210.8	117241
300	53.5	65749	256.0	130689
310	44.8	55949	240.5	109860
320	46.2	57372	206.2	118458
330	51.5	62442	230.4	132012
340	48.5	60013	195.2	129474
350	51.9	63371	628.2	178219

TABLE 6.2.1-63 (Sheet 3)

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TABLE 6.2.1-63 (Sheet 4)

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TABLE 6.2.1-63 (Sheet 5)

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TABLE 6.2.1-64

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TABLE 6.2.1-65

Large-Break LOCA Containment Data Used for Pressure Calculations

Maximum Containment Net Free Volume	2,700,000 ft^3
Initial Conditions	
Minimum initial containment pressure at full power operation	14.7 psia
Minimum initial containment temperature at full power operation	90°F
Minimum RWST temperature (for Safety Injection)	37.0°F
Minimum Temperature outside containment	-60.0°F
Minimum Initial containment spray temperature	37.0°F
Spray System	
Maximum number of containment spray pumps in operation	2
Minimum Post-accident containment spray system initiation delay time	15 seconds (with offsite power) 25 seconds (with LOOP)
Maximum spray system flow from all containment spray pumps	7,754 gal/min.
Recirculation Spray Not Applicable	
Fan Coolers (1)	
Maximum number of containment fan coolers in operation	4
Minimum fan cooler initiation delay time	35 seconds (with offsite power) 45 seconds (with LOOP)
Containment Purge	
Maximum number of containment purge lines OPEN at onset of transient	2
Maximum containment purge valve closure time	5 seconds
Containment purge valve diameter	18 in.

NOTES:

(1) The containment fan cooler performance is determined based on:

a) Essential Service Water (ESW) is entering the containment fan cooler at 1000 gpm**.
b) Steam/air mixture leaving the containment fan cooler at a flowrate of 69,400 acfm.
c) ESW temperature of 33°F, with an zero internal fouling factor.

** The impact of the increase in containment fan cooler heat removal rate due to the potential of higher ESW flow on the limiting large break LOCA has been assessed.

TABLE 6.2.1-66

Large-Break LOCA Containment Heat Sink Data Used for Containment Pressure Calculations

Structural Heat Sinks					
	Wall (feet)	**T_{Air} (°F)**	**Area (ft^2)**	**Height (ft)**	**$T_{initial}$ (°F)**
1.	0.000167 paint 0.021 carbon steel 4.0 concrete	-60.0	64919.0	10.0	90.0
2.	0.000167 paint 0.021 carbon steel 3.0 concrete	-60.0	34129.0	10.0	90.0
3.	0.000167 paint 1.5 concrete 0.021 carbon steel, 10.0 concrete	90.0	13538.0	10.0	90.0
4.	1.0 concrete	90.0	8564.0	10.0	90.0
5.	2.0 concrete	90.0	43497.0	10.0	90.0
6.	2.5 concrete	90.0	17061.0	10.0	90.0
7.	0.000167 paint, 0.021 carbon steel, 2.0 concrete	90.0	7821.0	10.0	90.0
8.	0.021 stainless steel, 2.0 concrete	90.0	8708.0	10.0	90.0
9.	0.0001083 zinc coating, 0.005 carbon steel, 2.0 concrete	90.0	8081.0	10.0	90.0
10.	0.0001083 zinc coating, 0.0104 carbon steel	90.0	186183.0	10.0	90.0
11.	0.000167 paint, 0.0104 carbon steel	90.0	17746.0	10.0	90.0
12.	0.000167 paint, 0.0208 carbon steel	90.0	114205.0	10.0	90.0
13.	0.000167 paint, 0.0417 carbon steel	90.0	49101.0	10.0	90.0
14.	0.000167 paint, 0.0833 carbon steel	90.0	31372.0	10.0	90.0
15.	0.000167 paint, 0.1667 carbon steel	90.0	5631.0	10.0	90.0
16.	0.000167 paint, 0.3333 carbon steel	90.0	8355.0	10.0	90.0
17.	0.000167 paint, 0.6667 carbon steel	90.0	189.0	10.0	90.0
18.	0.000167 paint, 1.333 carbon steel	90.0	157.0	10.0	90.0

TABLE 6.2.1-66 (Sheet 2)

Large-Break LOCA Containment Heat Sink Data Used for Containment Pressure Calculations

19.	0.08333 carbon steel	90.0	261.0	10.0	90.0
20.	0.1667 carbon steel	90.0	863.0	10.0	90.0
21.	0.333 carbon steel	90.0	522.0	10.0	90.0
22.	0.6667 carbon steel	90.0	424.0	10.0	90.0
23.	1.333 carbon steel	90.0	141.0	10.0	90.0
24.	0.0104 stainless steel	90.0	7827.0	10.0	90.0
25.	0.0208 stainless steel	90.0	5976.0	10.0	90.0
26.	0.0417 stainless steel	90.0	8166.0	10.0	90.0
27.	0.08333 stainless steel	90.0	1321.0	10.0	90.0
28.	0.1667 stainless steel	90.0	20.0	10.0	90.0

Notes:

The heat sinks thermal conductivities (BTU/hr/ft/°F) are:

Paint: 0.63
Carbon steel: 30
Stainless steel: 10
Zinc coating: 65
Concrete: 1.2

TABLE 6.2.2-1

COMPARISON OF THE RECIRCULATION SUMP DESIGN WITH EACH OF THE POSITIONS OF REGULATORY GUIDE 1.82

Regulatory Guide 1.82 Position	Recirculation Sump Design
1. A minimum of two sumps should be provided, each with sufficient capacity to serve one of the redundant halves of the ECCS and CS systems.	Two sumps are provided, and each has sufficient capacity to serve one of the redundant halves of the ECCS and CS systems.
2. The redundant sumps should be physically separated from each other and from high energy piping systems by structural barriers, to the extent practical, to preclude damage to the sump intake filters by whipping pipes or high-velocity jets of water or steam.	The redundant sumps are physically separated from each other and from high energy piping.
3. The sumps should be located on the lowest floor elevation in the containment exclusive of the reactor vessel cavity. As a minimum, the sump intake should be protected by two screens: (1) an outer trash rack and (2) a fine inner screen. The sump screens should not be depressed below the floor elevation.	The sumps are located in El.2000, which is the lowest floor elevation in the Reactor Building, exclusive of the reactor cavity. The strainers are made out of steel with structural steel members supporting the top and bottom. The perforated plate is structurally stiffer than the wire screen and does not need trash racks to protect it from damage. The sump strainers are installed in the recirculation sump pits and extend approximately one foot above the Reactor Building floor. The intent is met.

TABLE 6.2.2-1 (Sheet 2)

Regulatory Guide 1.82 Position	Recirculation Sump Design
4. The floor level in the vicinity of the coolant sump location should slope gradually down away from the sump.	The floor is level in the vicinity of the sump. However, a 6-inch concrete curb is provided which prevents the high-density particles from reaching the sumps. The intent is met.
5. All drains from the upper regions of the reactor building should terminate in such a manner that direct streams of water, which may contain entrained debris, will not impinge on the filter assemblies.	All drains in the upper regions of the reactor building are terminated in such a manner that direct streams of water which may contain entrained debris will not impinge on the filter assemblies
6. A vertically mounted outer trash rack should be provided to prevent large debris from reaching the fine inner screen. The strength of the trash rack should be considered in protecting the inner screen from missiles and large debris.	Each sump strainer has approximately 3300 ft^2 of effective surface area that can accomodate the amount of debris generated and carried to the sumps following a debris-generating event. The sumps and strainers are located outside the Secondary Shield Wall, which protects them from missiles. The intent is met.
7. A vertically mounted fine inner screen should be provided. The design coolant velocity at the inner screen should be approximately 6 cm/sec (0.2 ft/sec). The available surface area used in determining the design coolant velocity should be based on one-half of the free surface area of the fine inner screen to conservatively account for partial blockage. Only the vertical screens should be considered in determining available surface area.	The strainers are installed in the sump pit with each strainer consisting of 72 modules stacked in a four by four matrix. The approach velocity of the recirculation coolant flow at the sump strainer face is less than 0.006 ft/sec. The intent is met. In addition, in accordance with Generic Letter 2004-02 requirements,a mechanistic analysis has been performed to assess the potential adverse effects of post-accident debris blockage and operation with debris-laden fluids to impede or prevent the recirculation functions of the ECCS and CSS following postulated accidents for which the recirculation of these systems is required. The methodology for this analysis is consistent with that documented in NEI 04-07.

WOLF CREEK

TABLE 6.2.2-1 (Sheet 3)

Regulatory Guide 1.82 Position	Recirculation Sump Design
8. A solid top deck is preferable, and the top deck should be designed to be fully submerged after a LOCA and completion of the safety injection.	The strainers consist of individual modules stacked on top of each other. The top of each module on the top layer contains a perforated plate. The strainers extend approximately one foot above the Reactor Building floor. Therefore, they will be submerged following a Large Break LOCA. For the small break LOCA, a small portion of the upper modules will not be submerged. The intent is met.
9. The trash rack and screens should be designed to withstand the vibratory motion of seismic events without loss of structural integrity.	The strainers are designed to be seismic Category I.
10. The size of openings in the fine screen should be based on the minimum restrictions found in systems served by the sump. The minimum restriction should take into account the overall operability of the system served.	The strainers have a nominal 0.045” hole size. The strainers protect the downstream equipment by removing material from the flow stream that potentially could cause damage. The performated hole size effectively removes particles larger than 0.045” from the fluid stream. This protects the reactor core channels, safety injection valves and other equipment from clogging.

WOLF CREEK

TABLE 6.2.2-1 (Sheet 4)

Regulatory Guide 1.82 Position	Recirculation Sump Design
11. Pump intake locations in the sump should be carefully considered to prevent degrading effects, such as vortexing on the pump performance.	The pump intake location in the sump is horizontal to limit any degrading effects due to vortexing.
12. Materials for trash racks and screens should be selected to avoid degradation during periods of inactivity and operation and should have a low sensitivity to adverse effects, such as stress-assisted corrosion, that may be induced by the chemically reactive spray during LOCA conditions.	The strainers are made out of stainless steel that has a low sensitivity to corrosion.
13. The trash rack and screen structure should include access openings to facilitate inspection of the structure and pump suction intake.	The inspection of the liner plate in the recirculatin sumps will be remotely done via cameras, boro-scope, mirrors or other devices. The intent is met.
14. Inservice inspection requirements for coolant sump components (trash racks, screens, and pump suction inlets) should include the following: a. Coolant sump components should be inspected during every refueling period downtime, and b. The inspection should be a visual examination of the components for evidence of structural distress or corrosion.	Inservice inspection requirements consist of visual examination during every scheduled refueling downtime.

TABLE 6.2.2-2

CONTAINMENT HEAT REMOVAL SYSTEMS COMPONENT DESIGN PARAMETERS

Containment Spray Pumps	
Type	Vertical centrifugal
Quantity	2
Design pressure, psig	450
Design temperature, F	300
Motor, hp	500
Service factor	1.15
Start time, sec	4
Design flow rate, gpm (injection/recirculation)	3,165/3,750
Design head, ft (injection/recirculation)	464/400
NPSH available, ft	See Table 6.2.2-7
Material in contact with fluid	Stainless steel
Design codes	
Pump	ASME Section III, Class 2
Motor	NEMA, IEEE 323, 334, 344
Seismic design	Category I
Containment Spray Nozzles	
Type	Whirljet, hollow cone spray nozzles
Design flow per nozzle at 40 psi ΔP	15.2 gpm
Number of nozzles	197/header
Material	Stainless steel

TABLE 6.2.2-2 (Sheet 2)

Design code	ASME Section III, Class 2
Seismic design	Category I
Refueling Water Storage Tank	
Quantity	1
Type	Vertical
Assured Water Volume, gal	394,000
Design temperature, F	120
Design pressure, psig	Atmospheric
Material	Stainless steel
Design code	ASME Section III, Class 2
Seismic design	Category I
Containment Spray System Piping	
Material	Stainless steel
Design code	ASME Section III, Class 2
Seismic design	Category I
Containment Air Coolers	
Quantity	4
Type	Draw-through
Duty Btu/hr each	
Normal	3.68×10^6 (Note 1) (Note 5)
Post Accident	Figure 6.2.1-15
Air side flow (normal/accident), acfm each	140,000/69,400
Static pressure (normal/accident), in. w.g.	3.76/2.38
Water flow (normal/accident), gpm each	925/1,000

TABLE 6.2.2-2 (Sheet 3)

Inlet water temp (normal/accident), F	90/95
Leaving water temp (normal/accident), F	101/244 (277) (Notes 1,2,3, &4)
Inlet air temp (normal/accident), F	120/277 (Note 2)
Leaving air temp (normal/accident), F	100/274 (Notes 1 & 2)
Type of fan	Vaneaxial
Arrangement	4
Motor horsepower (normal/accident), hp	150/75
Motor rpm (normal/accident)	1,200/600
Fouling factor	0.002
Material (tube)	Cu-Ni
Material (header)	Cu-Ni
Design Code	ASME Section III, Class 3
Seismic Design	Category I

Containment Spray System Isolation Valve Encapsulation Tank

Manufacturer	Richmond Eng.
Quantity	2
Height ft-in.	10 - 9
Diameter, ft-in.	4 - 0
Design pressure, psig	75
Design temperature, F	400
Material	Austenitic Stainless Steel
Codes and standards	ASME Section III, Class 2
Seismic Category	I

TABLE 6.2.2-2 (Sheet 4)

Note 1 Design value based on 0.002 fouling factor, specified flow rate and inlet temperature, and no tubes plugged or coils removed from service. Actual heat transfer performance will be sufficient to limit containment temperature to 120F during normal operation. Corresponding outlet temperatures may vary.

Note 2 Design value based on 0.002 fouling factor, specified flow rate and inlet temperature, no tubes plugged or coils removed from service, and a gas inlet temperature of 277F. 277F bounds the saturation temperature corresponding to the maximum post accident vapor pressure. Actual heat transfer performance will be sufficient to limit Actual heat transfer performance (and corresponding outlet temperatures) will be sufficient to limit the maximum peak containment pressure obtained from a steam line break event to 48.9 psig.

Note 3 DELETED

Note 4 277°F could occur Post-LOCA with clean (unfouled) coil tubes.

Note 5 Duty Btu/hr in normal conditions for Containment Air Cooler “D” cooler is 3.67×10^6.

TABLE 6.2.2-3

SUMMARY OF ACCIDENT CHRONOLOGY FOR CONTAINMENT SPRAY SYSTEM FOR LOSS-OF-COOLANT ACCIDENT

Injection Phase

Time (Sec)	Action
0.0	Event, SI signal, and start diesel generators.
3.0	Containment pressure reaches Hi-1 containment pressure setpoint (6 psig), assuming worst case LOCA or MSLB inside the containment. Time includes instrument lag time.
9.0	Hi-3 containment pressure setpoint (30 psig)* attained.
12.0	Diesel generators attain rated speed and voltage, including actuation instrument lag time.
12.0	Sequencer energizes motor control centers to open motor-operated valves in spray additive tank discharge and spray header isolation valves. Maximum valve opening time is 15 seconds.
27.0	Sequencer applies power to containment spray pumps.
27.0	Slowest spray header motor-operated isolation valves reach full open position.
31.0	Containment spray pumps attain operating speed and design flow.
≤60.0	Flow is delivered to the containment.
-	When containment pressure drops below 3 psig, reset containment spray actuation signal (CSAS).

NOTES: The worst case LOCA inside the containment is assumed to occur at time zero.

Using conservative analyses, spray flow will be delivered to all spray nozzles within 25 seconds after the spray pump starts; however, 33 seconds is assumed for conservatism.

*Actual setpoint for Hi-3 is 27 psig. The safety analysis uses 30 psig for conservatism.

TABLE 6.2.2-3 (Sheet 2)

Recirculation Phase

Time (Minutes)	Action
0.0	Upon reaching RWST Level LO LO-2, initiate opening HV-1 and HV-7
0.8	Verify valves HV-1 & HV-7 are open and initiate closing BN-HV-3 & BN-HV-4

Note: Time 00 begins when RWST Level reaches LOLO-2 (Annunciator 00-047C is LIT) or RWST Level is <12% on indicators BN LI-930, BN LI-931, BN LI-932, BN LI-933.

TABLE 6.2.2-3 (Sheet 3)

SUMMARY OF ACCIDENT CHRONOLOGY FOR CONTAINMENT SPRAY FOR MAIN STEAM LINE BREAK WITH OFFSITE POWER AVAILABLE (CASE 7 AND CASE 9) (1)

Time (sec)		Action
Case 7	Case 9	
0	0	Break occurs, blowdown from all steam generators.
4.2	15.3 (2)	Containment pressure Hi-1 setpoint reached. Initiate SI, CIS-A, feedline isolation, etc. Since offsite power is available, the load sequencer starts and provides power to the CSS containment isolation valve immediately and 15 seconds later power is supplied to the containment spray pump. (The CSS components do not actuate until CSMS is generated by a containment Hi-3 pressure signal).
95.0	144.0	Containment pressure Hi-3 setpoint reached. CSAS generated which simultaneously open the containment isolation valves and starts the spray pumps.
99.0	148.0	Containment spray pumps reach operating speed. The flow rate has rapidly increased toward runout conditions as flow fills pipe. The resistance of the partially open containment isolation valve rapidly decreases as the circular wedge arises.
110.0	159.0	Containment isolation valve reaches the first open position. Runout flow rates are conservatively assumed as flow continues to fill the spray headers which offer little flow resistance.
125.0	174.0	All air is vented from the last spray nozzle as the headers become water solid. The system flow rate rapidly reduces from runout conditions to the design flow rate as the nozzles impose the design pressure drop shown on Figure 6.5-1.
1800	1800	Mass and energy addition to the containment ends, containment pressure reduces. Containment spray may be terminated.

(1) Table 6.2.1-58 provides information on 16 steam line breaks analyzed for containment pressure and temperature analyses and includes the times at which Hi-1 and Hi-3 containment pressures are reached for each case.

(2) As described in Section 15.1.5, low steam line pressure could initiate safety injection sooner than Hi-1; however, the use of Hi-1 is conservative.

TABLE 6.2.2-4

SPRAY INJECTION PHASE DURATION

Case	Flow Condition	Single Failure	Operator Action For Spray Switchover	Time Length Of Injection (Min.)	Remarks
1	Two trains ECCS Two trains spray	None	20 seconds after receipt of the lo-lo-2 alarm	22.50	Refer to Table 6.3-11.
2	Two trains ECCS Two trains spray	RHR/RWST Valve fails to close	20 seconds after receipt of the lo-lo-2 alarm	21.44	Refer to Table 6.3-12.
3	Two trains ECCS One train spray	One spray train fails	30 seconds after receipt of the lo-lo-2 alarm	43.7	
4	Two trains spray One train ECCS	One train of ECCS pumps assumed to fail	30 seconds after receipt of the lo-lo-2 alarm	53.2	ECCS one-train flow rates are as follows: RHR 5100 gpm SI 660 gpm CC 550 gpm
5	Two trains spray Two trains ECCS	Ctmt spray sump valve fails to open	30 seconds after receipt of the lo-lo-2 alarm	26.4	Operator shuts down one spray train to protect the pump.

TABLE 6.2.2-5

CONTAINMENT SPRAY SYSTEM SINGLE-FAILURE ANALYSIS

Component	Malfunction	Comments
Containment spray pump	Fails to start	Two pumps provided; operation of one required.
Containment each spray pump discharge isolation valve* one	Fails to open	Two pumps provided, with a separate discharge isolation pump valve; operation of required.
Containment sump recirculation isolation valve	Fails to open	Two lines in parallel, one each spray pump; operation of one required.

*Opens on coincidence of two-out-of-four Hi-3 containment pressure signals.

TABLE 6.2.2-6

WATER SOURCES AND WATER LOSSES WHICH CONTRIBUTE TO THE WATER LEVEL WITHIN THE REACTOR BUILDING FOLLOWING A LARGE LOCA

Water Sources	Min.	Max.
Reactor coolant inventory, lbm	504,520	504,520
Accumulator tanks inventory, lbm	200,300	220,100
Initial atmosphere water vapor, lbm	732	12,245
Containment spray additive solution, lbm	17,540	39,190
RWST, lbm at:		
Initiation of ECCS switchover	1,964,000	2,181,000
Containment spray switchover	2,766,000	3,036,000
Long-term recirculation	2,954,000	3,209,000
Total at:		
Initiation of ECCS switchover, ft^3	44,925	51,051
Containment spray switchover, ft^3	57,605	65,472
Long-term recirculation, ft^3	59,584	66,627
Water Losses		
Below El 2,000 ft, ft^3	15,685	15,685
Water remaining in RCS, ft^3	1,901	2,651
Trenches below El 2,000 ft, ft^3	147	176
Trenches below El 2,001 ft-4 in., ft^3	100	120
Miscellaneous wetted surfaces, ft^3	582	2,328
Upending pit, ft^3	158	159
Water vapor, ft^3 at:		
Initiation of ECCS switchover	1,563	4,817
Containment spray switchover	813	4,134
Long-term recirculation	198	813
Total at:		
Initiation of ECCS switchover, ft^3	20,136	25,936
Containment spray switchover, ft^3	19,386	25,253
Long-term recirculation, ft^3	18,771	21,932
Accumulation Volume Available for Buildup		
From El 2,000 ft to El 2001 ft-4 in., ft^3	9,898	9,948
From El 2,001 ft-4 in. to El. 2,005 ft-4 in., ft3/ft	11,599	11,838
Results		
Elevation of water at:		
Initiation of ECCS switchover	2,002'-1”	2,003'-2”
Containment spray switchover	2003’-2 1/2"	2,004'-6"
Long-term recirculation	2003’ 8”	2,004'-8"

TABLE 6.2.2-6a

WATER SOURCES AND WATER LOSSES WHICH CONTRIBUTE TO THE WATER LEVEL WITHIN THE REACTOR BUILDING FOLLOWING A MAIN STEAM LINE BREAK

Water Sources	Min.	Max.
Blowdown + Aux Feedwater mass, lbm (1)	146,510	624,700
Containment spray additive solution, lbm	17,540	39,190
RWST, lbm at:		
Initiation of ECCS switchover	2,048,700	2,765,700
Containment spray switchover	2,766,000	3,036,000
Long-term recirculation	2,954,000	3,209,000
Net Volume added excluding Primary side loss due to shrinkage:		
Initiation of ECCS switchover, ft^3	34,252	47,747
Containment spray switchover, ft^3	46,192	62,186
Long-term recirculation, ft^3	49,239	63,427
Water Losses		
a. Primary side loss due to shrinkage,lbm at:		
Initiation of ECCS switchover	79,277	79,277
Containment spray switchover	79,277	79,277
Long-term recirculation	79,277	79,277
b. Other losses, ft^3		
Below Elevation 2,000 ft	15,685	15,685
Trenches below Elevation 2,000 ft	147	176
Trenches below Elevation 2,001 ft-4 in.	100	120
Miscellaneous wetted surfaces	582	2,328
Upending pit	158	159
Water vapor at:		
Initiation of ECCS switchover	1,563	4,817
Containment spray switchover	813	4,134
Long-term recirculation	198	813
Total (b), ft^3 at:		
Initiation of ECCS switchover	18,235	23,285
Containment spray switchover	17,485	22,602
Long-term recirculation	16,870	19,281
Accumulation Volume Available for Buildup		
From Elevation 2,000 ft to Elevation 2,001 ft-4 in., ft^3	9,898	9,948
From Elevation 2,001 ft-4 in. to Elevation 2,005 ft - 4 in., ft^3/ft	11,599	11,838

TABLE 6.2.2-6a (Sheet 2)

Results(1)	Min.	Max.
Elevation of water at:		
Initiation of ECCS switchover	2,001'-5"	2,003'-5/16"
Containment spray switchover	2,002'-5 11/16"	2,004'-4"
Long-term recirculation	2,003'-3/16"	2,004'-6"

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(1) The AFW mass addition and the resultant maximum flood depths are based on operator action at 20 minutes to terminate AFW flow to the affected steam generator.

TABLE 6.2.2-7

INPUT AND RESULTS OF NPSH ANALYSIS

<u>Containment Spray Pumps</u>	
Static head available (MSLB)	31 ft - 9-3/16 in.
Pump elevation (discharge centerline)	1971 ft - 0-3/4 in.
Suction line losses @ 3,950 gpm	9.56 ft
Available NPSH @ 3,950 gpm (3)	20.1 ft
Required NPSH @ 3,950 gpm (from Figure 6.2.2-5)	16.5 ft
<u>Residual Heat Removal Pumps</u>	
NPSH Reference Elevation (2)	1972.07 ft.
Static head available (LOCA)(1)	30.015 ft
Suction line losses @ 4,760 gpm	3.945 ft
Available NPSH @ 4,760 gpm (3)	23.79 ft
Required NPSH @ 4,760 gpm	21.01 ft

---

(1) Large LOCA conditions are provided for the RHR pumps since the flow rates, line losses, and NPSH required are greater than those associated with an MSLB wherein the RCS pressure remains above the RHR shutoff head at switchover to recirculation.

(2) NPSH reference elevation is 3 3/8 inches above the discharge centerline.

(3) Includes 1.724 ft. total head loss across the sump strainer with both the Spray Pump and RHR Pump running in Recirculation, and a 0.56 ft. allowance for EDG frequency uncertainities.

TABLE 6.2.2-8

CONTAINMENT AIR COOLING SYSTEM

Component	Malfunction	Comments
Containment cooler housing	Housing failure, air bypasses coils	One unit out of service. Three units are functional.*
Cooling coils	Loss of one train of essential service water	Two units out of of service. Redundant train (two coolers) is functional.
	Loss of one emergency diesel	Two units out of service. Redundant train (two coolers) is functional.
Fan	Fails to start at half speed	One unit out of service. Three units are functional.*
Fusible link plates	Fails to open, partial to complete loss of one cooler, depending upon degree of restriction in ductwork system	One unit out of service. Three units are functional.*

* Consists of the redundant train (two coolers) and the remaining functional cooler associated with the malfunctioning unit.

TABLE 6.2.2-9

SUMP STRAINER APPROACH VELOCITIES FOR LOCA AND MSLB CONDITIONS

OPERATIONAL PHASE/MODE	FLOOD DEPTH(1) Min	FLOOD DEPTH(1) Max	FLOW RATE gpm	FLOW VELOCITIES - FPS Approach to Sump Area(3)	FLOW VELOCITIES - FPS At Strainer Surface(5)
LARGE LOCA					
- At ECCS Switchover	2002-1	2003-0	4800	0.07	0.003
- At Ctmt. Spray Switchover	2003-3	2004-4	8750	0.08	0.006
- During Long-Term Cooling(6)	2003-8	2004-5	4800	0.04	0.003
MSLB					
- At ECCS SwItchover	2001-8	2002-B	1200	0.02	0.001
- At Ctmt. Spray Switchover	2002-9	2003-11	5150	0.06	0.003
- During Long-Term Cooling(7)	2003-3	2004-1	1200	0.01	0.001

NOTES:

(1) Flood depths (minimum and maximum) for each operational mode or phase are taken from Tables 6.2.2-6 and 6.2.2-6a.

(2) Flow velocities are based on the minimum and maximum flood depths. Minimum depths are used for NPSH available calculations and maximum depths are for worst-case flooding analysis.

(3) The sump area approach velocity is based on a point 6 inches in front of the curb. This velocity more accurately describes the maximum velocity associated with debris settlement.

(4) Deleted

(5) This flow velocity is based upon the surface area of the sump strainer exposed to flow.

(6) The velocities for long-term cooling following a LOCA assume that the contaimnent spray system operation Is terminated since the cooling function is completed at switchover and iodine removal has been accomplished.

(7) The velocities for long-term cooling following an MSLB assume that contaimnent spray system operation is terminated and the RCS pressure is at 400 psig which is above the shutoff head of the RHR pumps. As noted on Table 6.2.2-6a, isolation of auxiliary feedwater to the broken loop occurs at 10 minutes which terminates blowdown to the containment. Long-term recovery from an MSLB will be through cooldown using the normal RHR suction from the primary loop hot legs. Once flow is established from the primary loop suction from the sump will not be required.

TABLE 6.2.4-1

LISTING OF CONTAINMENT PIPING PENETRATIONS

Penetration Number	Service	Section Number
Listing of Penetrations Under Category GDC-55		
P-21	RHR hot leg injection	5.4.7/6.3
P-22	RCP-B seal water supply	5.4
P-23	CVCS letdown	9.3.4
P-24	RCP seal water return	5.4
P-27	RHR cold leg injection loops 3 and 4	5.4.7/6.3
P-39	RCPC, seal water supply	5.4
P-40	RCPD, seal water supply	5.4
P-41	RCP-A, seal water supply	5.4
P-48	SI pump - B, discharge to hot legs 1 and 4	6.3
P-49	SI pumps crosstie to cold legs 1, 2, 3, and 4	6.3
P-52	RHR pump suction from hot leg loop 4	5.4.7/6.3
P-64	RC loop and pressurizer liquid sample	9.3.2/18.2.3
P-69	Pressurizer vapor sample	9.3.2
P-79	RHR pump suction from hot leg loop 1	5.4.7/6.3
P-80	CVCS charging	9.3.4
P-82	RHR pump discharge to hot leg loops 1 and 2	5.4.7/6.3
P-87	SI pump A discharge to hot leg loops 2 & 3	6.3
P-88	Boron injection supply to cold leg loops 1, 2, 3, and 4	6.3
P-93	RC loop liquid sample	9.3.2/18.2.3
P-95	Accumulator liquid sample	9.3.2
P-59	Reactor Vessel Level Indication System	18.2.13.2
P-91	Reactor Vessel Level Indication System	18.2.13.2

TABLE 6.2.4-1 (Sheet 2)

LISTING OF CONTAINMENT PIPING PENETRATIONS

Penetration Number	Service	Section Number
Listing of Penetrations Under Category GDC-56		
P-13	Containment recirculation sump to containment spray pump	6.2.2
P-14	Containment recirculation sump to RHR pump suction	5.4.7/6.3
P-15	Containment recirculation sump to RHR pump suction	5.4.7/6.3
P-16	Containment recirculation sump to containment spray pump	6.2.2
P-25	Reactor make-up water supply	9.2.7
P-26	Reactor coolant drain tank discharge	11.2
P-28	ESW supply to containment air coolers	6.2.2
P-29	ESW return from containment air coolers	6.2.2
P-30	Instrument air	9.3.1
P-32	Containment sump pump discharge	9.3.3
P-34	Containment ILRT test line	6.2.6
P-43	Auxiliary steam-decontamination	12.3
P-44	Reactor coolant drain tank vent	11.2
P-45	Accumulator nitrogen supply	6.3
P-51	ILRT pressure test line	6.2.6
P-53	FPC and clean-up, refueling pool supply	9.1.3
P-54	FPC and clean-up, refueling pool suction	9.1.3
P-55	FPC and clean-up, refueling pool skimmer	9.1.3
P-56	Post-LOCA hydrogen analyzer return	6.2.5
P-56	Containment atmosphere monitor GT-RE-31 return	9.4.6
P-57	TO RCDT (former PASS sampling return)	18.2.3

TABLE 6.2.4-1 (Sheet 3)

LISTING OF CONTAINMENT PIPING PENETRATIONS

Penetration Number	Service	Section Number
Listing of Penetrations Under Category GDC-56 (Continued)		
P-58	Accumulator fill line from SI pumps	6.3
P-62	Pressurizer relief tank nitrogen supply	5.4
P-63	Service air supply	9.3.1
P-65	Hydrogen purge	6.2.5
P-66	Containment spray supply from pump B	6.2.2
P-67	Fire protection	9.5.1
P-71	ESW supply to containment coolers	6.2.2
P-73	ESW return from containment coolers	6.2.2
P-74	CCW supply	9.2.2
P-75	CCW return	9.2.2
P-76	Cooling water thermal barrier return	9.2.2
P-78	Drain line from steam generator	10.4.8
P-89	Containment spray supply from pump A	6.2.2
P-92	ECCS test line return	6.3
P-97	Post-LOCA hydrogen analyzer return	6.2.5
P-97	Containment atmosphere monitor GT-RE-32 return	9.4.6
P-98	Breathing Air Supply	9.5.10
P-99	Post-LOCA hydrogen analyzer supply	6.2
P-99	Containment atmosphere monitor GT-RE-31 supply	9.4.6

TABLE 6.2.4-1 (Sheet 4)

LISTING OF CONTAINMENT PIPING PENETRATIONS

Penetration Number	Service	Section Number
Listing of Penetrations Under Category GDC-56 (Continued)		
P-101	Post-LOCA hydrogen analyzer supply	6.2
P-101	Containment atmosphere monitor GT-RE-32 supply	9.4.6
P-103	Containment pressure sensing monitor	6.3/9.4
P-104	Containment pressure sensing monitor	6.3/9.4
V-160	Containment purge	9.4
V-161	Containment purge	9.4

TABLE 6.2.4-2

DESIGN COMPARISON TO REGULATORY GUIDE 1.141 REVISION 0, DATED APRIL 1978, TITLED CONTAINMENT ISOLATION PROVISIONS FOR FLUID SYSTEMS

Regulatory Guide 1.141 Positions	WCGS
C. REGULATORY POSITION	
The requirements and recommendations for containment isolation of fluid systems that penetrate the primary containment of light-water-cooled reactors as specified to ANSI N271-1976, "Containment Isolation Provisions for Fluid Systems," are generally acceptable and provide an adequate basis for complying with the pertinent containment isolation requirements of Appendix A to 10 CFR Part 50, subject to the following:	Figure 6.2.4-1 shows the arrangement and justifies compliance with the intent of GDC-55, 56, and 57. Guidelines provided by Regulatory Guide 1.11, ANSI N271-1976, NRC SRPs 6.2.4 and 6.2.6, and this guide are the bases for compliance.
1. Section 3.64 of ANSI N271-1976 states: "The closed system shall be leak tested in accordance with 5.3 of this standard unless it can be shown by inspection that system integrity is being maintained for those systems operating at a pressure equal to or above the containment design pressure." This exception to system leak testing is also applicable to closed systems inside the containment.	1. Complies as shown for Penetrations P-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 83, 84, 85, and 86.
2. Section 4.2.3 of ANSI N271-1976 states: "Sealed closed isolation valves are under administrative controls and do not require position indication in the	2. Complies as described in Section 6.2.4.5.

TABLE 6.2.4-2 (Sheet 2)

Regulatory Guide 1.141 Positions	
control room for valve status." Since the containment isolation valves are components of the containment isolation system, which is an engineered-safety-feature system, all power-operated valves should have position indication in the control room.	
3. Section 9.2.5 of ANSI N271-1976 states: "Diversity in means of actuation of automatic isolation valves should be considered to preclude common mode failure." The NRC staff's position is that there should be diversity in the parameters sensed (i.e., types of isolation signals) for the initiation of containment isolation.	3. Complies as described in Section 7.3.
4. Section 4.4.8 of ANSI N271-1976 gives general design requirements for closed systems. In addition, all branch lines and their isolation valves in closed systems both inside and outside the containment should meet the design criteria of Section 3.5 or Section 3.6.7 if the branch lines constitute one of the containment isolation barriers.	4. Complies.
5. In Section 4.6.3 of ANSI N271-1976, reference is made to Regulatory Guide 1.7, "Control of Combustible Gas Concentrations in Containment Following a Loss-of-Coolant Accident," for guidance in determining radiation exposures for a loss-of-coolant accident. More appropriate guidance is given in Regulatory Guide 1.89, "Qualification of Class IE Equipment for Nuclear Power Plants."	5. Complies as described in Section 3.11.

TABLE 6.2.4-2 (Sheet 3)

Regulatory Guide 1.141 Positions	
6. Section 4.14 of ANSI N271-1976 states: "The piping between isolation barriers or piping which forms part of isolation barriers shall meet the requirements of 3.7 and applicable requirements for isolation barriers." Piping between isolation barriers should meet the applicable requirements of Section 3.5 or Section 3.7.	6. Complies.

TABLE 6.2.5-1

DESIGN DATA FOR CONTAINMENT HYDROGEN CONTROL SYSTEM COMPONENTS

Hydrogen Recombiners	
Quantity	2 per unit
Power (each), max/min, kW	75/50
Capacity (each), minimum, scfm	100
Heaters (per recombiner)	
Number	4 banks
Maximum heat flux, Btu/hr-ft^2	2,850
Maximum sheath temperature, F	1,550
Gas temperatures	
Inlet, F	80-155
Outlet of heater section, F	1,150 to 1,450
Exhaust	Approx 50 F above ambient
Materials	
Outer structure	Type 300 series SS
Inner structure	Incoloy 800
Heater element sheath	Incoloy 800
Base skid	Type 300 series SS
Weight, lbs	4,500
Codes and standards	ASME Sect. IX, UL, NEMA, NFPA, IEEE 279, 308, 323, 344, and 383, ANS Safety Class 2
Hydrogen Analyzer	
Quantity	2 per unit
Type	Thermal conductivity
Range	0-10 volume percent
Channel Accuracy	± 6 percent of full scale
Valves (isolation)	
Quantity	10
Type	Solenoid-operated gate valve
Tubing material	Stainless steel
Codes and standards	IEEE 279, 323, 344, 383, NEMA, ANS Safety Class 2

TABLE 6.2.5-1 (Sheet 2)

Hydrogen Mixing Fans (see note below)

Quantity	4
Type	Vaneaxial
Arrangement/AMCA class	4/II
Air flow (normal/accident), cfm each	85,000/42,500
Static pressure (normal/accident), in. w.g. each	0.71/0.50
Brake horsepower (normal/accident), hp each	26.6/9.3
Motor horsepower (normal/accident), hp each	50/25
Motor rpm (normal/accident)	900/450
Codes and standards	(Motor) IEEE Std 334 (Motor) NEMA (Fan) AMCA ANS Safety Class 2

NOTE: The hydrogen mixing fans are not required to operate following an accident.

TABLE 6.2.5-2

SUMMARY OF ASSUMPTIONS USED FOR HYDROGEN GENERATION FROM RADIOLYSIS

a. The average fuel exposure is 600 full power days at 3,636 MWt.

b. An insignificant quantity of hydrogen is generated due to the radiolysis from the noble gas isotopes.

c. The guidelines set forth in Regulatory Guide 1.7 were followed:

    1. 100 percent of the noble gases is released to the atmosphere.

    2. 50 percent of the halogens and 1 percent of the solids present in the core are intimately mixed with the coolant water.

    3. $G(H_2)$ is 0.5 molecule/100 eV.

    4. $G(O_2)$ is 0.25 molecule/100 eV.

    5. The following percentage of fission product radiation energy is absorbed by the coolant:

Percentage	Radiation Type	Location of Source
0%	Beta	Fuel rods
100%	Beta	Coolant
10%	Gamma	Fuel rods
100%	Gamma	Coolant

TABLE 6.2.5-3
PARAMETERS USED TO DETERMINE HYDROGEN GENERATION

Plant power level, MWt	3,636 MWt
Containment free volume, ft^3	2.5×10^6
Containment temperature at accident, F	120 F
Weight of zirconium, lb	54,000
Hydrogen generated zirconium-water reaction, lb-moles	59.20
Corrodible metals	Aluminum, zinc
Surface Area of Aluminum, ft^2	1,114*
Surface Area of Zinc, ft^2	550,000*

	Weight (lbs)	Surface Area (ft^2)
Initial Inventory of Aluminum in Containment*		
HVAC dampers	119	32
Source, intermediate and power range detectors	244	83
Control rod drive mechanism connectors	193	42
Miscellaneous hydraulic valves	230	86
Rod position indicators	151	81
Flux map drive system	205	88
Refueling machine	28	5
Contingency (NSSS)	250	85
Containment atmosphere control filtration train	34	20
Polar crane	134	99
Control valves on containment cooler standpipes	57	13
RPI system connectors	66	36
Control rod drive connectors @ intermediate connection panel	56	12
Reactor cavity cooling fans	200	14
Reactor building elevator, aux. monorail and hoist	25	6
RTD adapter plates (4 total) and containment jib cranes	1	negligible
Resistor temperature detectors (13 total)	2	1

	Surface Area (ft^2)
Initial Inventory of Zinc in Containment*	
Inorganic zinc based paint (includes containment liner plate, equipment, painted structural steel, conduit, etc.)	347,177
Galvanized surfaces (includes equipment, cable trays, conduit, etc.)	194,244

* Surface areas of aluminum and zinc greater than the actual inventories were used in the hydrogen generation calculation to allow for future additions. The current inventory is maintained in a station engineering calculation.

TABLE 6.2.5-4

This table is deleted. The information previously in this table is now in Figures 6.2.5-7, 6.2.5-8, and 6.2.5-9

TABLE 6.2.5-5

SINGLE FAILURE ANALYSIS CONTAINMENT HYDROGEN CONTROL SYSTEM

Component	Malfunction	Consequences
Hydrogen recombiner subsystem	Recombiner fails to operate properly	Redundant recombiner available
Hydrogen analyzer subsystem	Analyzer fails to operate and/or an isolation valve fails to open	Redundant analyzer with separate sampling lines available
Hydrogen mixing subsystem	With loss of one train of power, two fans fail to operate	Two redundant, full-capacity mixing fans available, powered from an independent Class IE bus

TABLE 6.2.5-6

COMPARISON OF THE DESIGN TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.7, REVISION 2, DATED NOVEMBER, 1978, TITLED "CONTROL OF COMBUSTIBLE GAS CONCENTRATIONS IN CONTAINMENT FOLLOWING A LOSS-OF-COOLANT ACCIDENT"

Regulatory Guide 1.7 Position	WCGS Position
1. Each boiling or pressurized light-water nuclear power reactor fueled with uranium oxide pellets within cylindrical zircaloy cladding should have the capability to measure the hydrogen concentration in the containment, mix the atmosphere in the containment, and control combustible gas concentrations without relying on purging and/or repressurization of the containment atmosphere following a LOCA.	1. Complies.
2. The continuous presence of redundant combustible gas control equipment at the site may not be necessary provided it is available on an appropriate time scale. However, appropriate design and procedural provisions should be made for its use. These provisions should include consideration of shielding requirements to permit access to the area where the mobile combustible gas control system will be coupled up and permit the coupling operation to be executed. In addition, centralized storage facilities that would serve multiple sites may be used, provided these facilities include provisions such as maintenance, protective features, testing, and transportation for redundant units to a particular site.	2. Equipment is permanently installed.

TABLE 6.2.5-6 (Sheet 2)

Regulatory Guide 1.7 Position	WCGS Position
3. Combustible gas control systems and the provisions for mixing, measuring, and sampling should meet the design, quality assurance, redundancy, energy source, and instrumentation requirements for an engineered safety feature. In addition, the system itself should not introduce safety problems that may affect containment integrity. The combustible gas control system should be designated Seismic Category I (see Regulatory Guide 1.29, "Seismic Design Classification"), and the Group B quality standards of Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," should be applied.	3. Complies.
4. All water-cooled power reactors should also have the installed capability for a controlled purge of the containment atmosphere to aid in cleanup. The purge or ventilation system may be a separate system or part of an existing system. It need not be redundant or be designated Seismic Category I (see Regulatory Guide 1.29), except insofar as portions of the system constitute part of the primary containment boundary or contain filters.	4. Complies. See Section 6.2.5.2.2.4.
5. The parameter values listed in Table 1 of the guide should be used in calculating hydrogen and oxygen gas concentrations in containments and evaluating designs provided to control and to purge combustible gases evolved in the course of loss-of-coolant accidents. These values may be changed on the basis of additional experimental evidence and analyses.	5. Complies by using Regulatory Guide 1.7 parameter values.

TABLE 6.2.5-6 (Sheet 3)

Regulatory Guide 1.7 Position	WCGS Position
6. Materials within the containment that would yield hydrogen gas due to corrosion from the emergency cooling or containment spray solutions should be identified, and their use should be limited as much as practical.	6. Complies. Table 6.2.5-3 provides the source inventories.

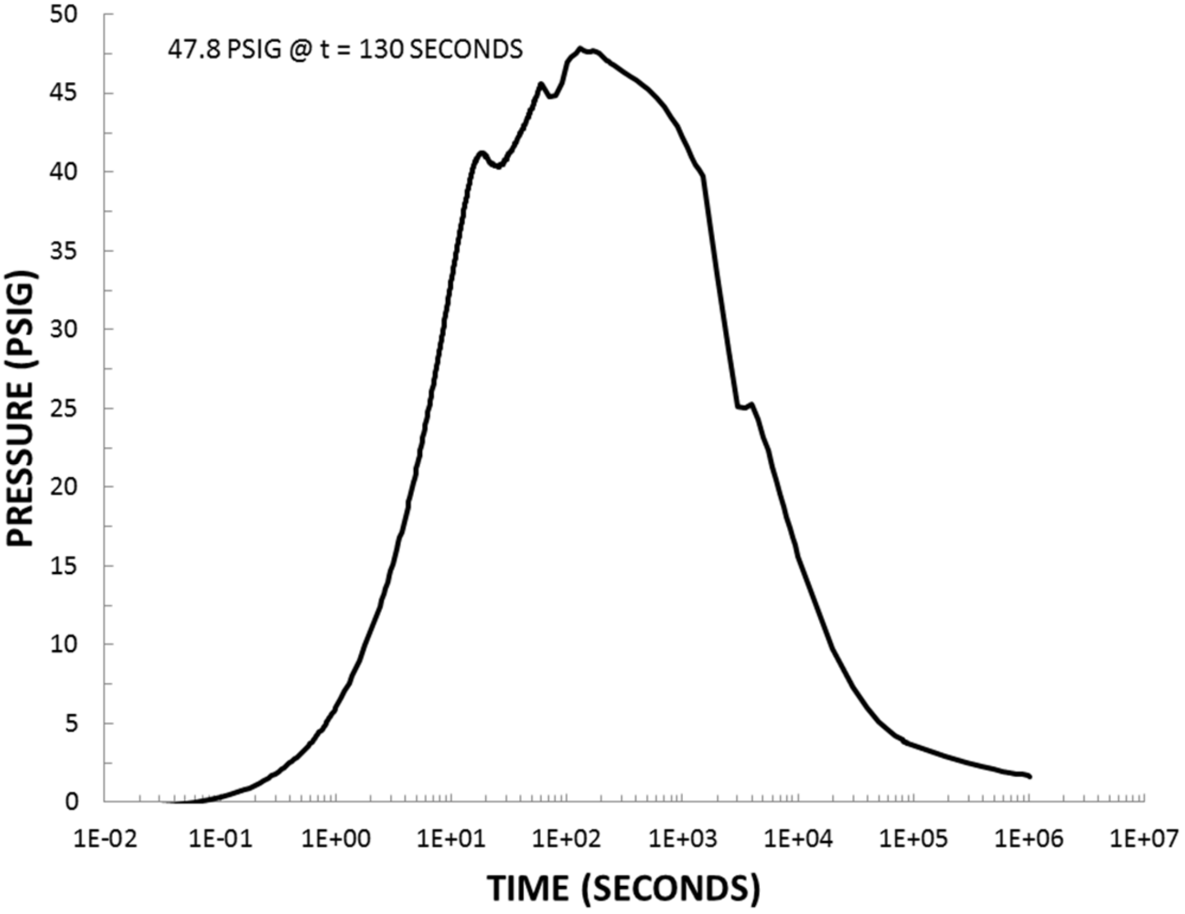

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FIGURE 6.2.1-1:
Double-Ended Pump Suction
Guillotine Break Minimum Safety
Injection, 2 Air Coolers,
Containment Pressure vs. Time

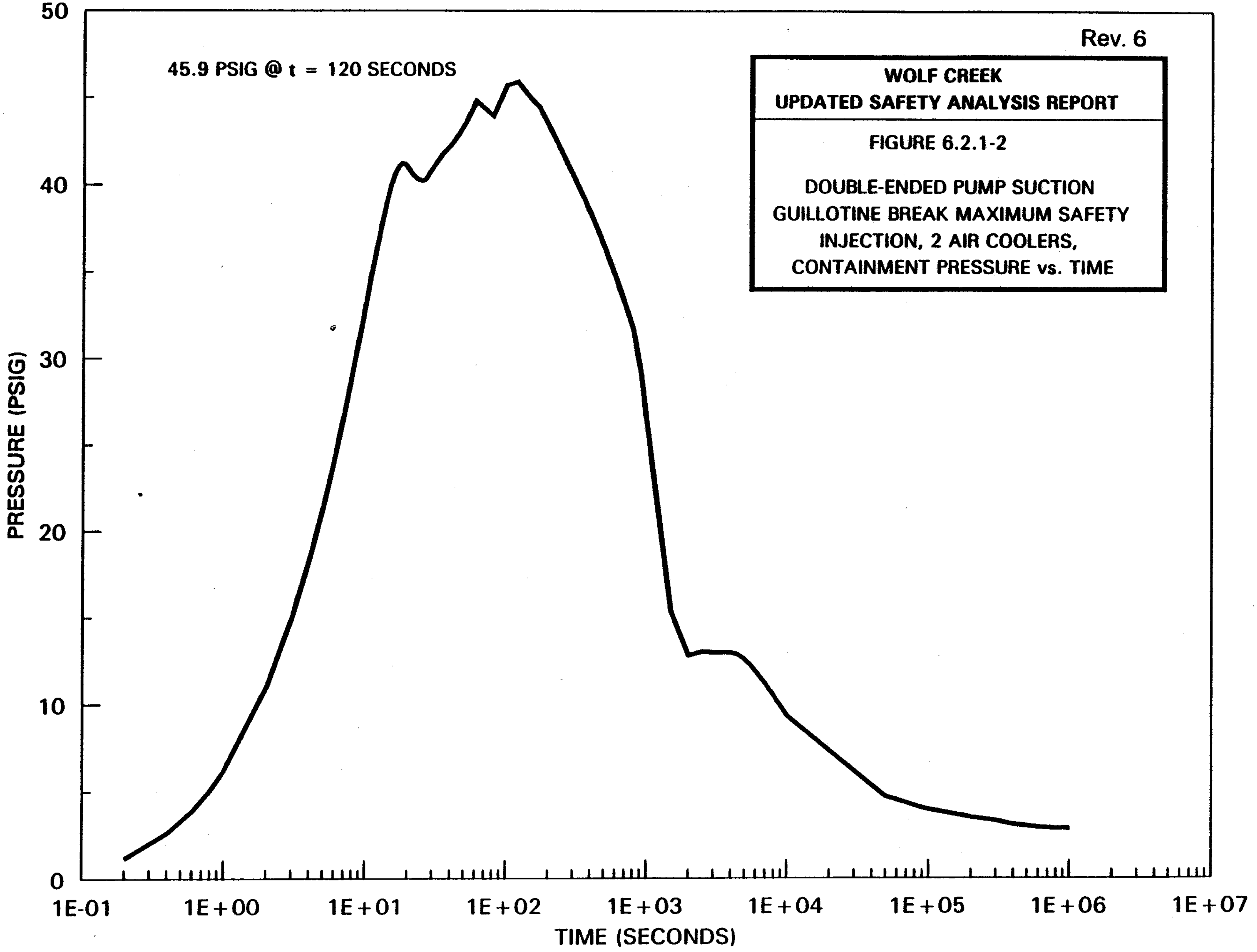

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FIGURE 6.2.1-2

DOUBLE-ENDED PUMP SUCTION GUILLOTINE BREAK MAXIMUM SAFETY INJECTION, 2 AIR COOLERS, CONTAINMENT PRESSURE vs. TIME

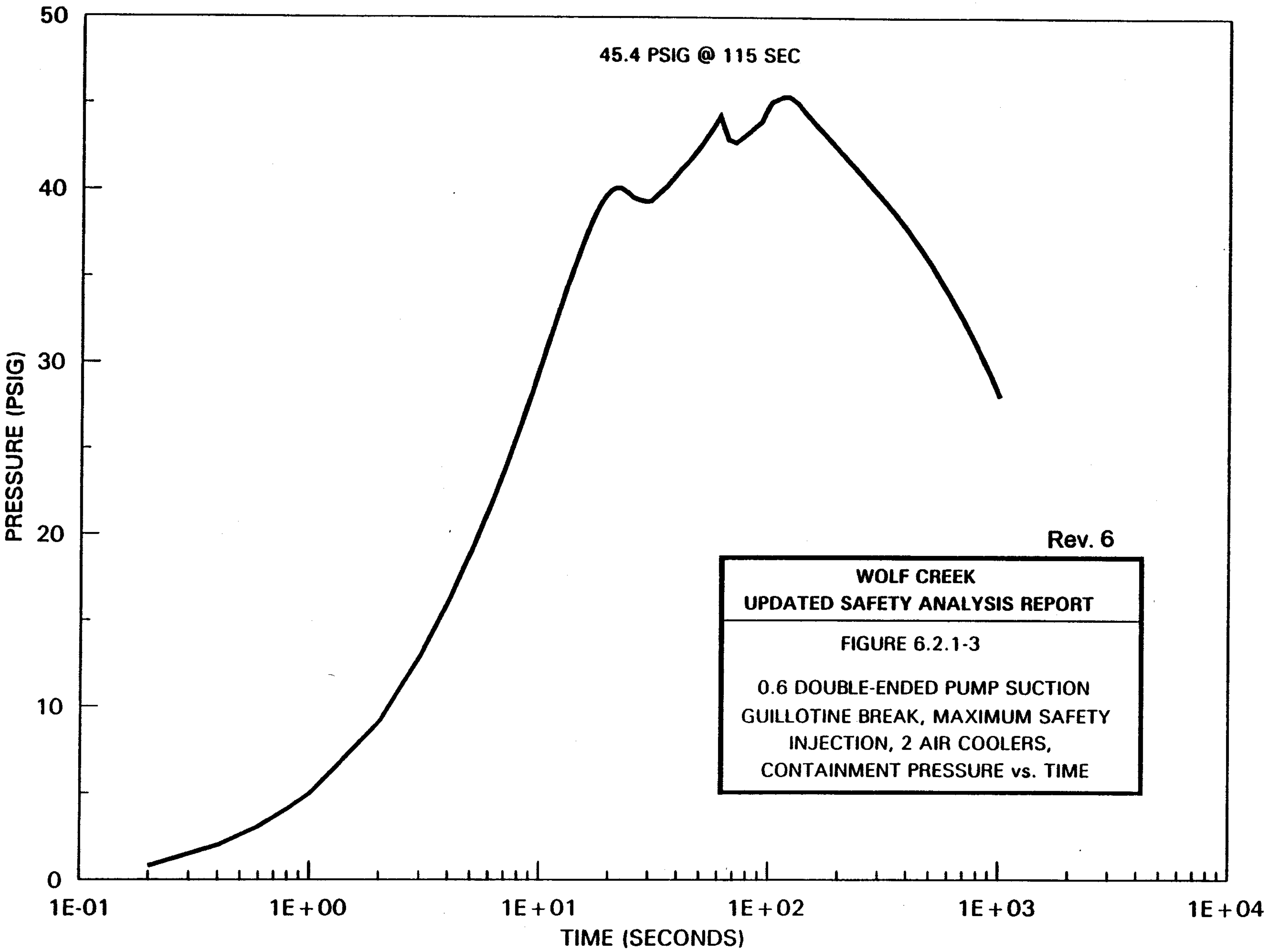

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FIGURE 6.2.1-3

0.6 DOUBLE-ENDED PUMP SUCTION GUILLOTINE BREAK, MAXIMUM SAFETY INJECTION, 2 AIR COOLERS, CONTAINMENT PRESSURE vs. TIME

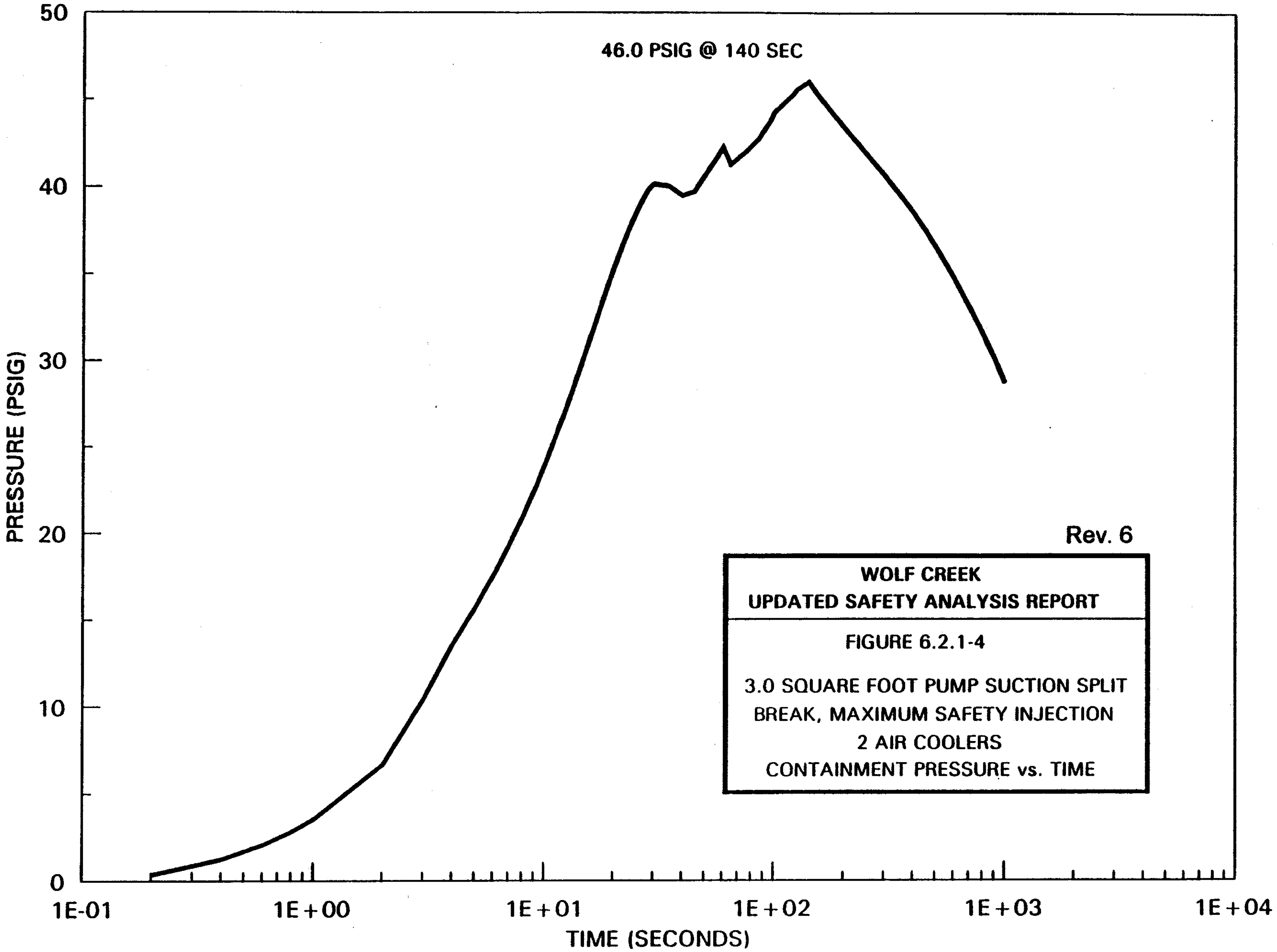

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FIGURE 6.2.1-4

3.0 SQUARE FOOT PUMP SUCTION SPLIT
BREAK, MAXIMUM SAFETY INJECTION
2 AIR COOLERS
CONTAINMENT PRESSURE vs. TIME

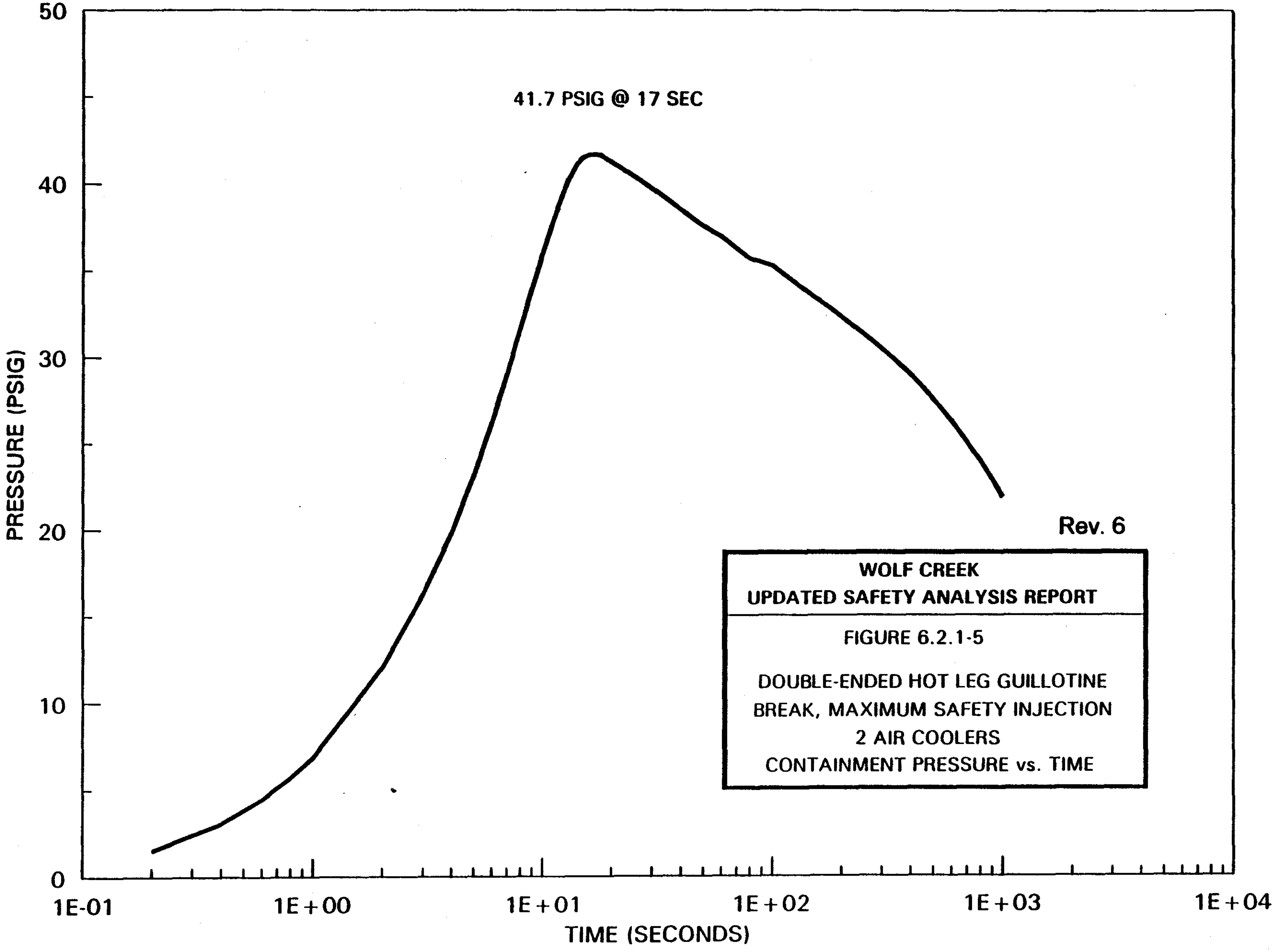

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FIGURE 6.2.1-5

DOUBLE-ENDED HOT LEG GUILLOTINE
BREAK, MAXIMUM SAFETY INJECTION
2 AIR COOLERS
CONTAINMENT PRESSURE vs. TIME

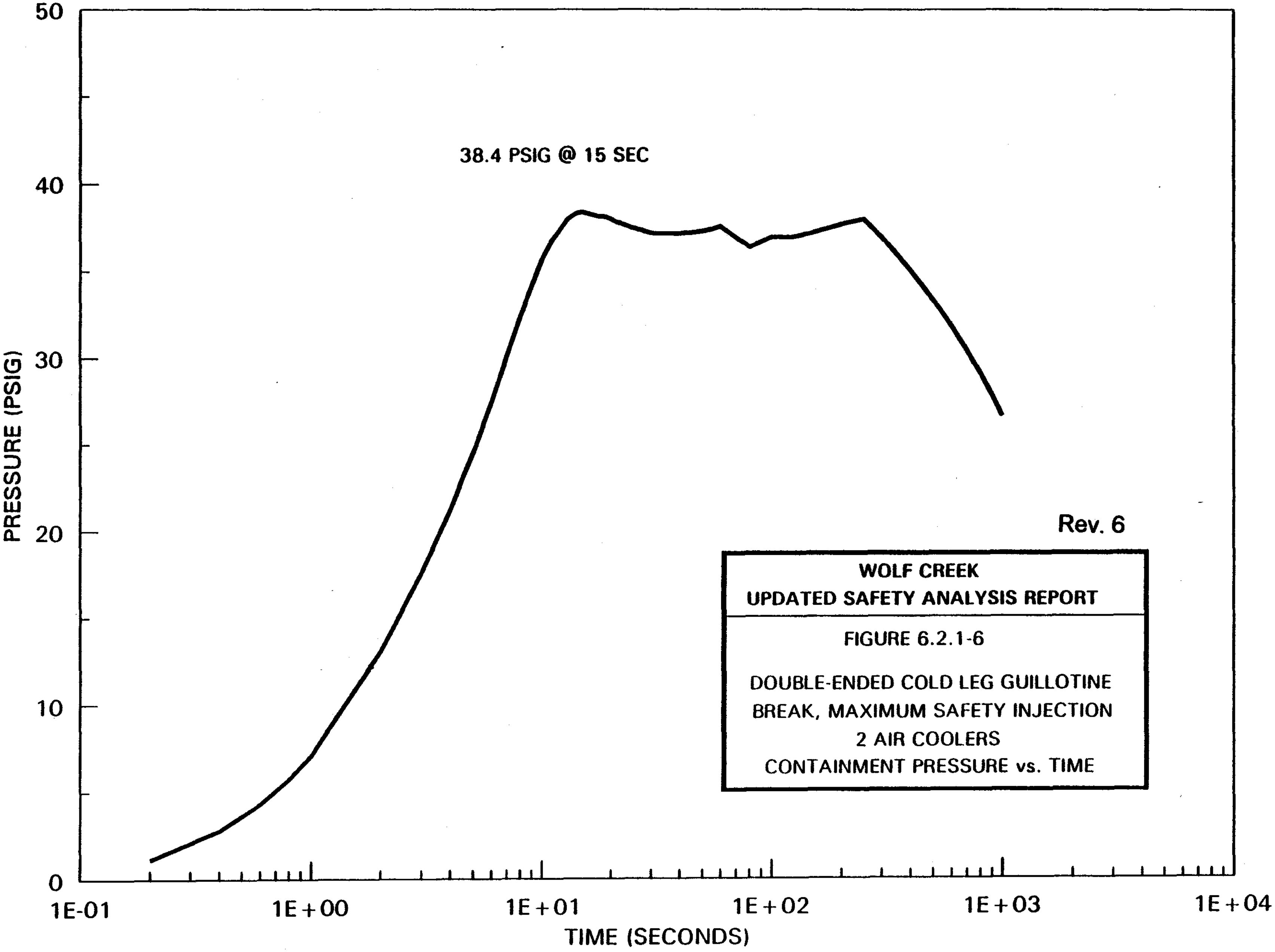

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FIGURE 6.2.1-6

DOUBLE-ENDED COLD LEG GUILLOTINE
BREAK, MAXIMUM SAFETY INJECTION
2 AIR COOLERS
CONTAINMENT PRESSURE vs. TIME

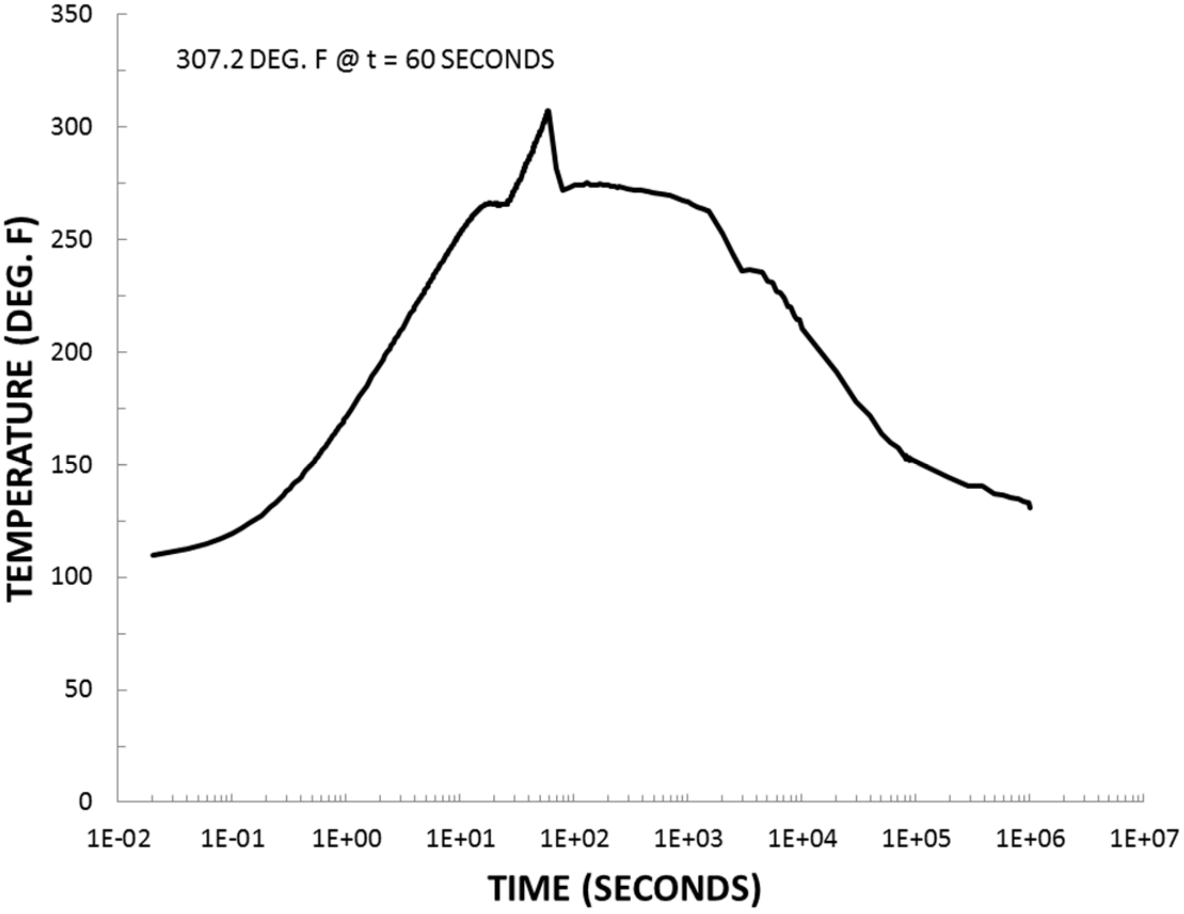

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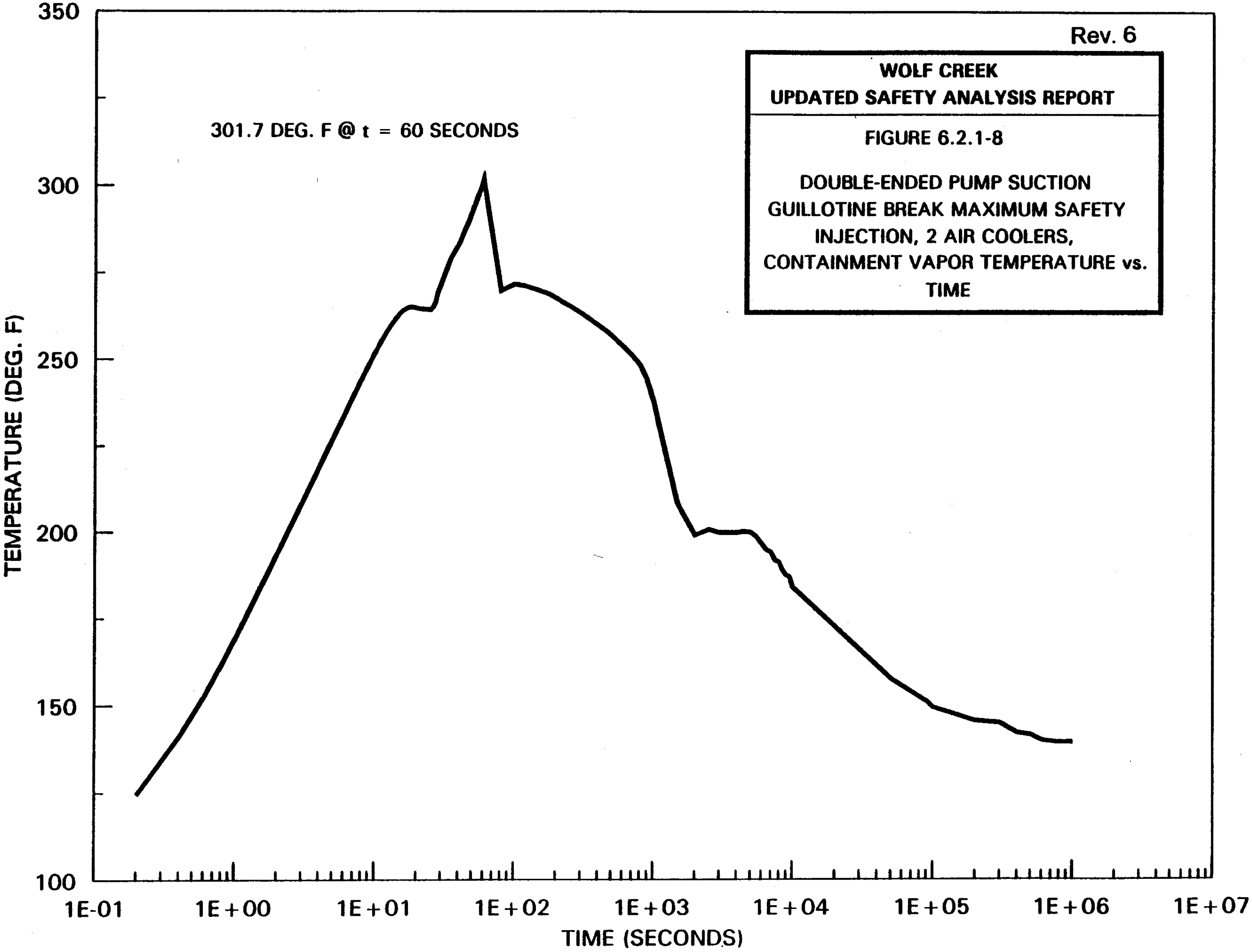
FIGURE 6.2.1-7:
Double-Ended Pump Suction Guillotine Break Minimum Safety Injection, 2 Air Coolers, Containment Vapor Temperature vs. Time



301.7 DEG. F @ t = 60 SECONDS

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FIGURE 6.2.1-8

DOUBLE-ENDED PUMP SUCTION GUILLOTINE BREAK MAXIMUM SAFETY INJECTION, 2 AIR COOLERS, CONTAINMENT VAPOR TEMPERATURE vs. TIME

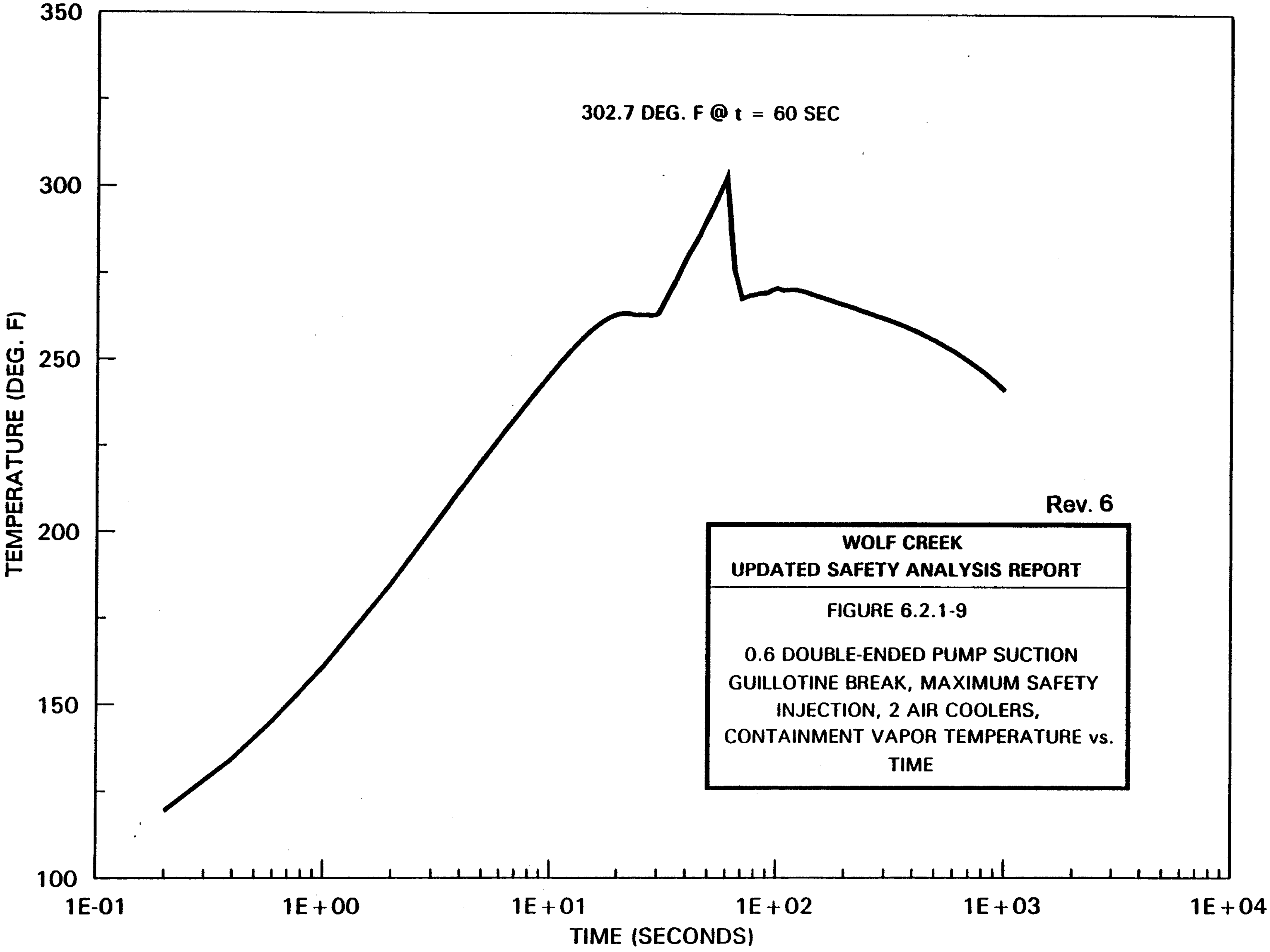

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FIGURE 6.2.1-9

0.6 DOUBLE-ENDED PUMP SUCTION GUILLOTINE BREAK, MAXIMUM SAFETY INJECTION, 2 AIR COOLERS, CONTAINMENT VAPOR TEMPERATURE vs. TIME

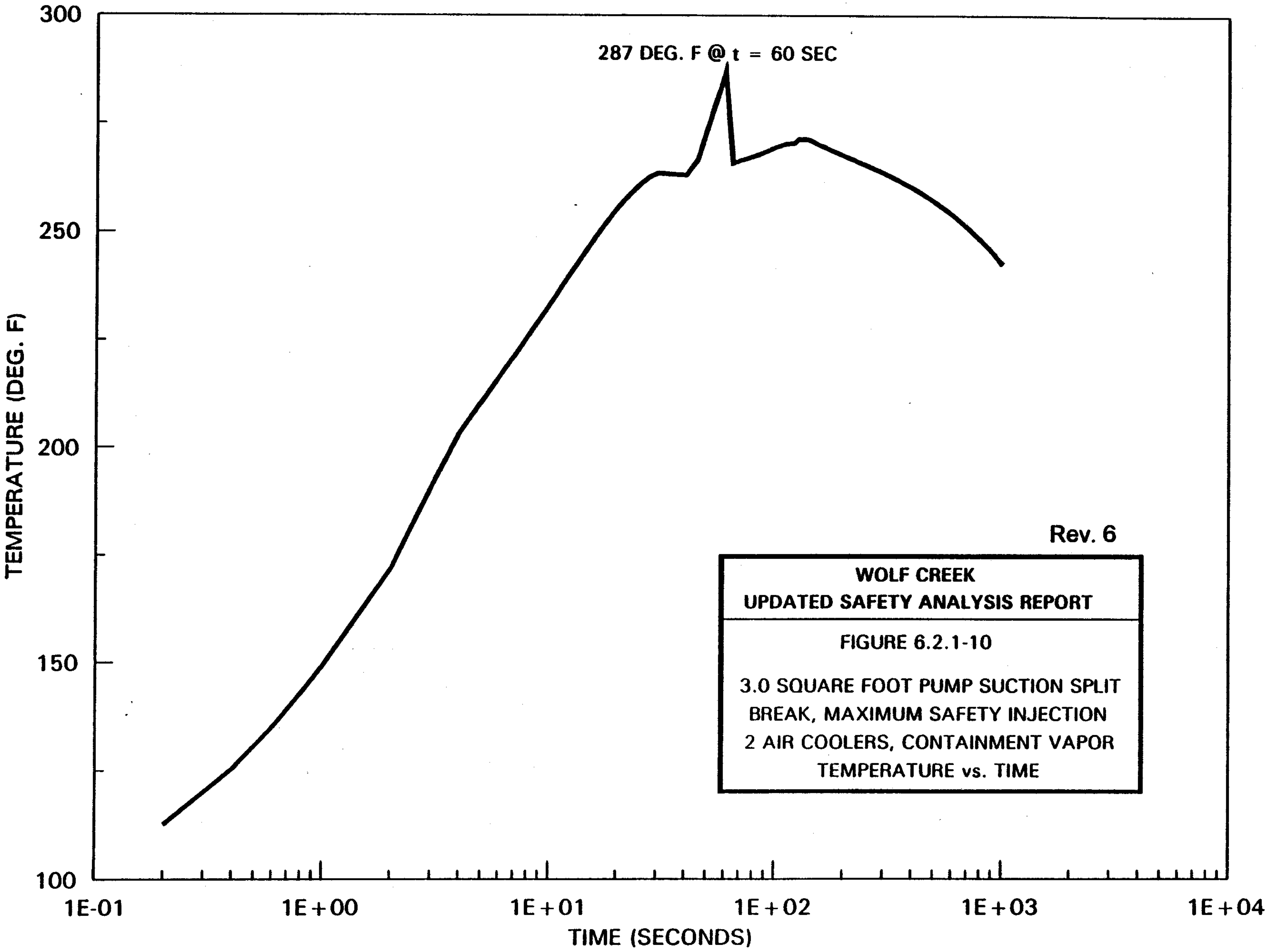

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FIGURE 6.2.1-10

3.0 SQUARE FOOT PUMP SUCTION SPLIT
BREAK, MAXIMUM SAFETY INJECTION
2 AIR COOLERS, CONTAINMENT VAPOR
TEMPERATURE vs. TIME

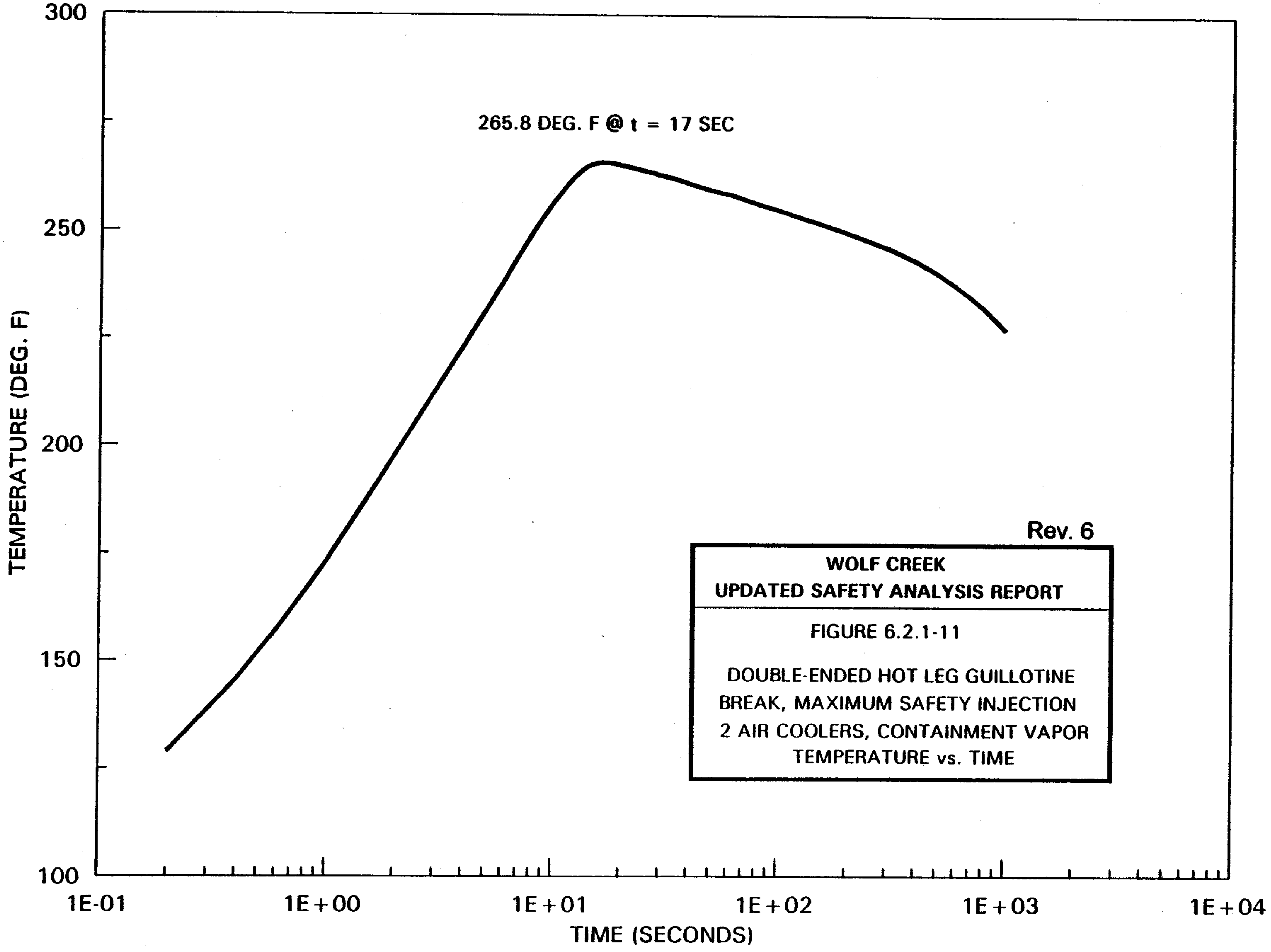

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FIGURE 6.2.1-11

DOUBLE-ENDED HOT LEG GUILLOTINE BREAK, MAXIMUM SAFETY INJECTION 2 AIR COOLERS, CONTAINMENT VAPOR TEMPERATURE vs. TIME

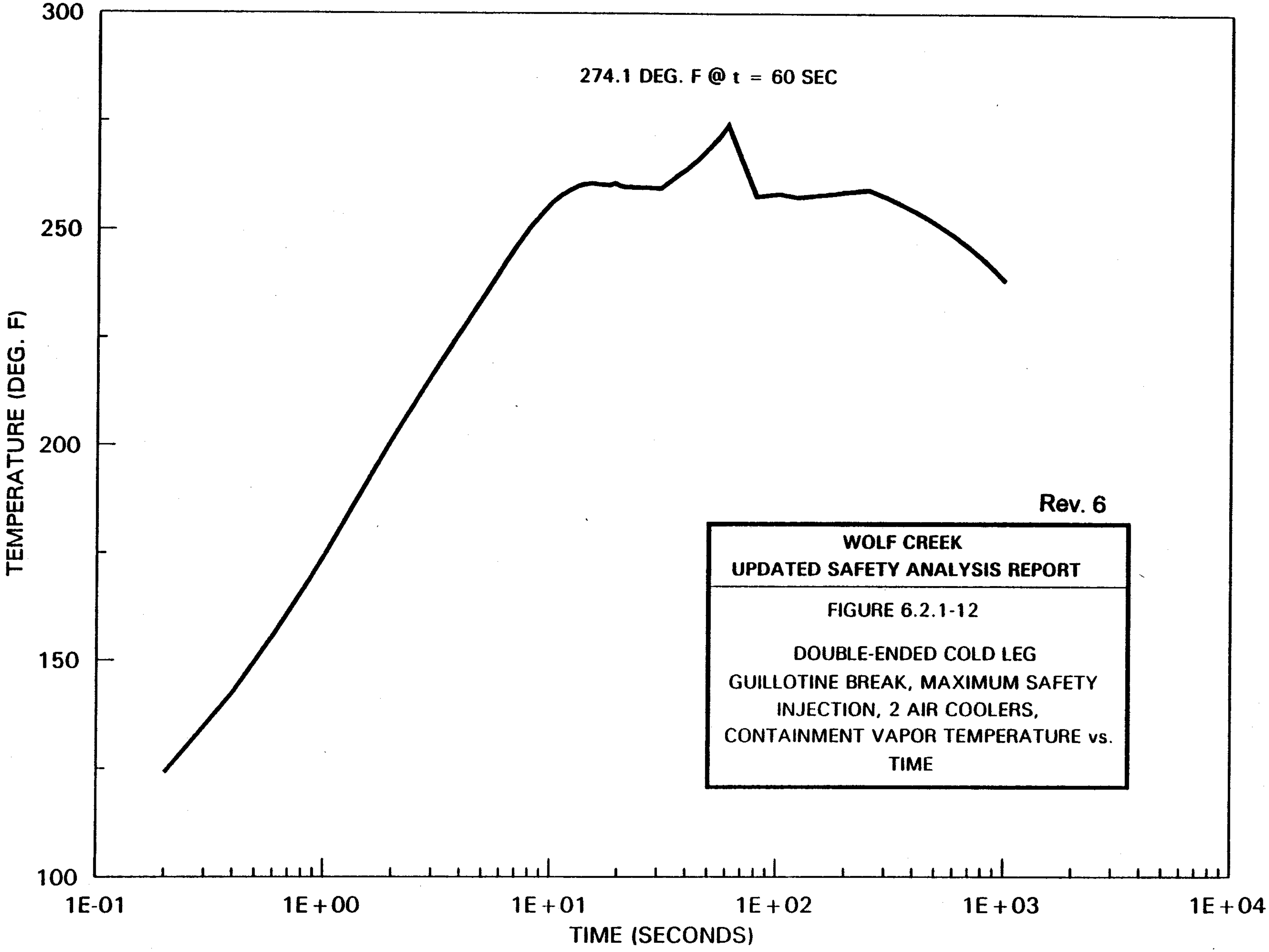

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FIGURE 6.2.1-12

DOUBLE-ENDED COLD LEG GUILLOTINE BREAK, MAXIMUM SAFETY INJECTION, 2 AIR COOLERS, CONTAINMENT VAPOR TEMPERATURE vs. TIME

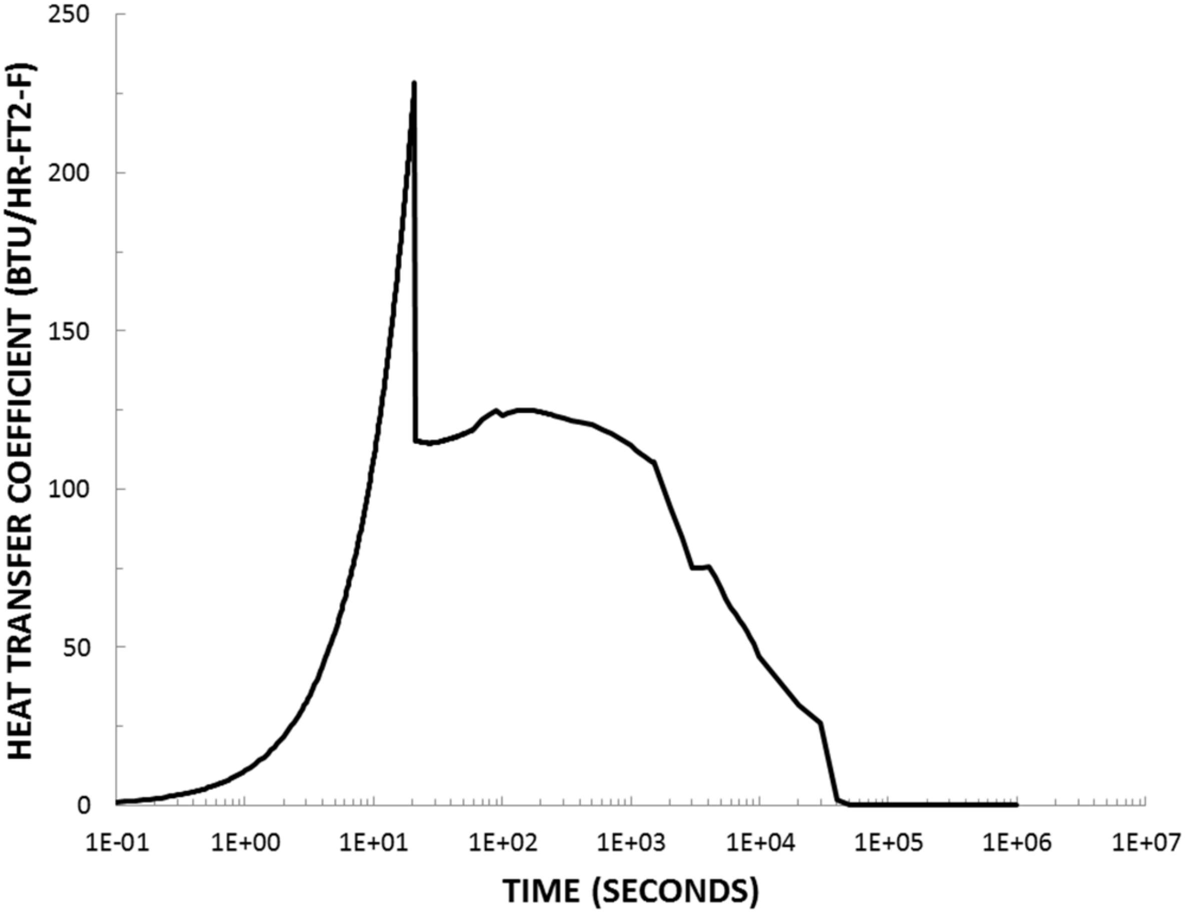

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FIGURE 6.2.1-13:
Double-Ended Pump Suction
Guillotine Break Minimum Safety
Injection, 2 Air Coolers,
Condensing Heat Transfer Coefficient
vs. Time

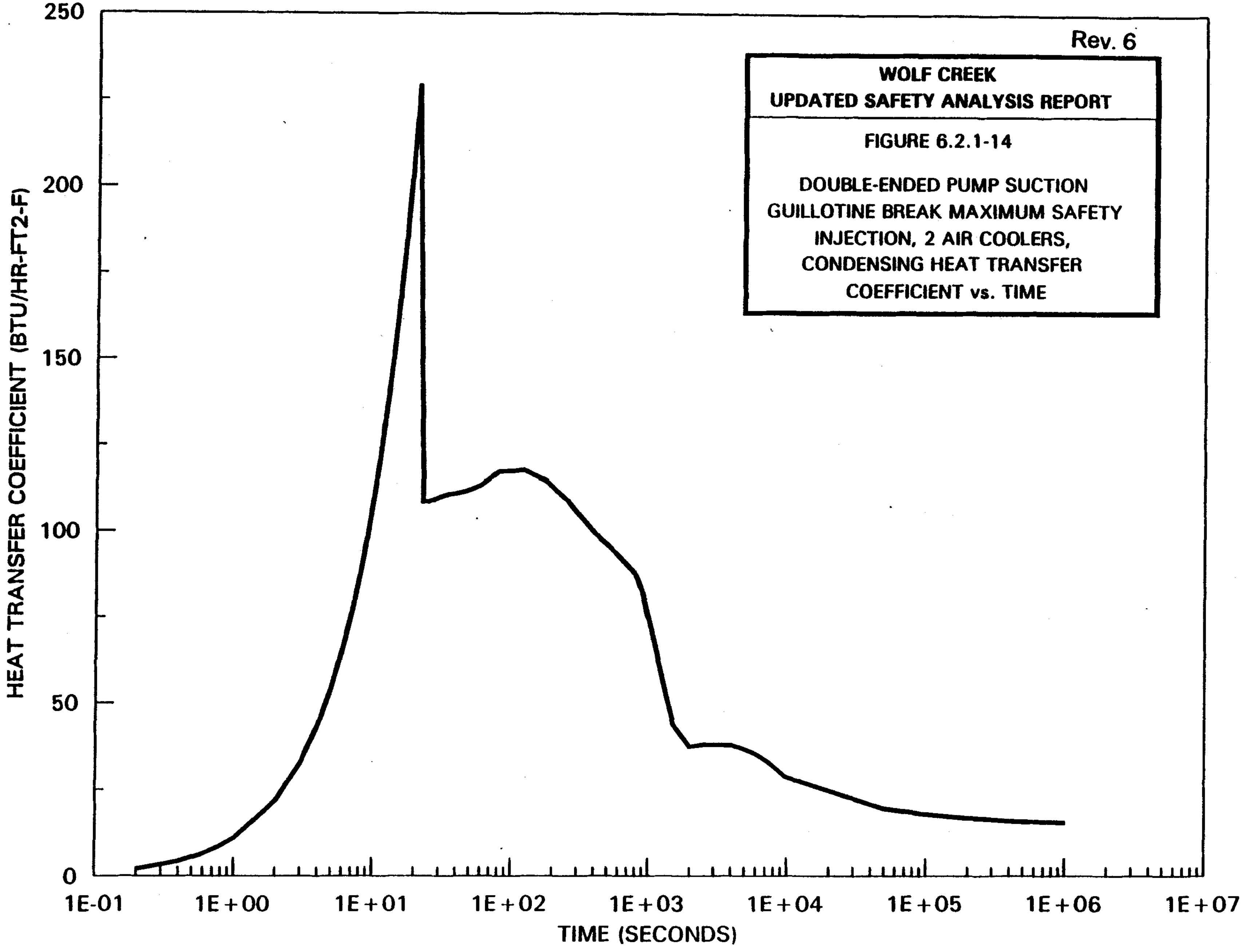

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FIGURE 6.2.1-14

DOUBLE-ENDED PUMP SUCTION GUILLOTINE BREAK MAXIMUM SAFETY INJECTION, 2 AIR COOLERS, CONDENSING HEAT TRANSFER COEFFICIENT vs. TIME

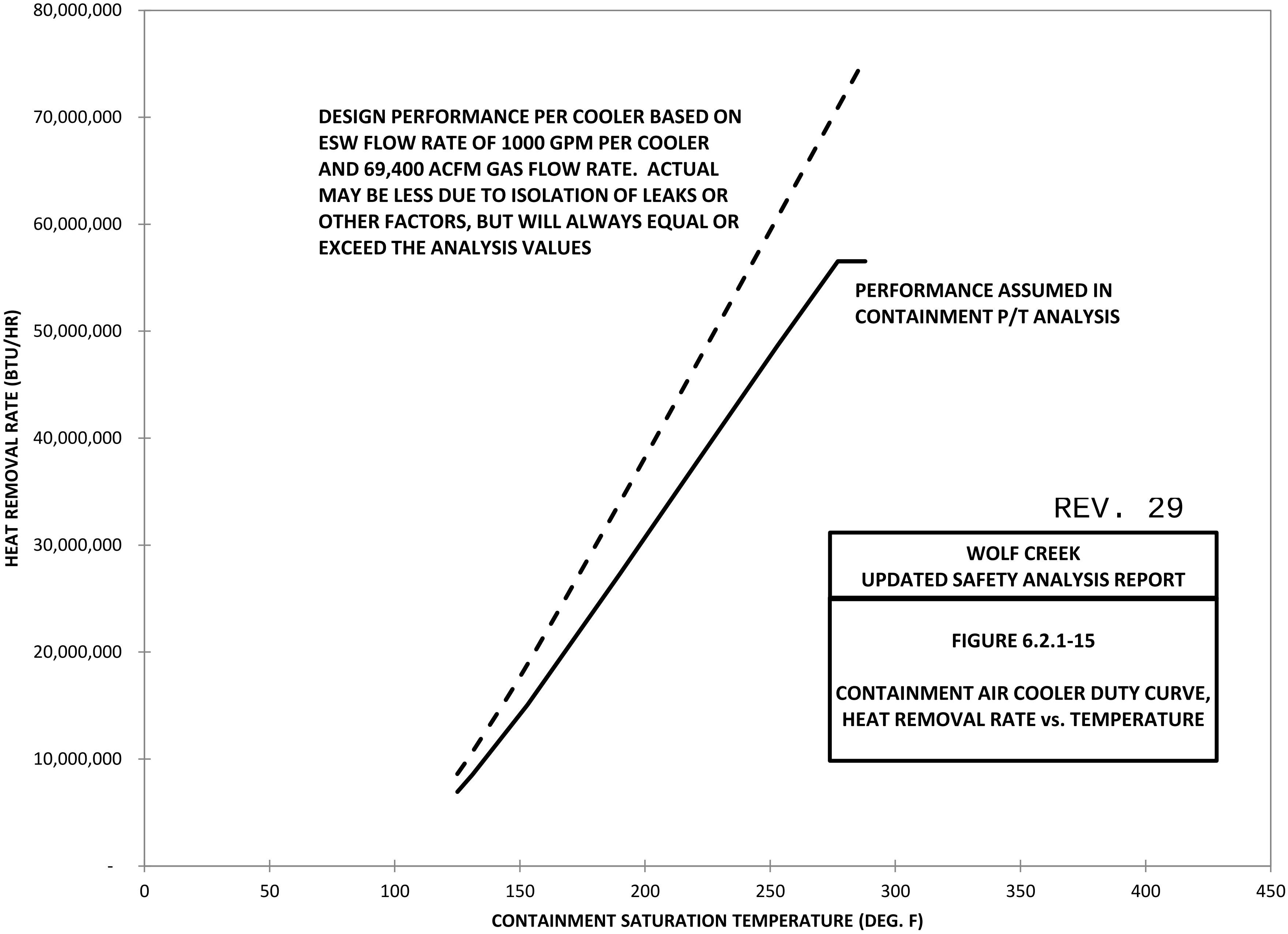

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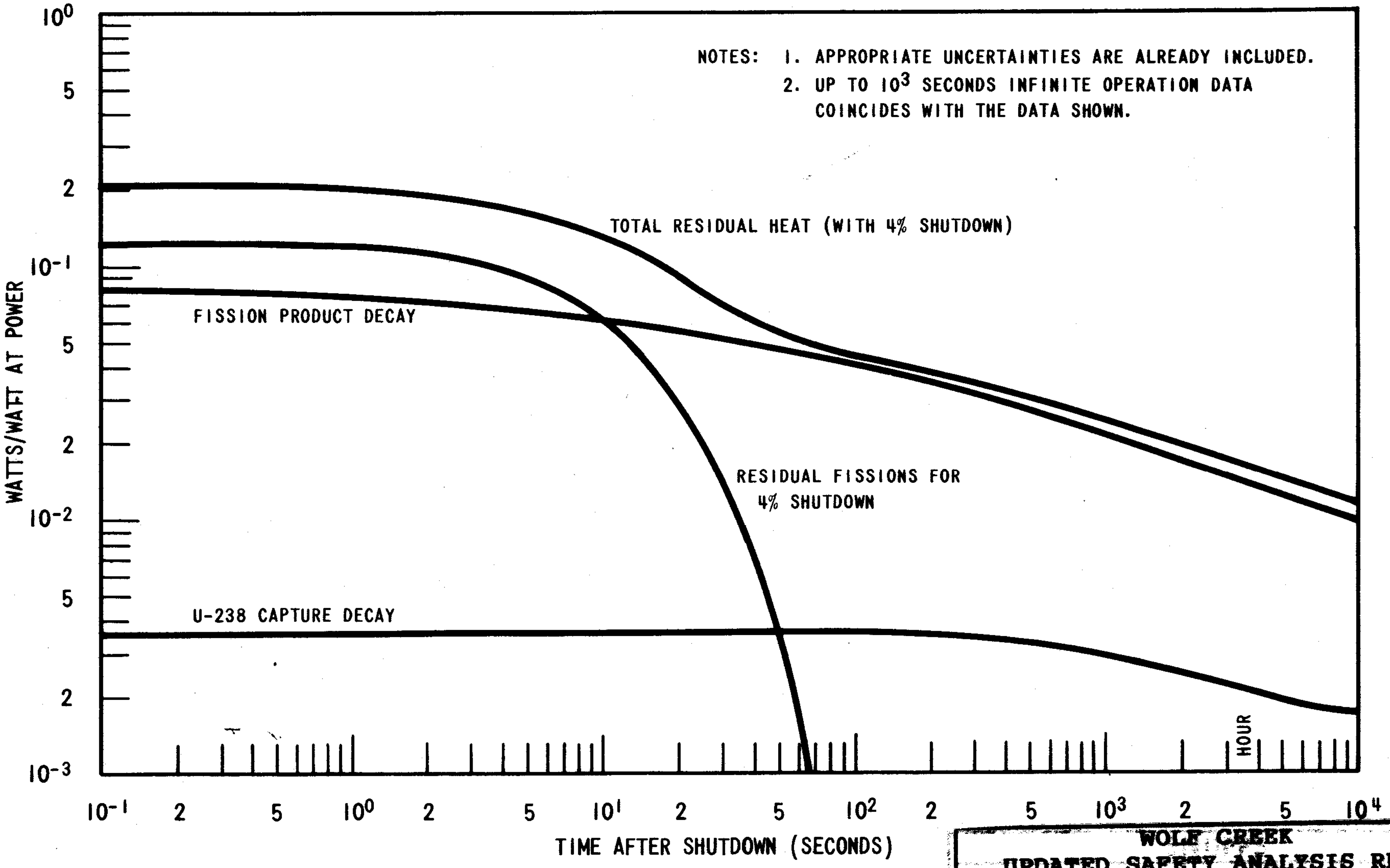
FIGURE 6.2.1-15

CONTAINMENT AIR COOLER DUTY CURVE, HEAT REMOVAL RATE vs. TEMPERATURE



NOTES: 1. APPROPRIATE UNCERTAINTIES ARE ALREADY INCLUDED.
2. UP TO 10^3 SECONDS INFINITE OPERATION DATA COINCIDES WITH THE DATA SHOWN.

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FIGURE 6.2.1-16

REACTOR DECAY POWER

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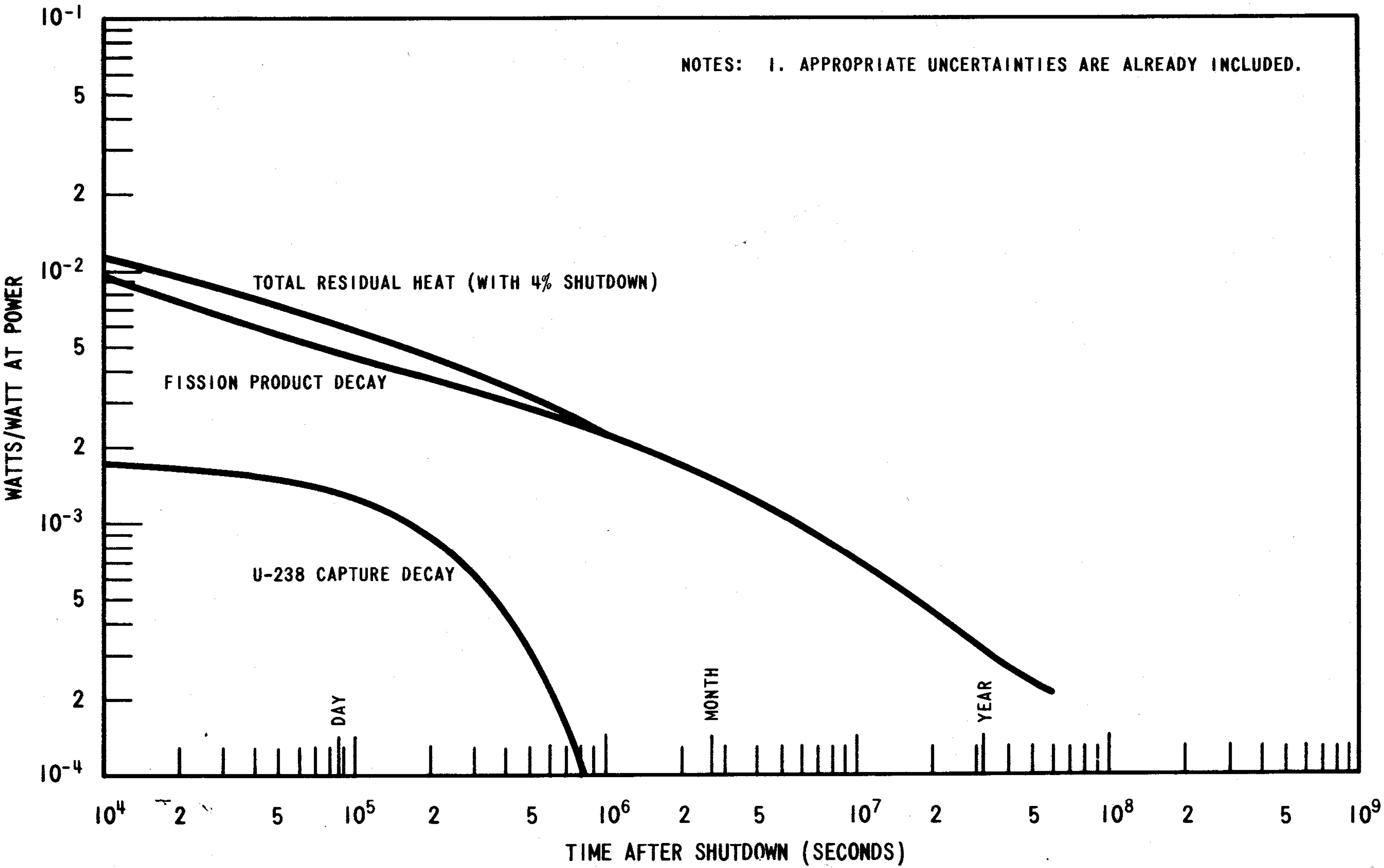
(SHEET 1)



NOTES: 1. APPROPRIATE UNCERTAINTIES ARE ALREADY INCLUDED.

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FIGURE 6.2.1-16

REACTOR DECAY POWER

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(SHEET 2)

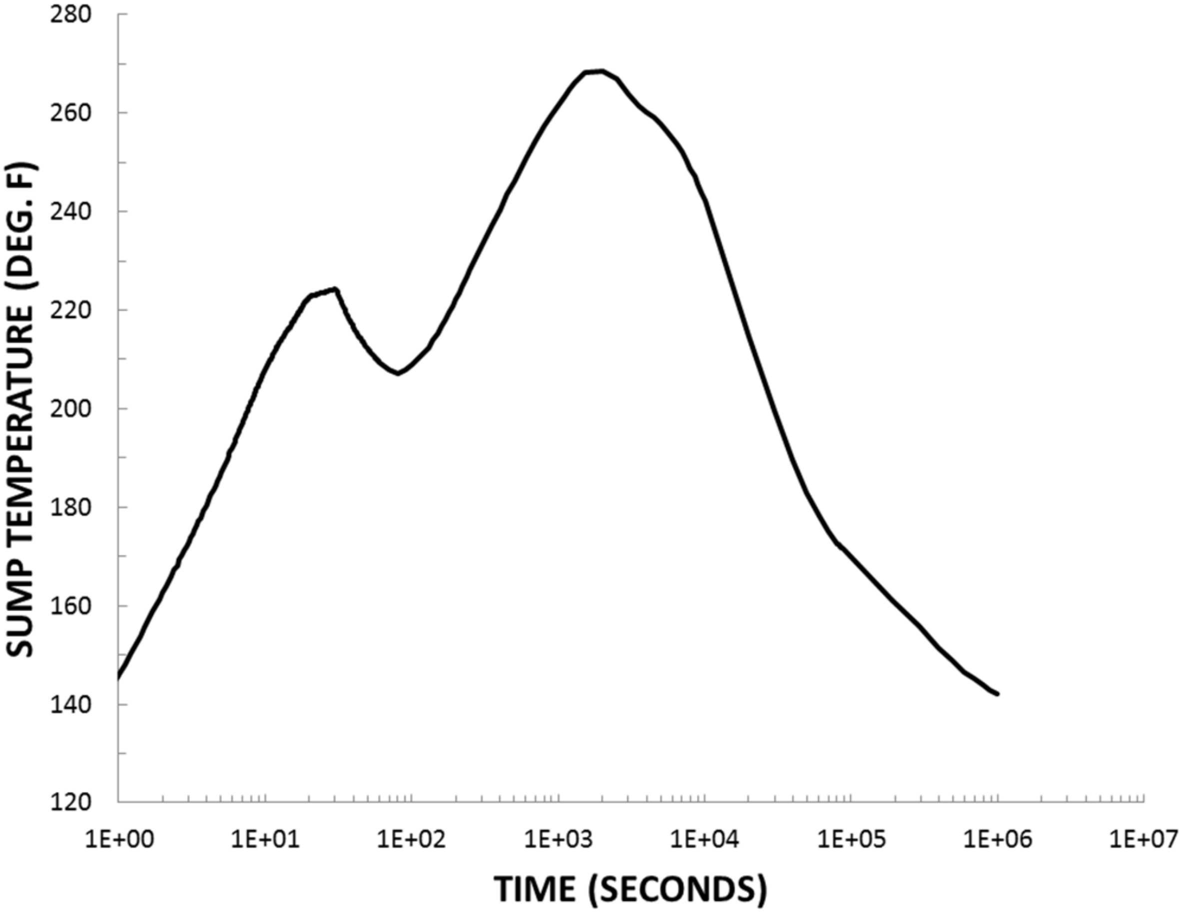

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FIGURE 6.2.1-17:
Double-Ended Pump Suction
Guillotine Break Minimum Safety
Injection, 2 Air Coolers,
Sump Temperature vs. Time

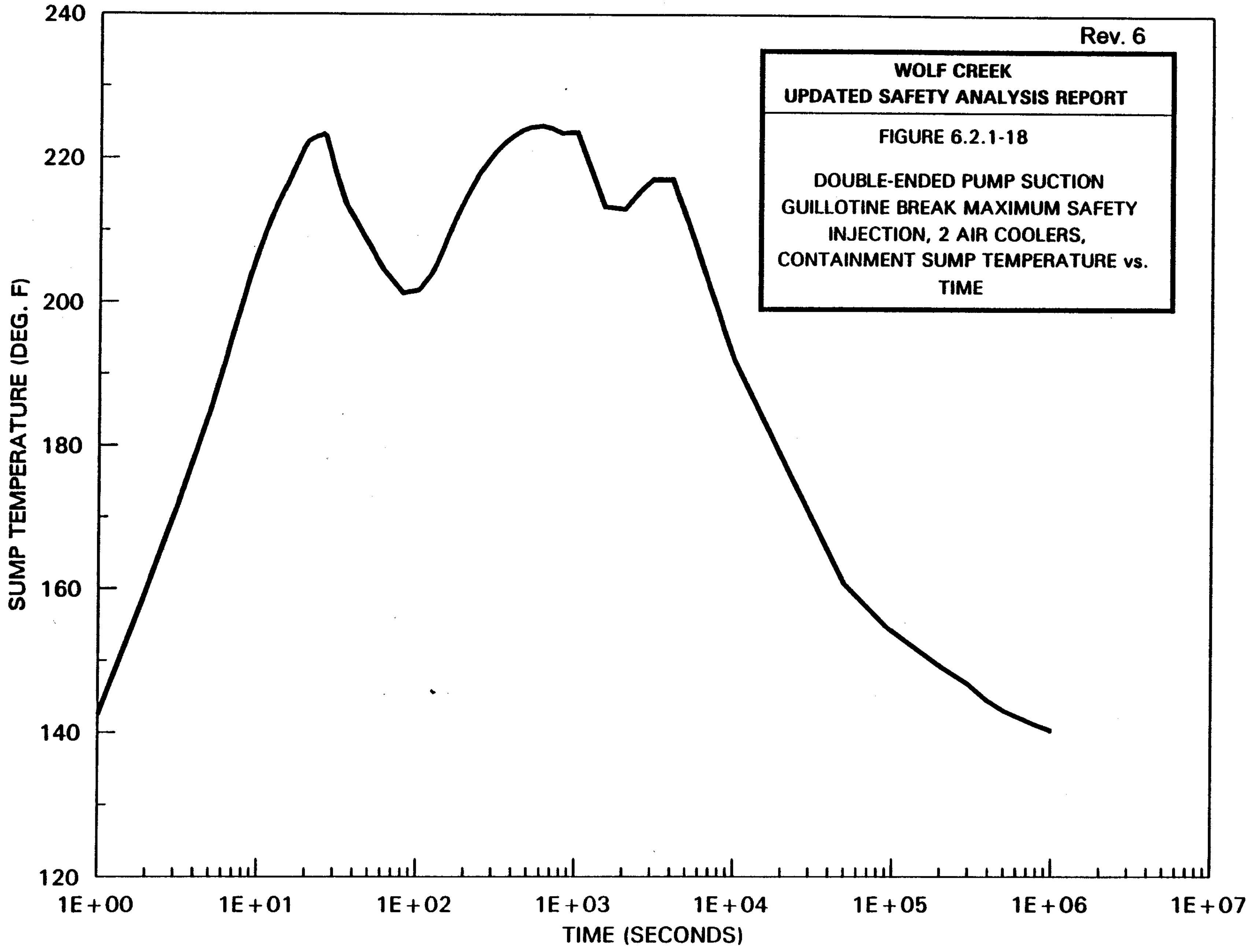

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FIGURE 6.2.1-18

DOUBLE-ENDED PUMP SUCTION GUILLOTINE BREAK MAXIMUM SAFETY INJECTION, 2 AIR COOLERS, CONTAINMENT SUMP TEMPERATURE vs. TIME

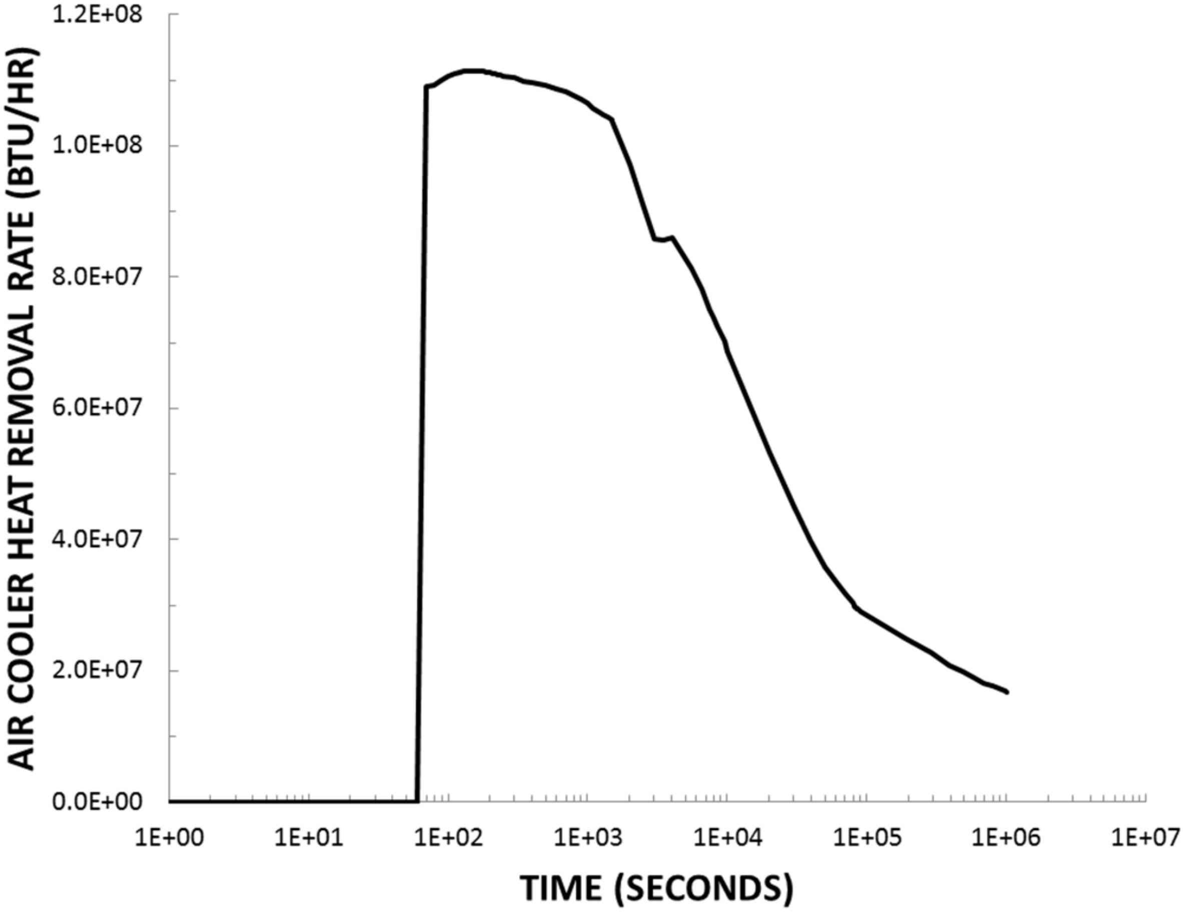

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FIGURE 6.2.1-19:
Double-Ended Pump Suction Guillotine Break Minimum Safety Injection, 2 Air Coolers,
Total Air Cooler Heat Removal Rate vs. Time

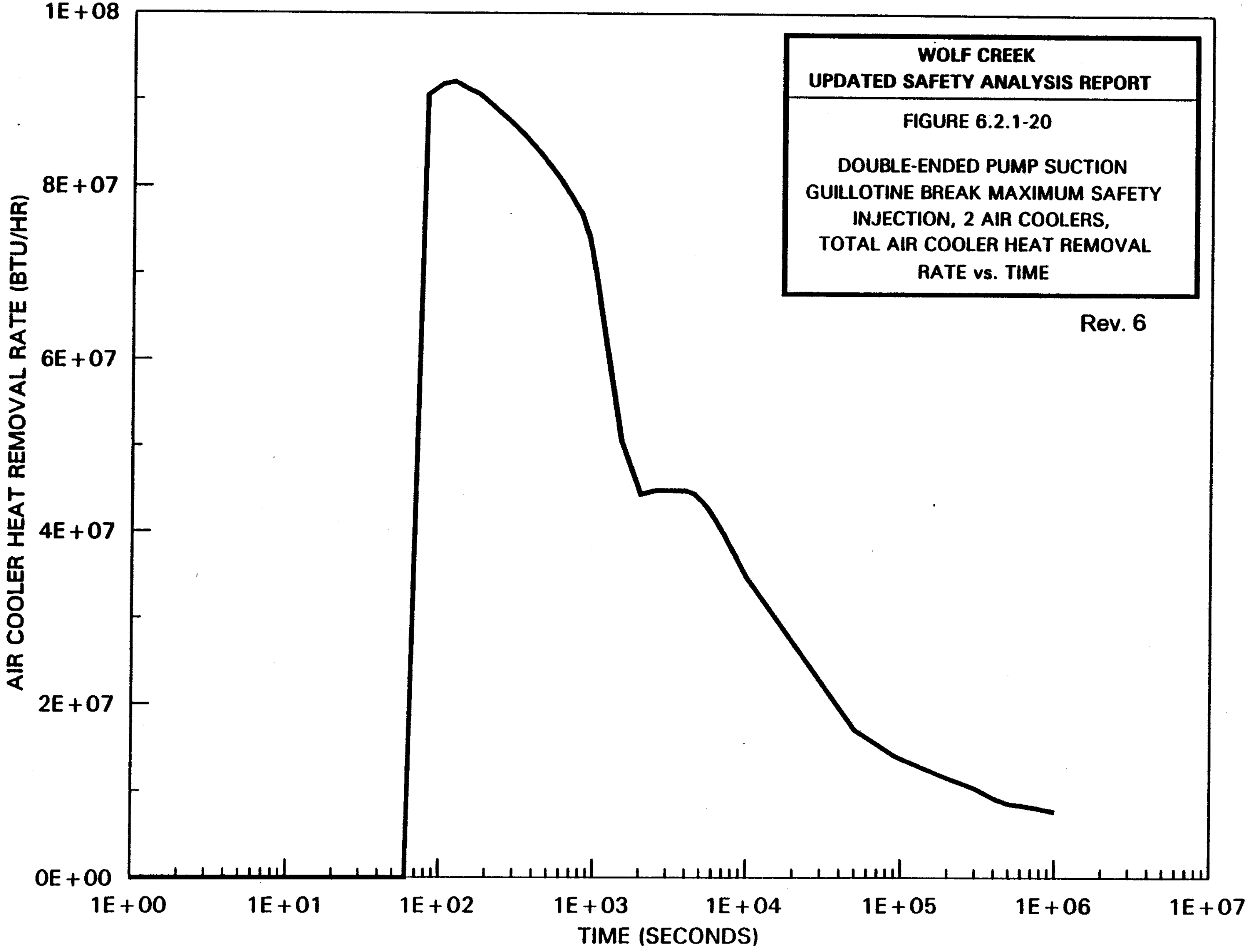

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FIGURE 6.2.1-20

DOUBLE-ENDED PUMP SUCTION GUILLOTINE BREAK MAXIMUM SAFETY INJECTION, 2 AIR COOLERS, TOTAL AIR COOLER HEAT REMOVAL RATE vs. TIME

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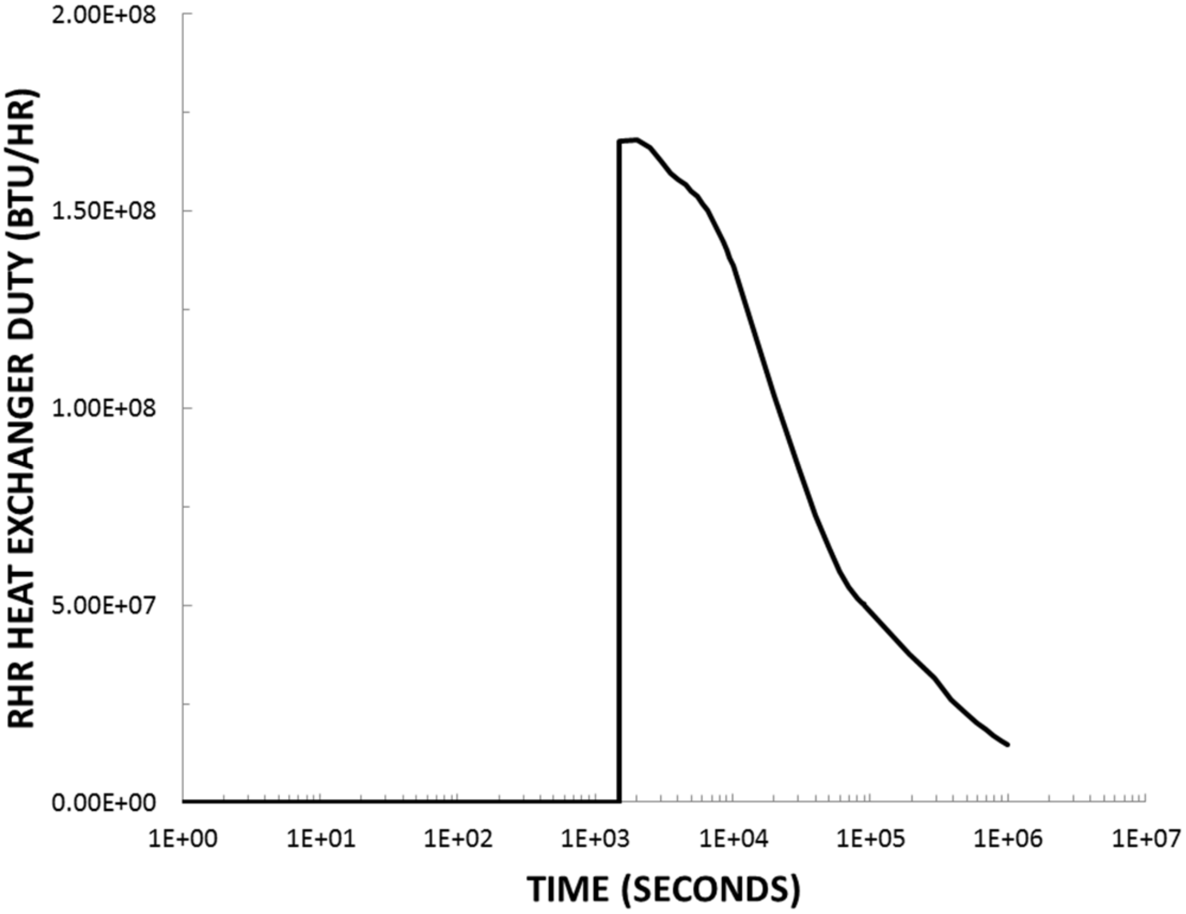

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FIGURE 6.2.1-21:
Double-Ended Pump Suction
Guillotine Break Minimum Safety
Injection, 2 Air Coolers,
RHR Heat Exchanger Heat Removal
Rate vs. Time

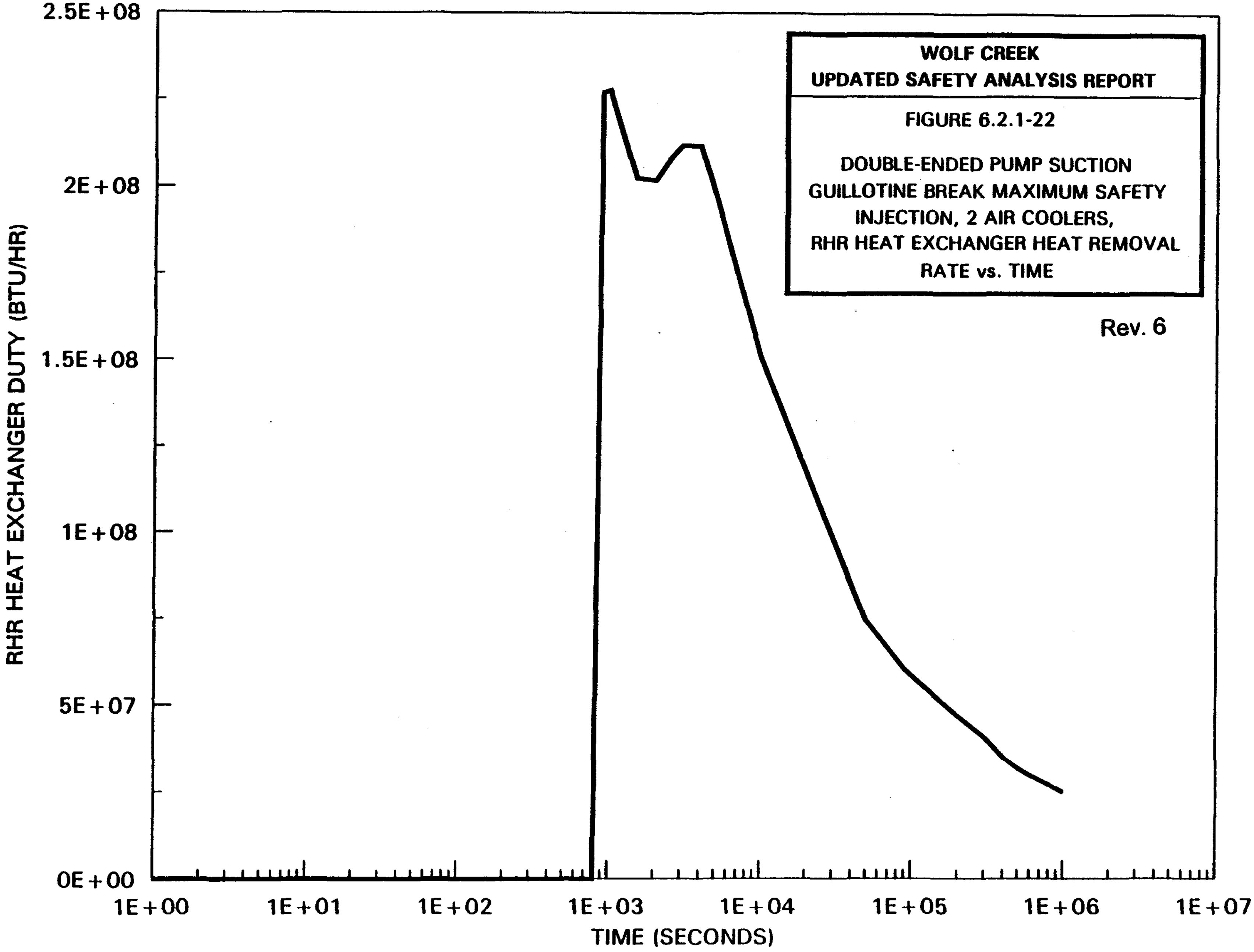

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FIGURE 6.2.1-22

DOUBLE-ENDED PUMP SUCTION GUILLOTINE BREAK MAXIMUM SAFETY INJECTION, 2 AIR COOLERS, RHR HEAT EXCHANGER HEAT REMOVAL RATE vs. TIME

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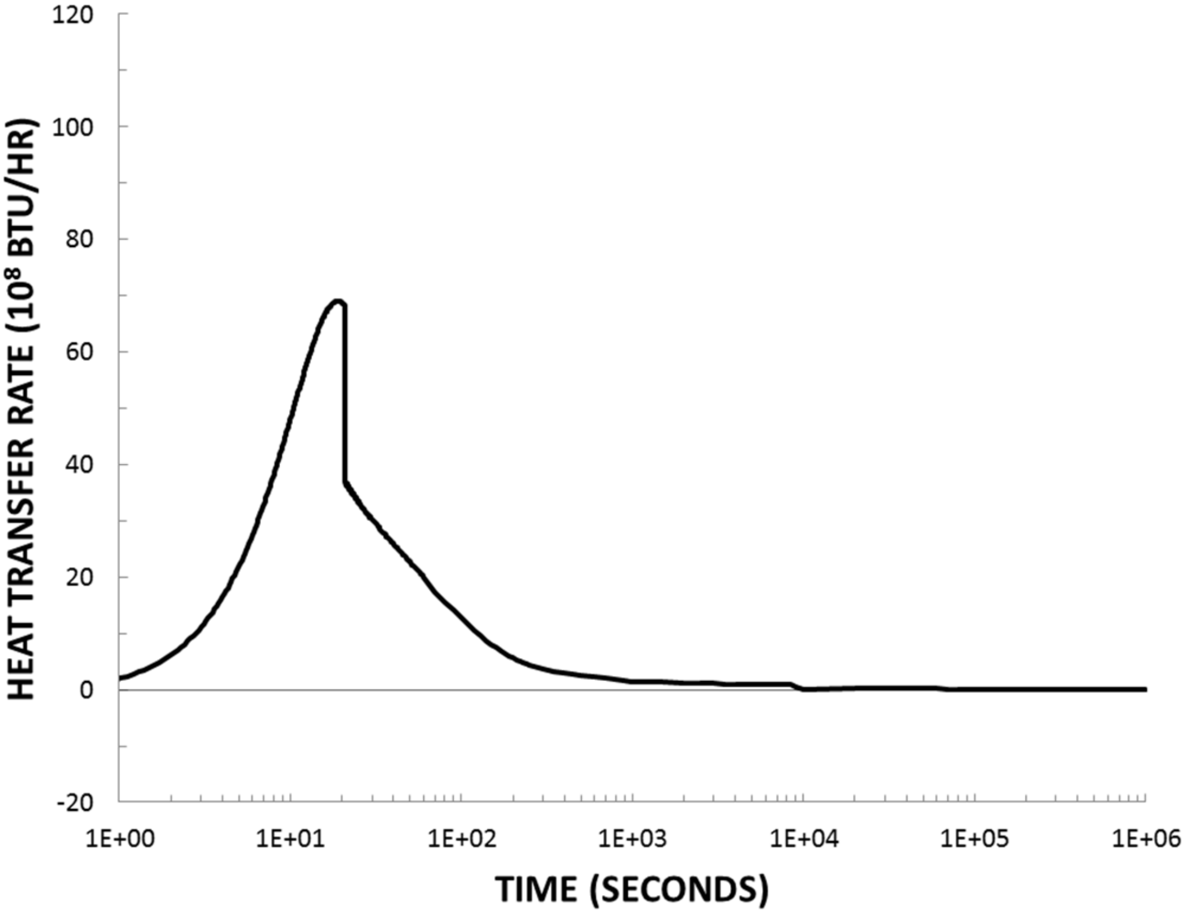

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FIGURE 6.2.1-23:
Double-Ended Pump Suction
Guillotine Break Minimum Safety
Injection, 2 Air Coolers,
Heat Sink Total Heat Transfer Rate vs.
Time

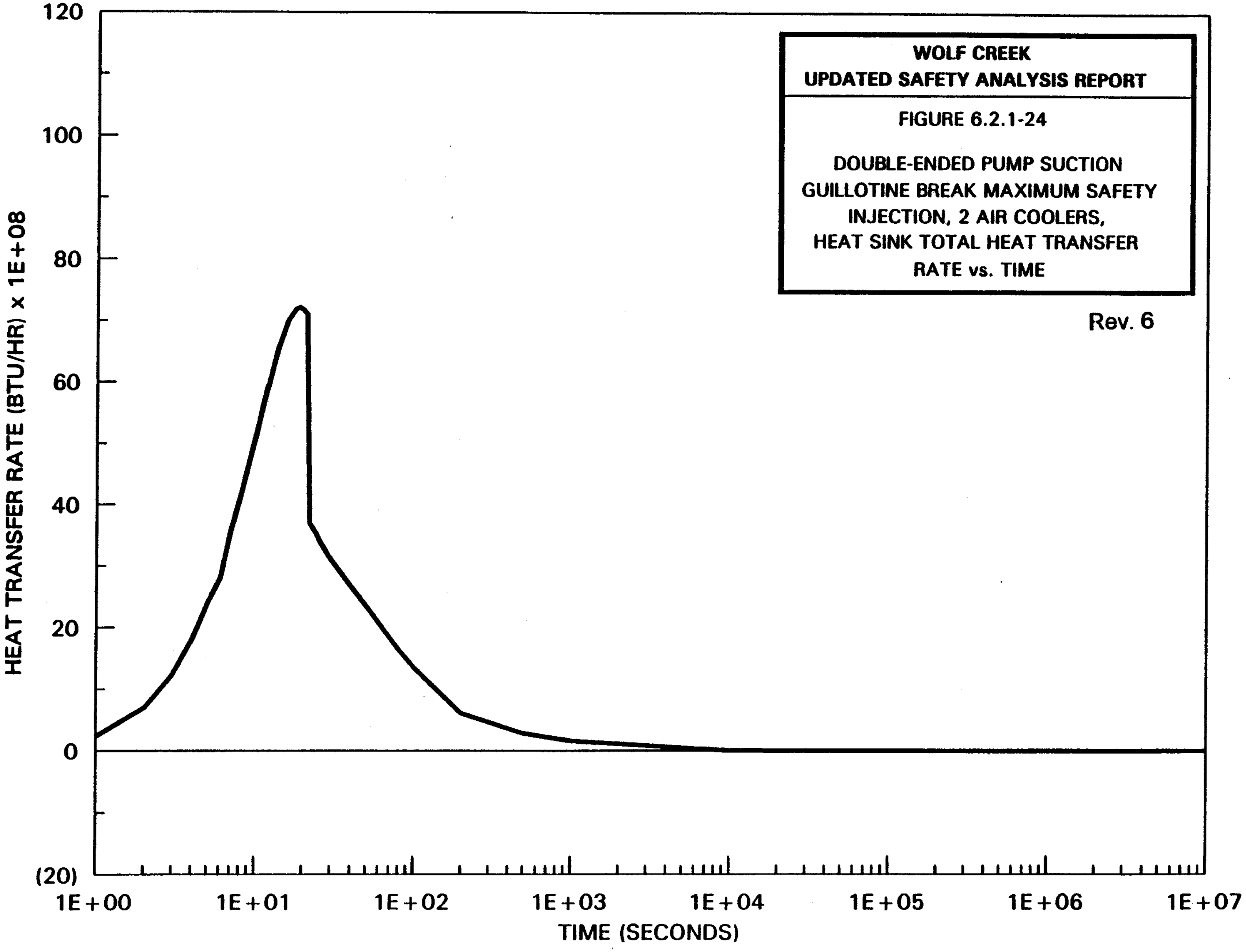

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FIGURE 6.2.1-24

DOUBLE-ENDED PUMP SUCTION GUILLOTINE BREAK MAXIMUM SAFETY INJECTION, 2 AIR COOLERS, HEAT SINK TOTAL HEAT TRANSFER RATE vs. TIME

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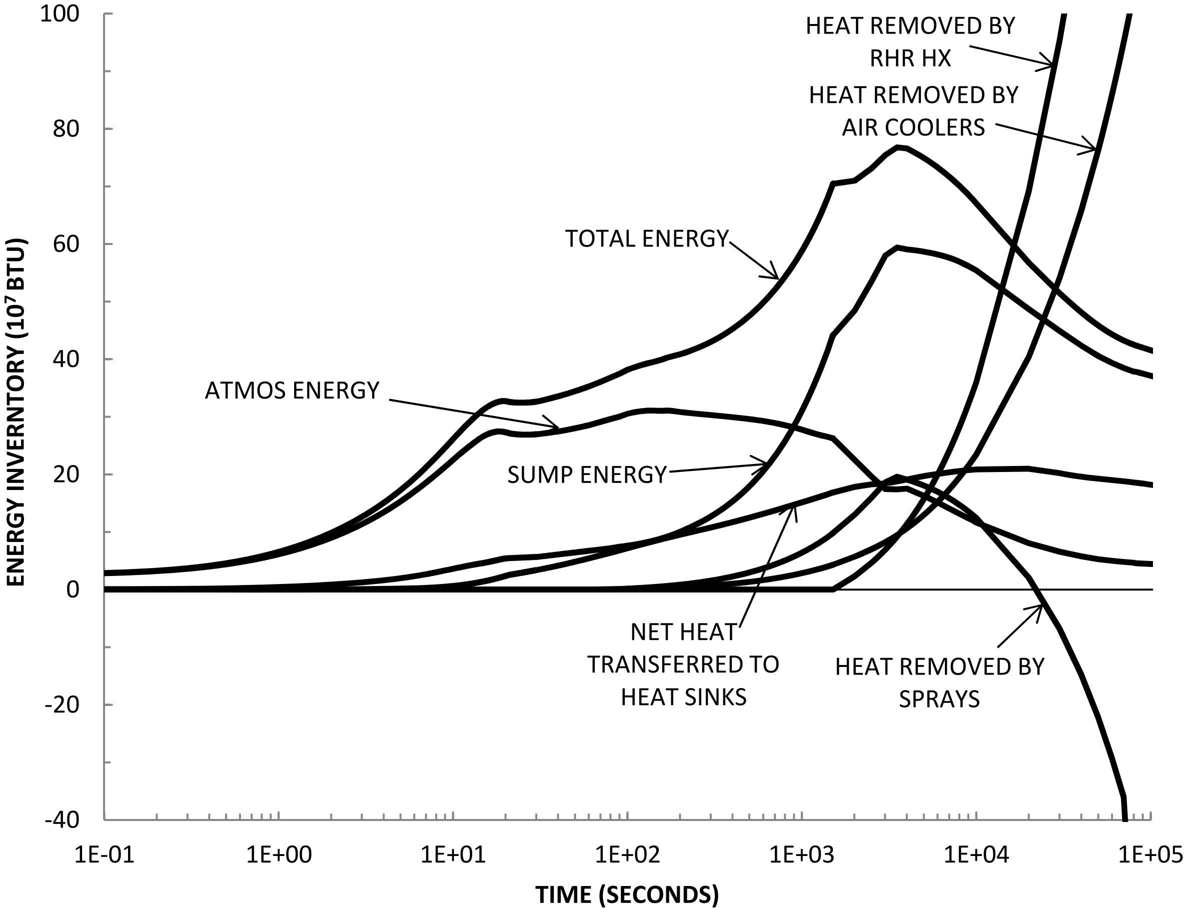

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FIGURE 6.2.1-25:
Double-Ended Pump Suction
Guillotine Break Minimum Safety
Injection, 2 Air Coolers,
Energy Inventory vs. Time

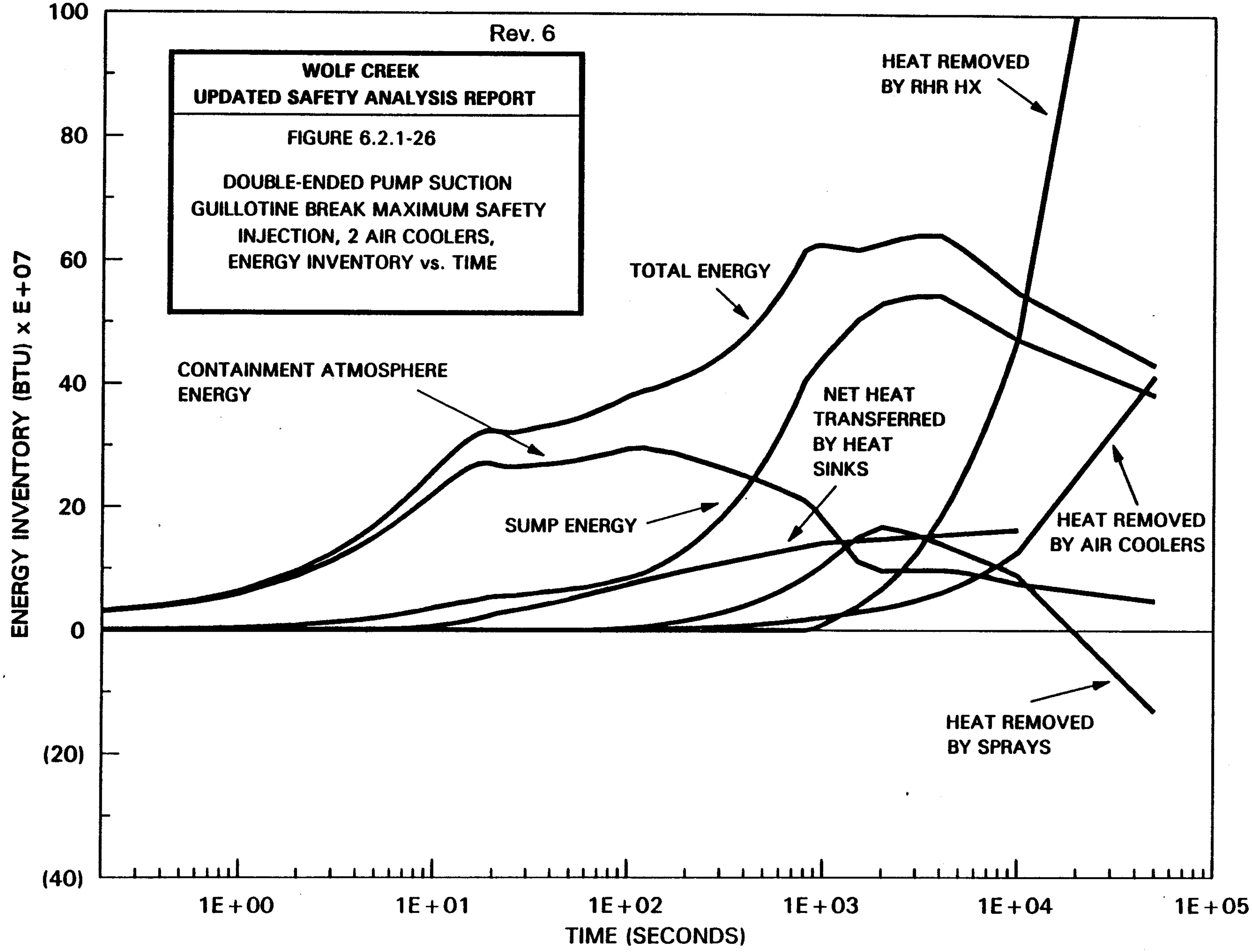

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FIGURE 6.2.1-26

DOUBLE-ENDED PUMP SUCTION GUILLOTINE BREAK MAXIMUM SAFETY INJECTION, 2 AIR COOLERS, ENERGY INVENTORY vs. TIME

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Figure 6.2.1-27

Reactor Cavity Analysis
Nodalization Scheme
Elevation View

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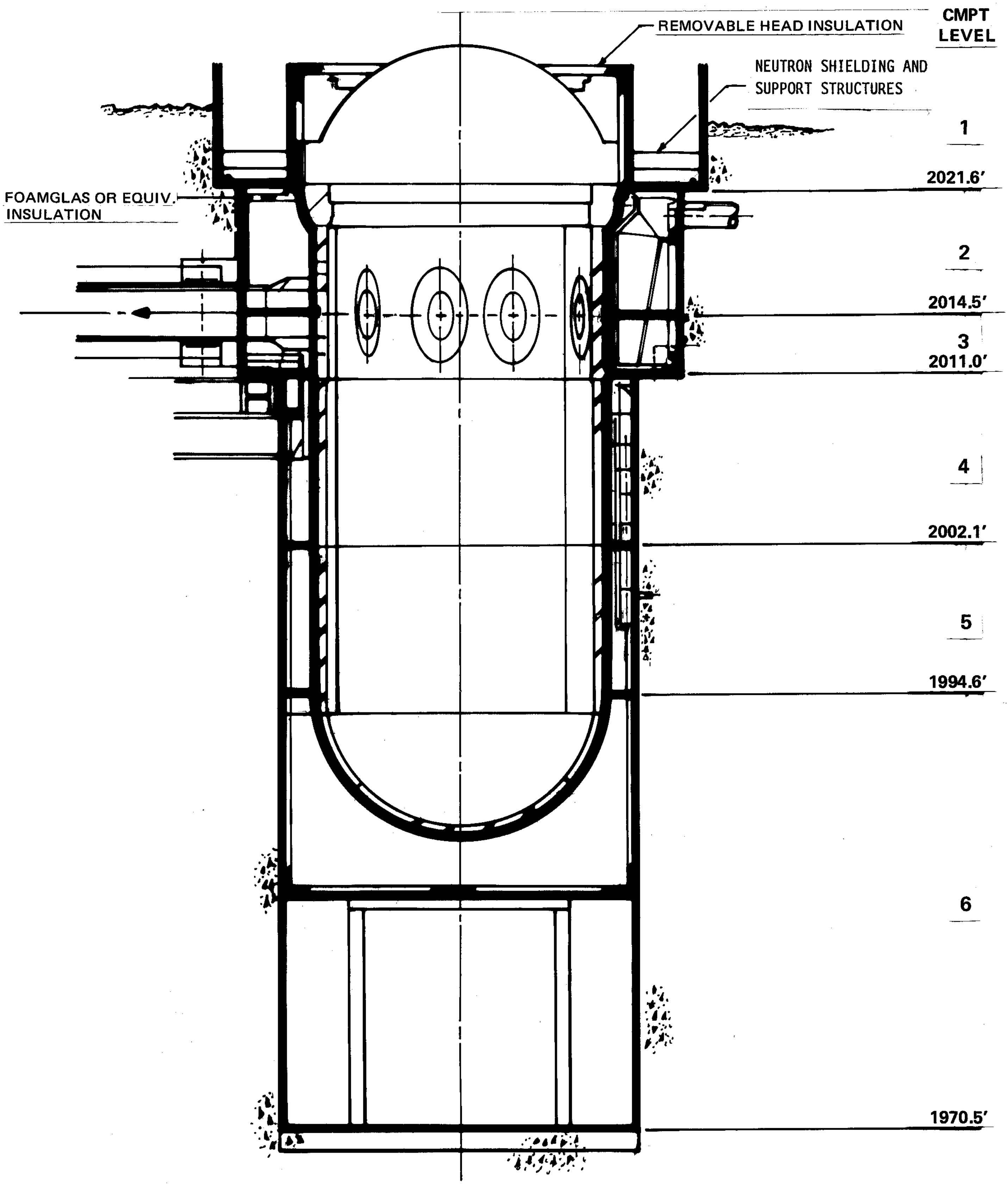

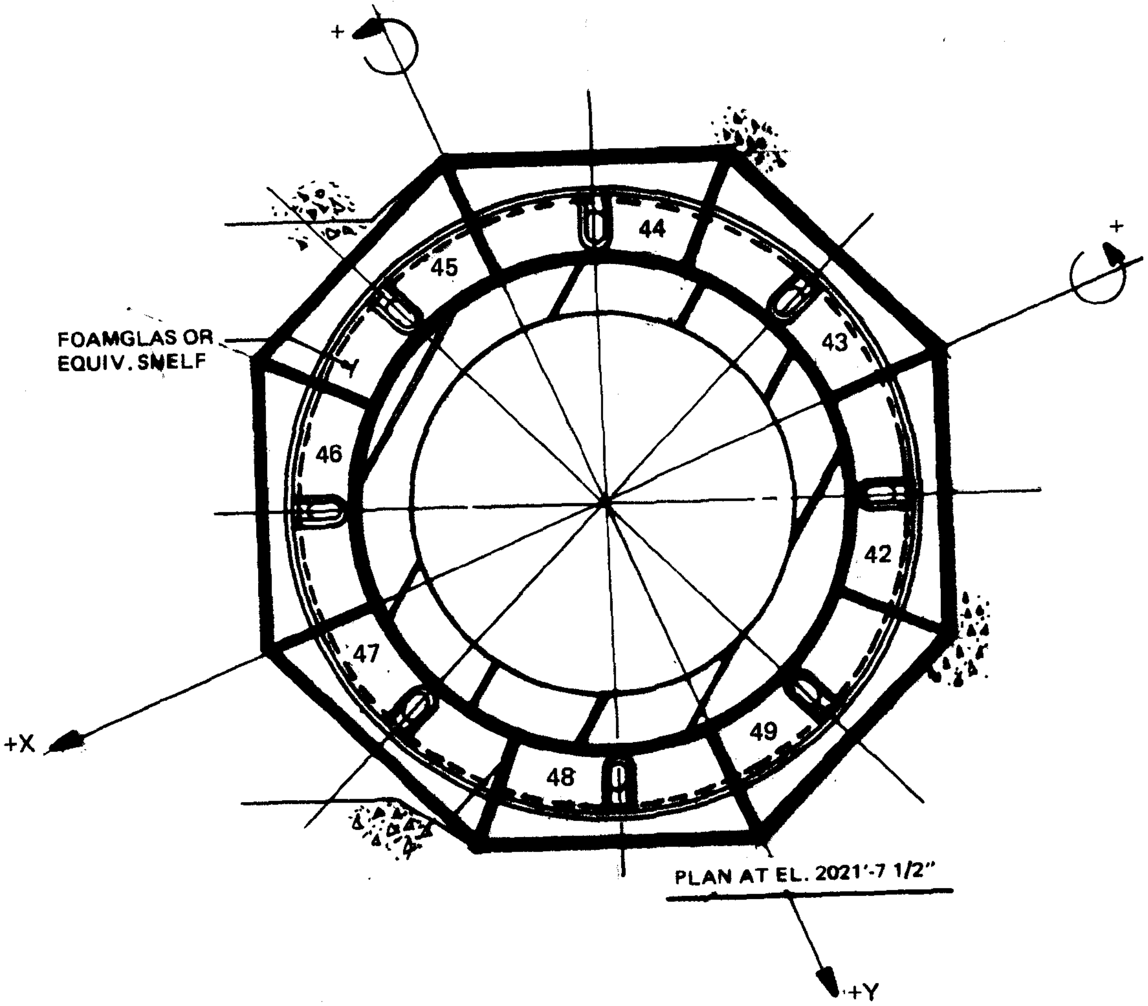

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FIGURE 6.2.1-28

REACTOR CAVITY ANALYSIS
NODALIZATION SCHEME - LEVEL 1

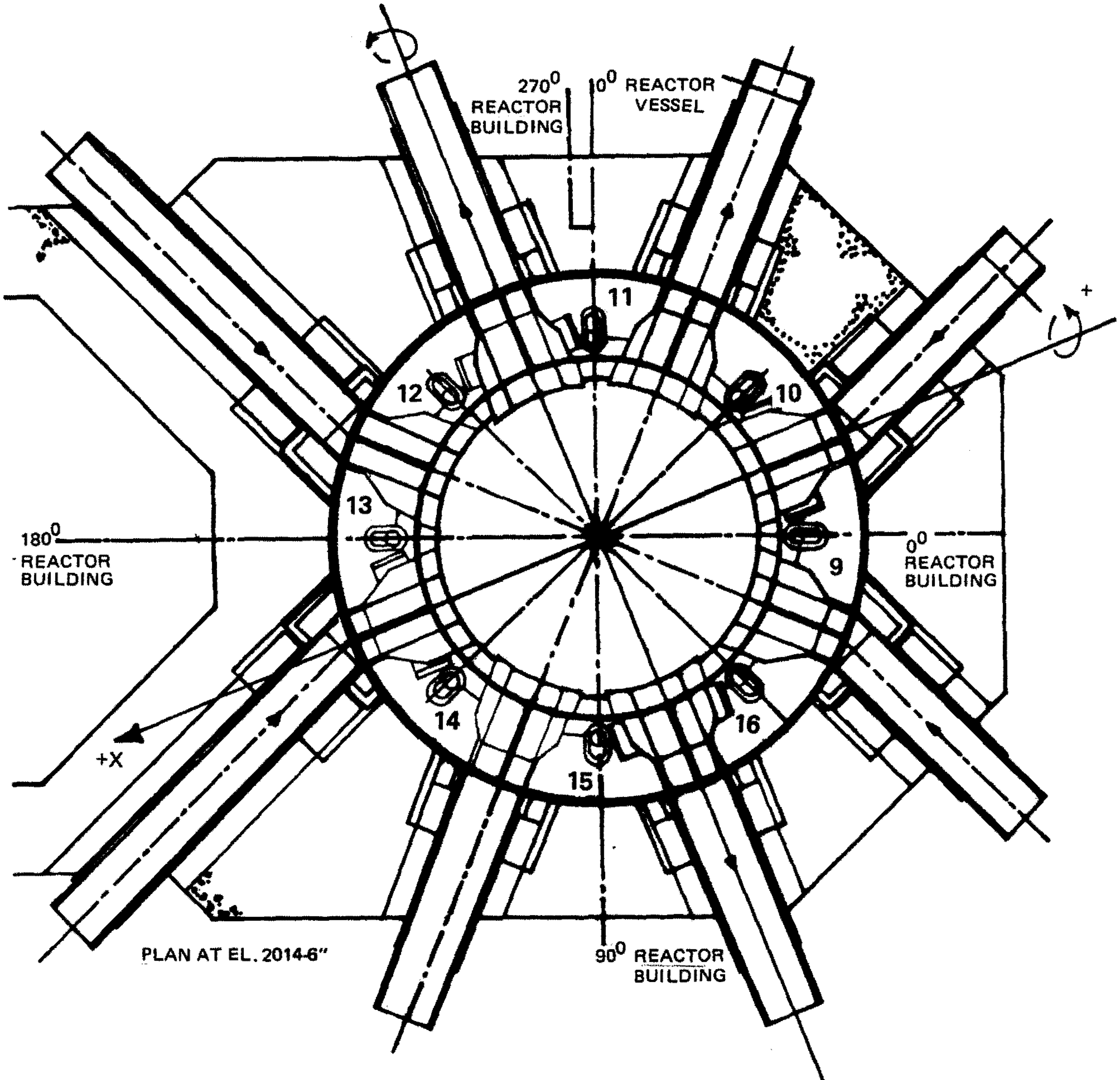

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FIGURE 6.2.1-29

REACTOR CAVITY ANALYSIS
NODALIZATION SCHEME - LEVEL 2

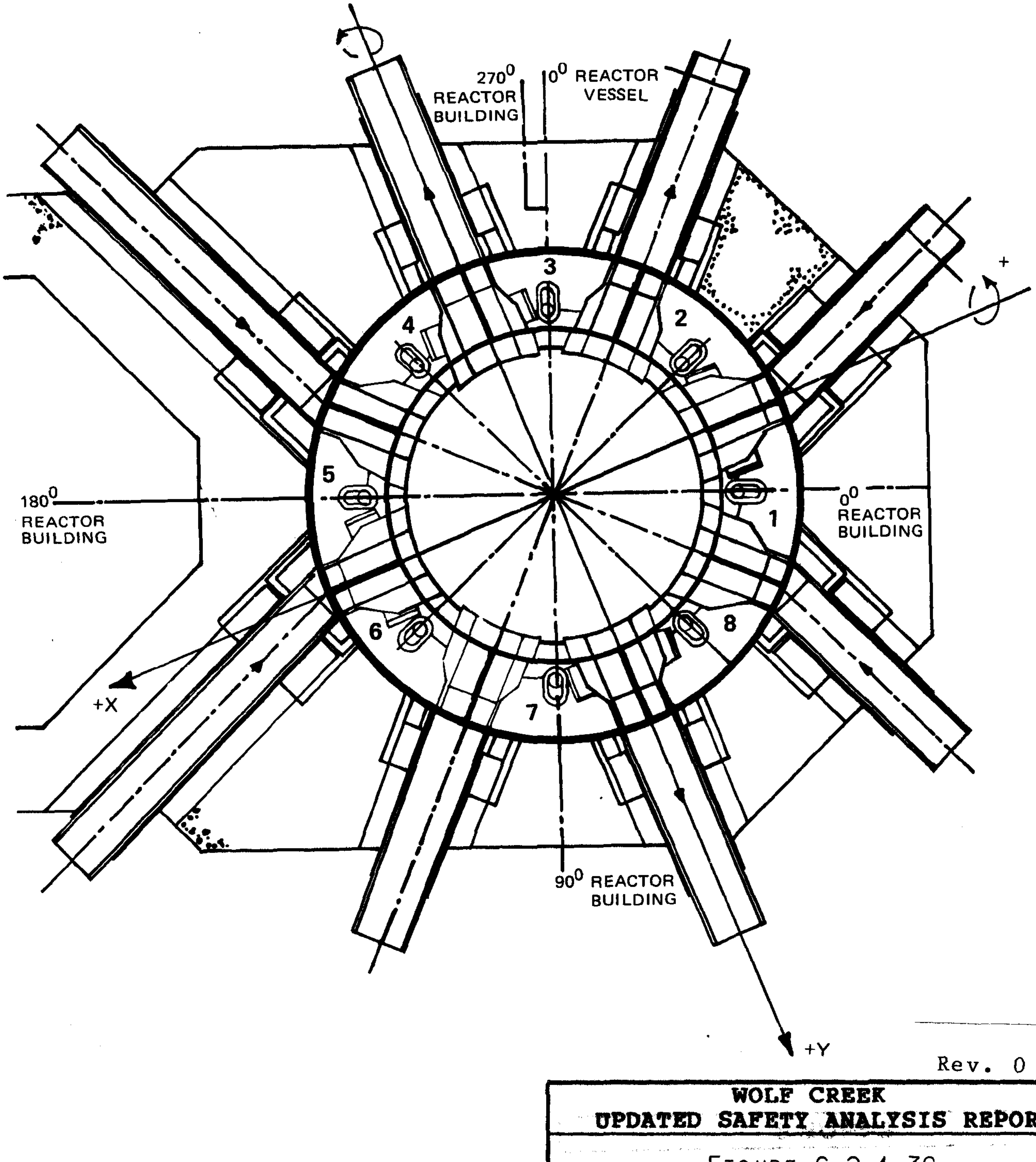

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FIGURE 6.2.1-30

REACTOR CAVITY ANALYSIS
NODALIZATION SCHEME - LEVEL 3

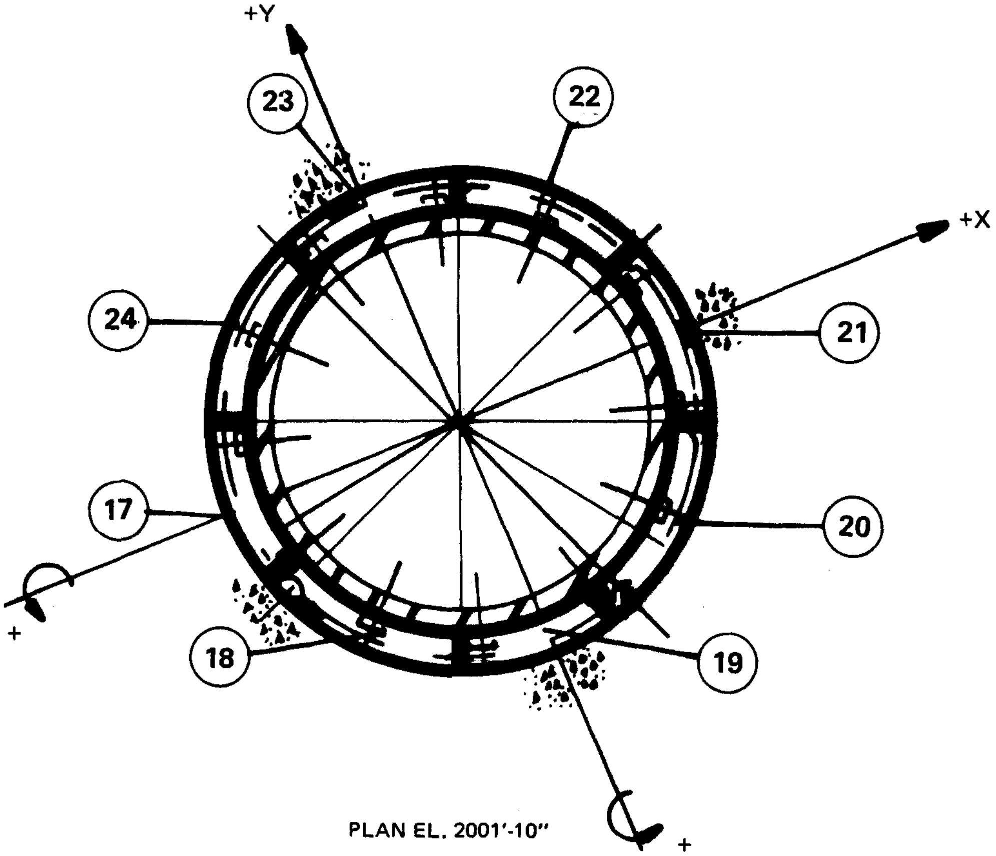

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FIGURE 6.2.1-31

REACTOR CAVITY ANALYSIS
NODALIZATION SCHEME - LEVEL 4

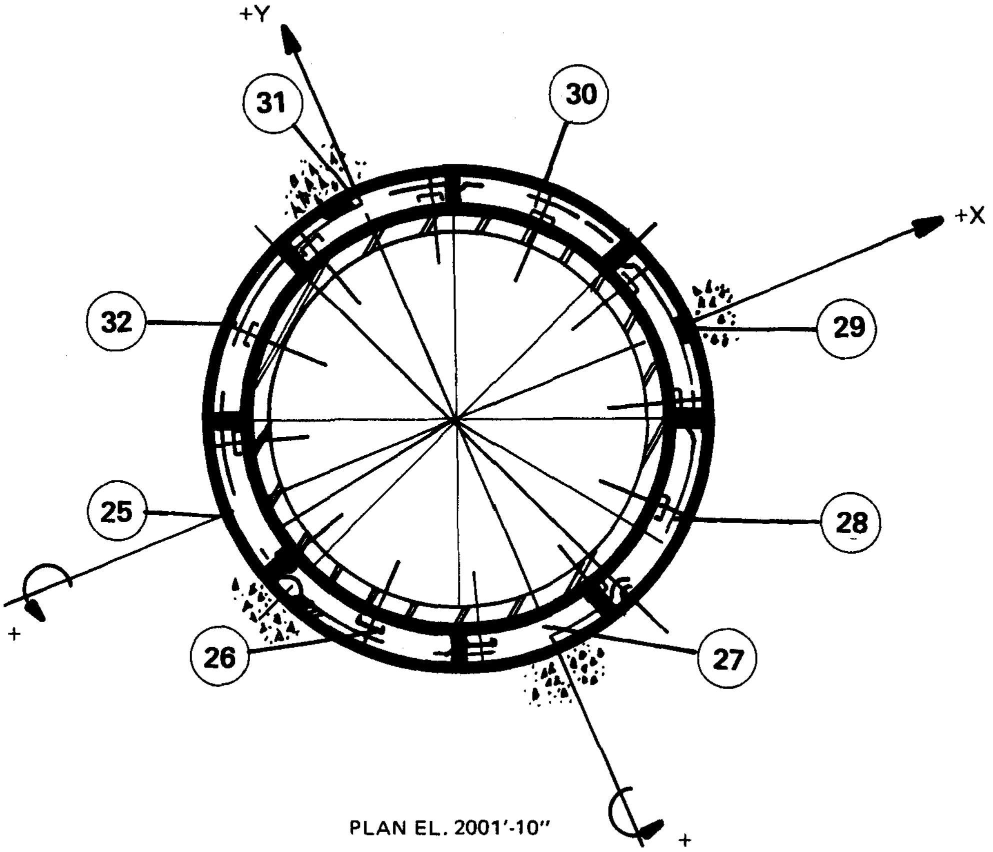

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FIGURE 6.2.1-32

REACTOR CAVITY ANALYSIS
NODALIZATION SCHEME - LEVEL 5

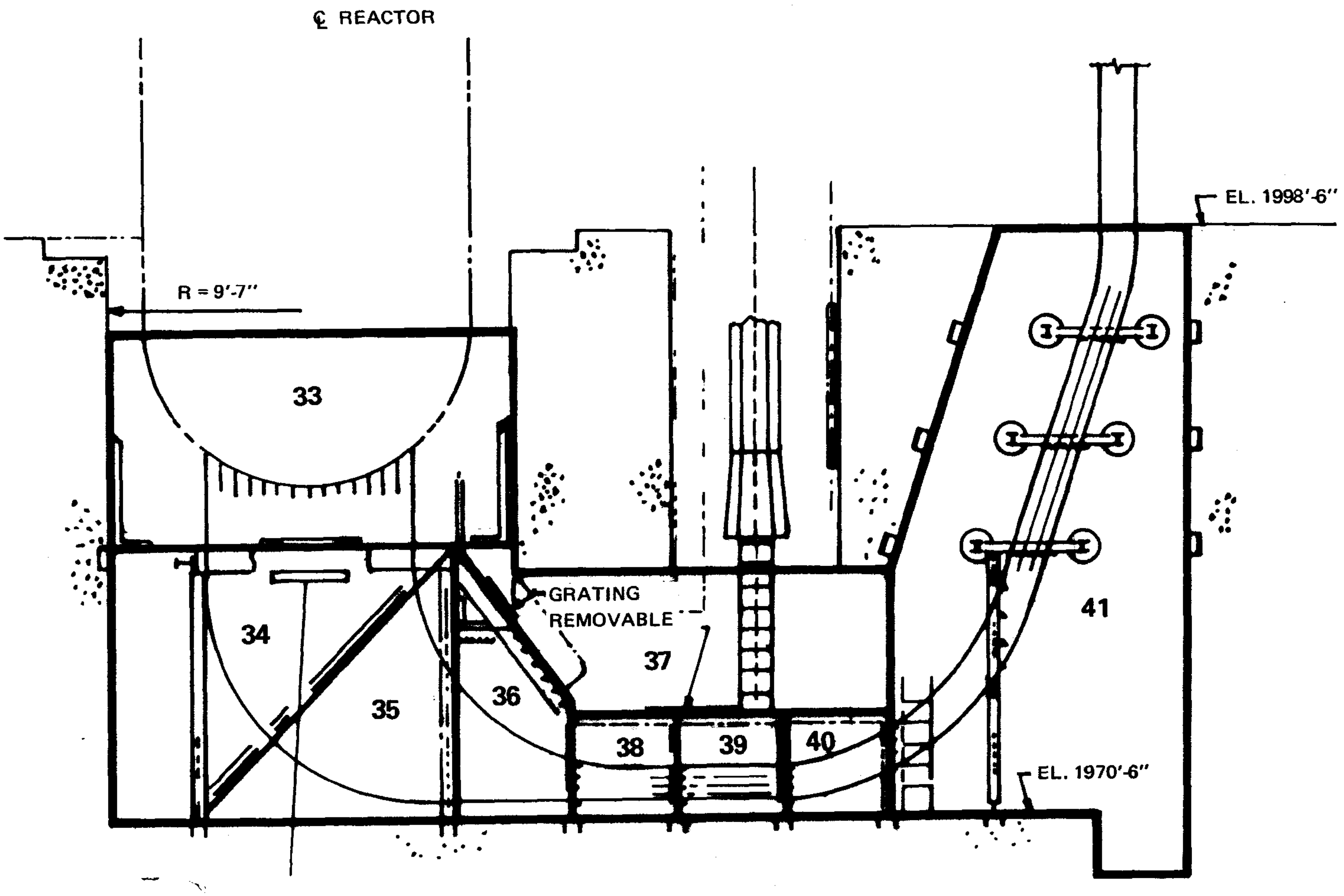

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FIGURE 6.2.1-33

ELEVATION ON ℄ REACTOR BLDG., NODALIZATION SCHEME FOR COMPARTMENT LEVEL 6

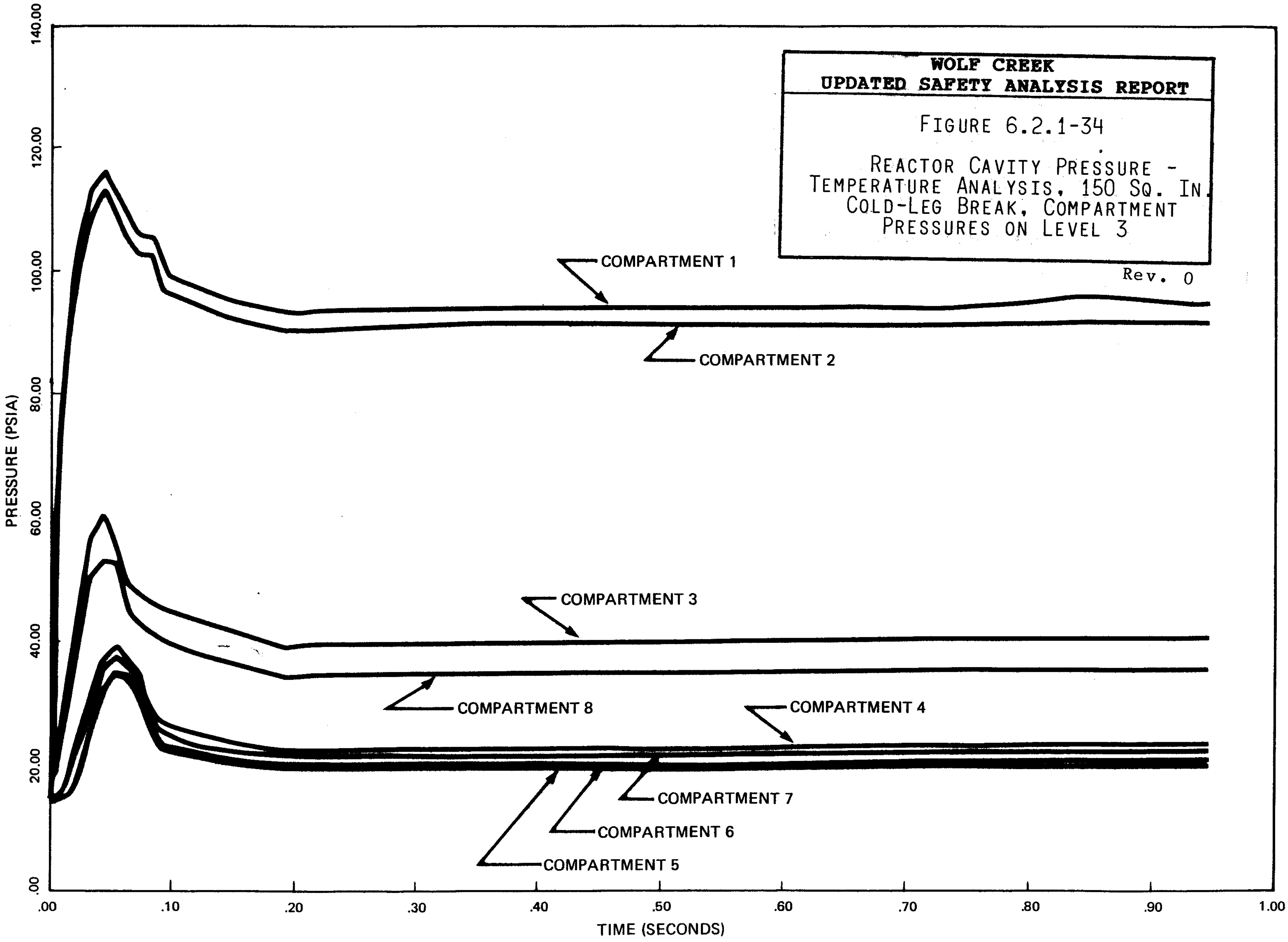

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FIGURE 6.2.1-34

REACTOR CAVITY PRESSURE - TEMPERATURE ANALYSIS, 150 SQ. IN. COLD-LEG BREAK, COMPARTMENT PRESSURES ON LEVEL 3

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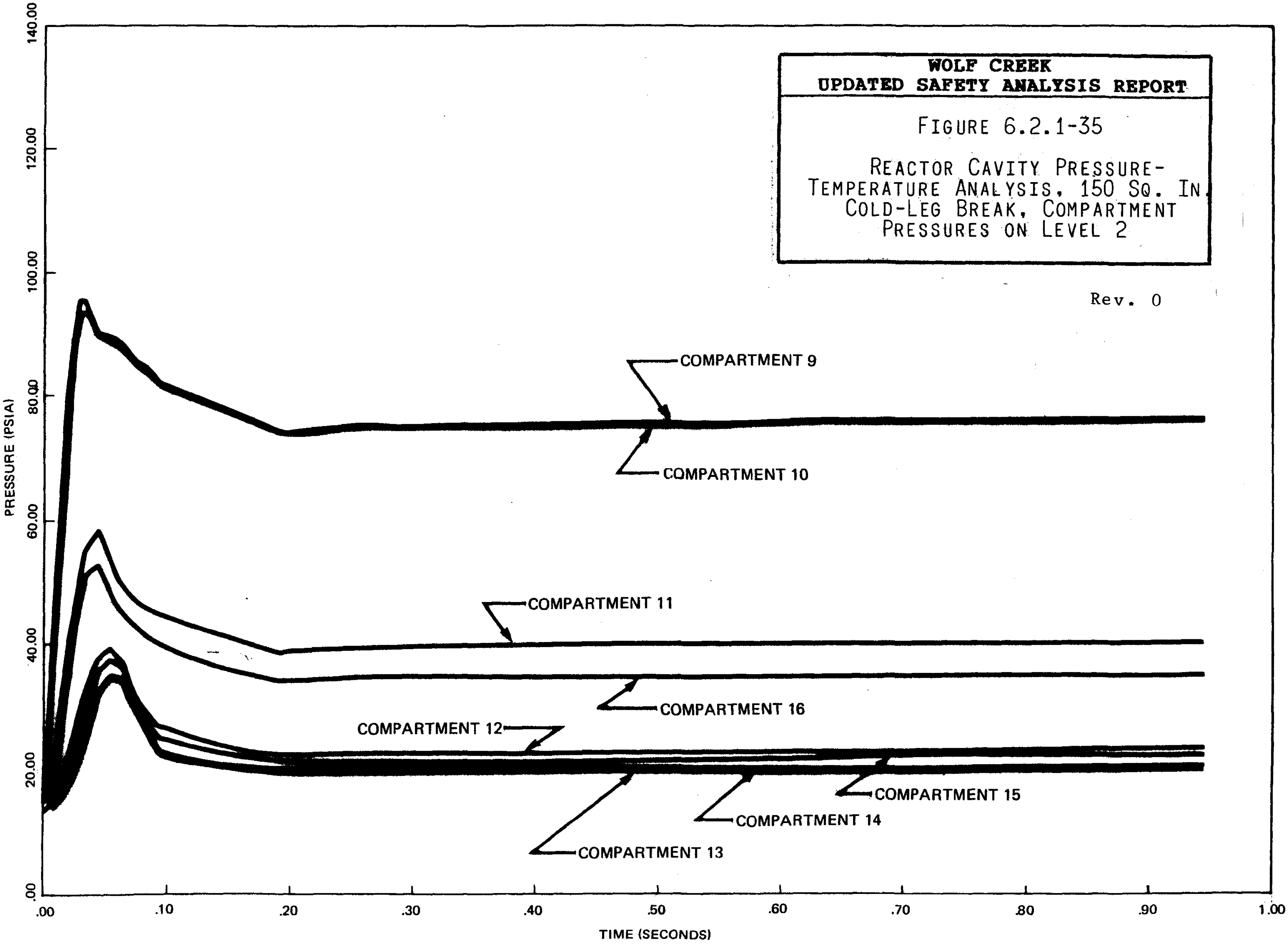

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FIGURE 6.2.1-35

REACTOR CAVITY PRESSURE-TEMPERATURE ANALYSIS, 150 SQ. IN. COLD-LEG BREAK, COMPARTMENT PRESSURES ON LEVEL 2

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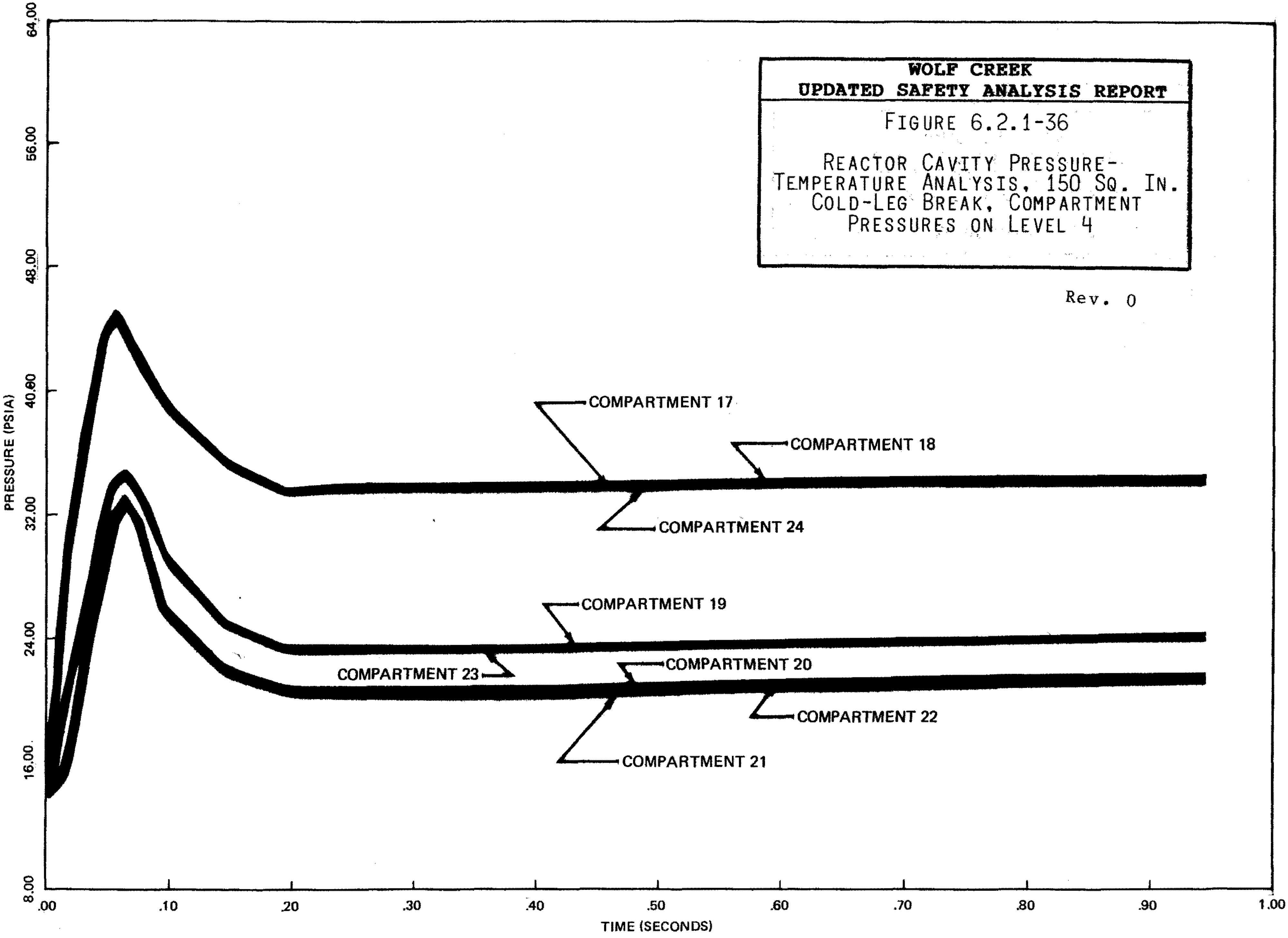

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FIGURE 6.2.1-36

REACTOR CAVITY PRESSURE-TEMPERATURE ANALYSIS, 150 SQ. IN. COLD-LEG BREAK, COMPARTMENT PRESSURES ON LEVEL 4

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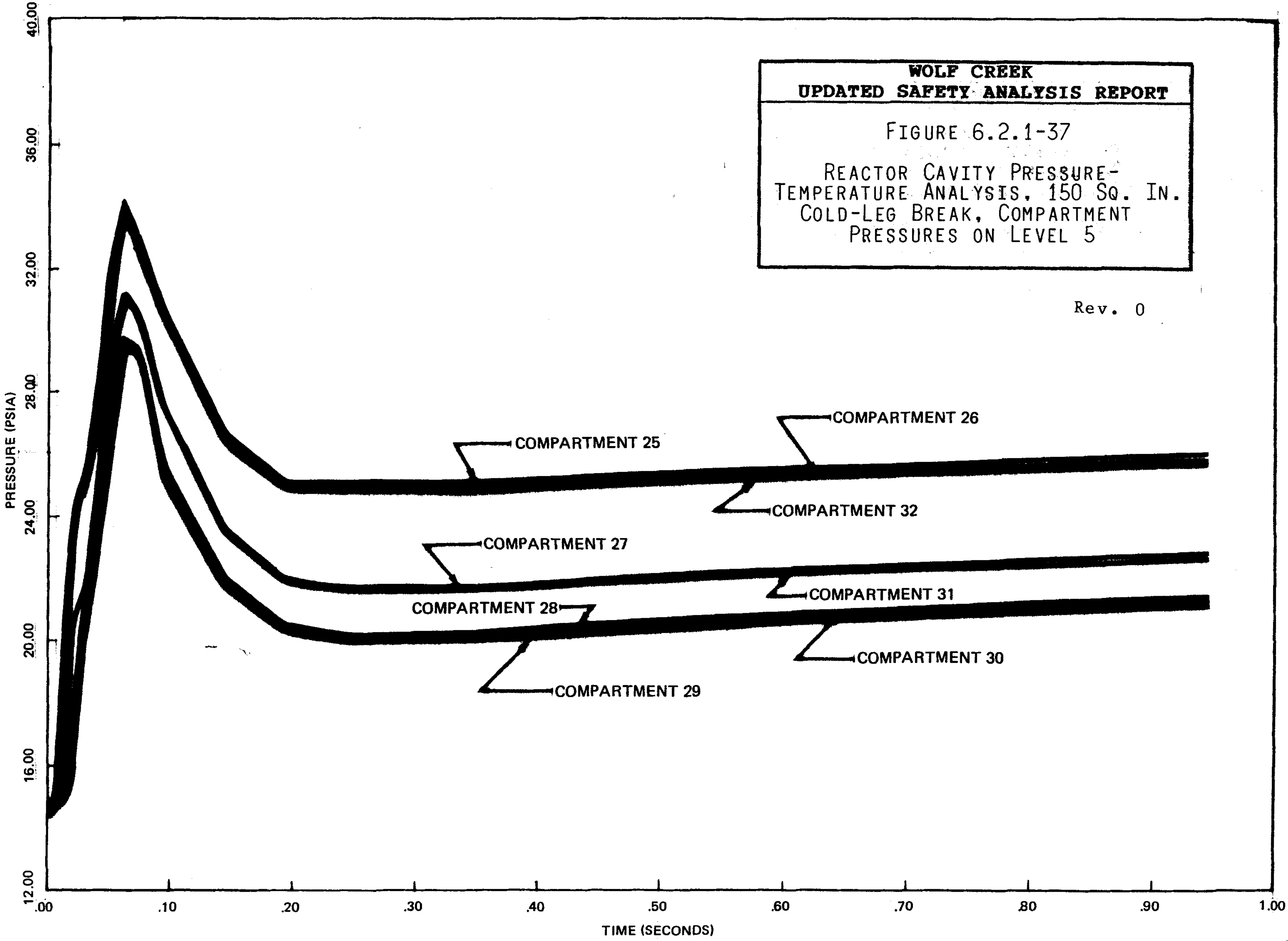

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FIGURE 6.2.1-37

REACTOR CAVITY PRESSURE-TEMPERATURE ANALYSIS, 150 SQ. IN. COLD-LEG BREAK, COMPARTMENT PRESSURES ON LEVEL 5

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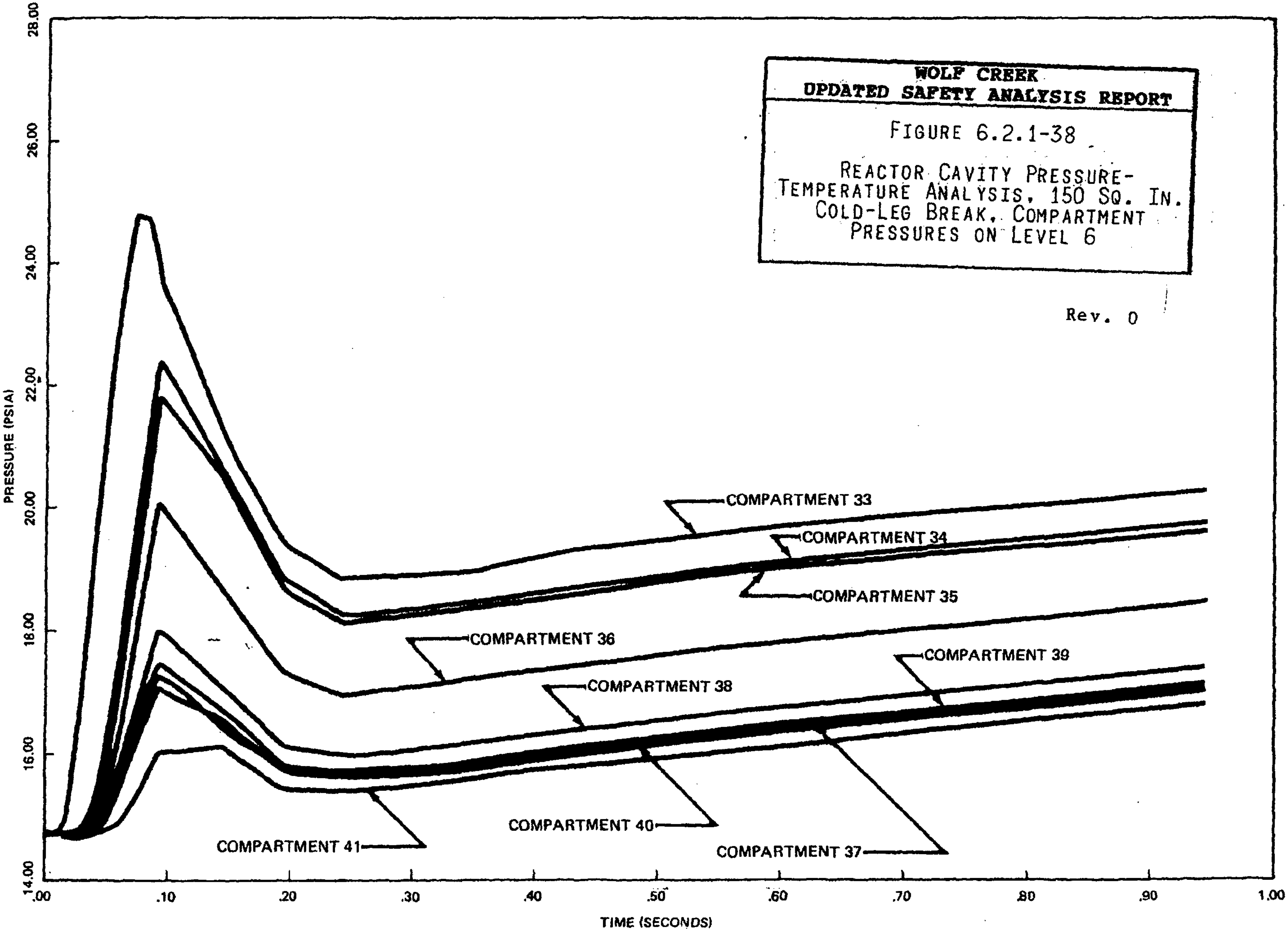

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FIGURE 6.2.1-38

REACTOR CAVITY PRESSURE-TEMPERATURE ANALYSIS, 150 SQ. IN. COLD-LEG BREAK, COMPARTMENT PRESSURES ON LEVEL 6

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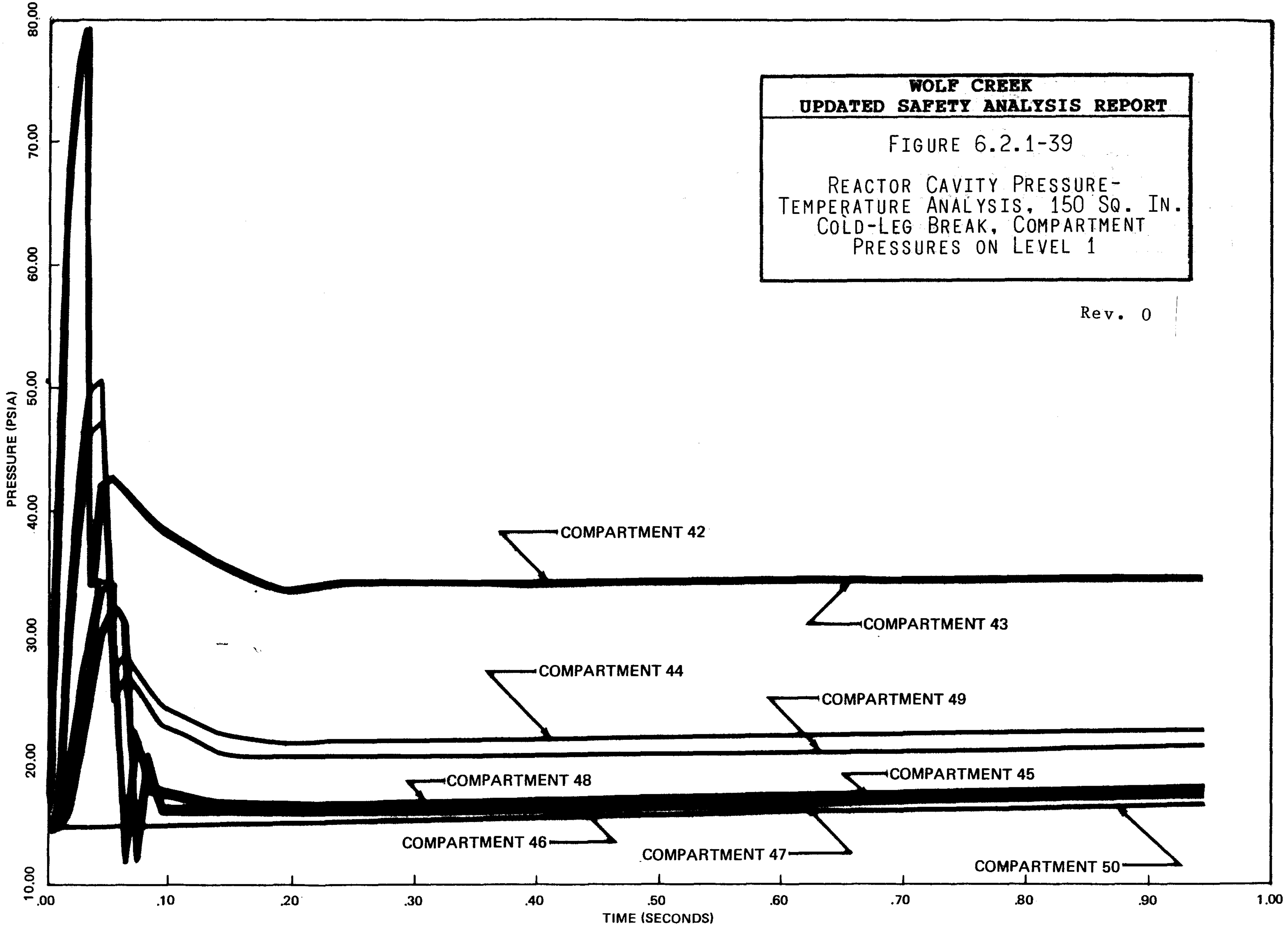

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FIGURE 6.2.1-39

REACTOR CAVITY PRESSURE-TEMPERATURE ANALYSIS, 150 SQ. IN. COLD-LEG BREAK, COMPARTMENT PRESSURES ON LEVEL 1

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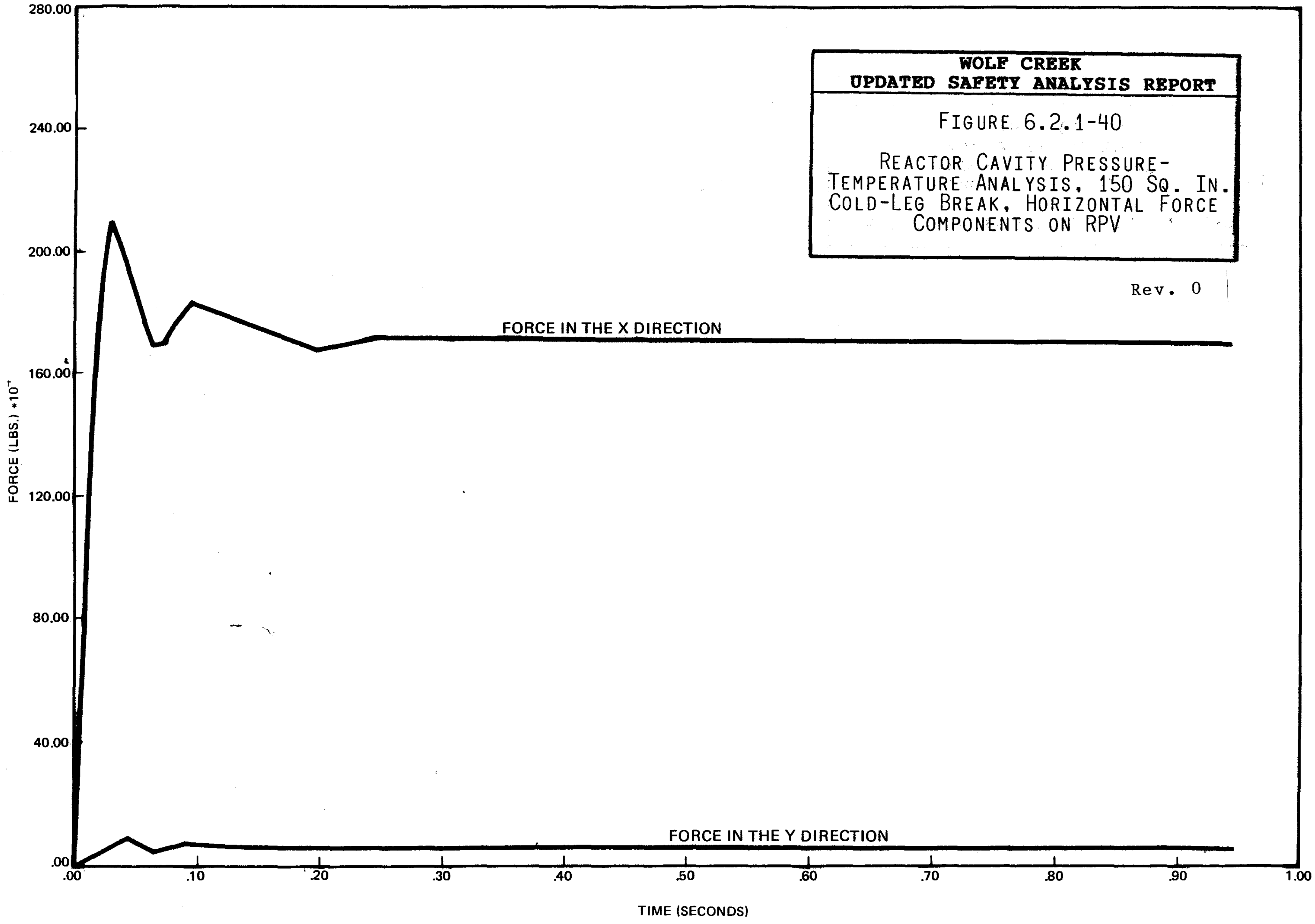

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FIGURE 6.2.1-40

REACTOR CAVITY PRESSURE-
TEMPERATURE ANALYSIS, 150 SQ. IN.
COLD-LEG BREAK, HORIZONTAL FORCE
COMPONENTS ON RPV

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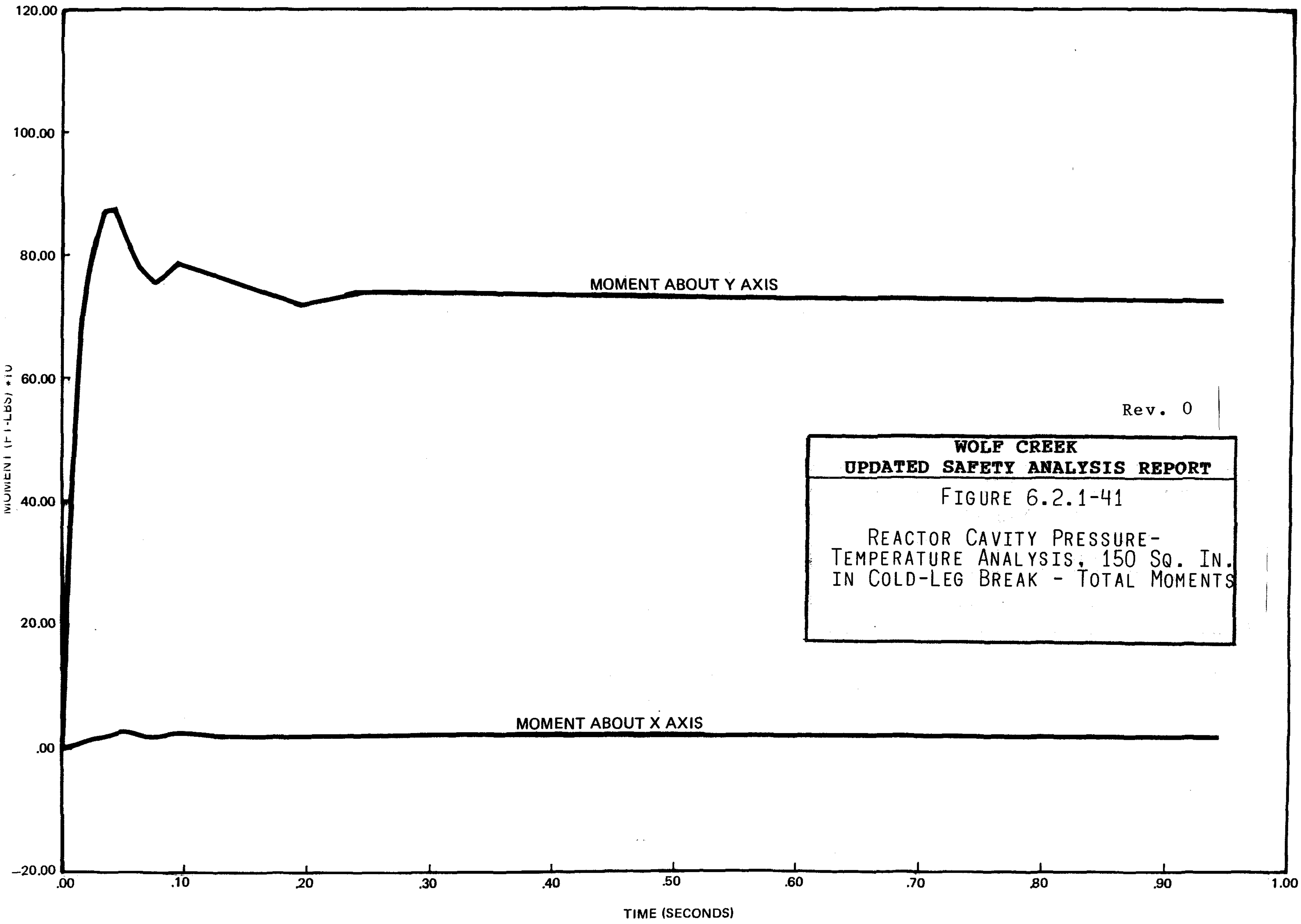

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FIGURE 6.2.1-41

REACTOR CAVITY PRESSURE-
TEMPERATURE ANALYSIS, 150 SQ. IN.
IN COLD-LEG BREAK - TOTAL MOMENTS

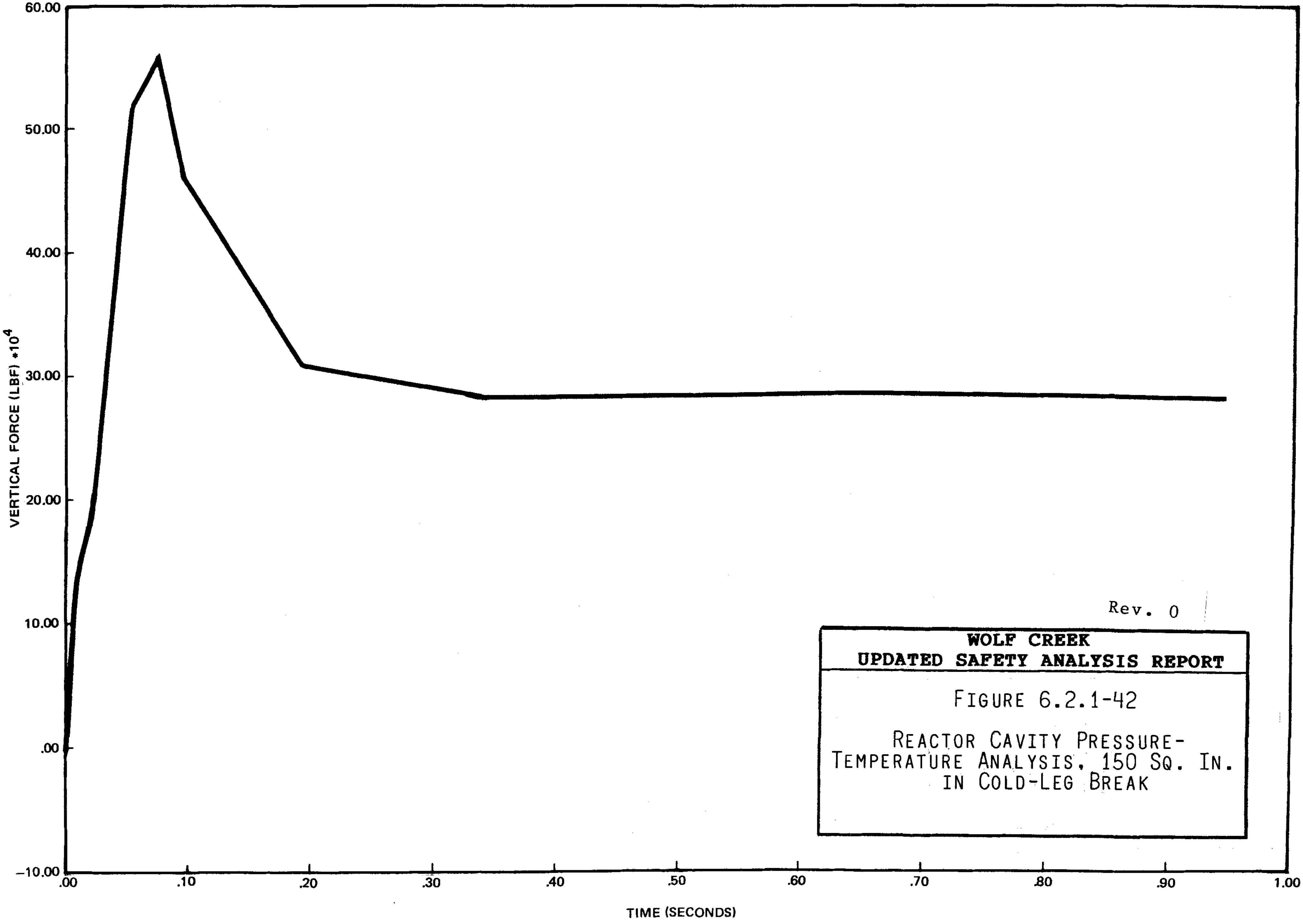

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FIGURE 6.2.1-42

REACTOR CAVITY PRESSURE-TEMPERATURE ANALYSIS, 150 SQ. IN. IN COLD-LEG BREAK

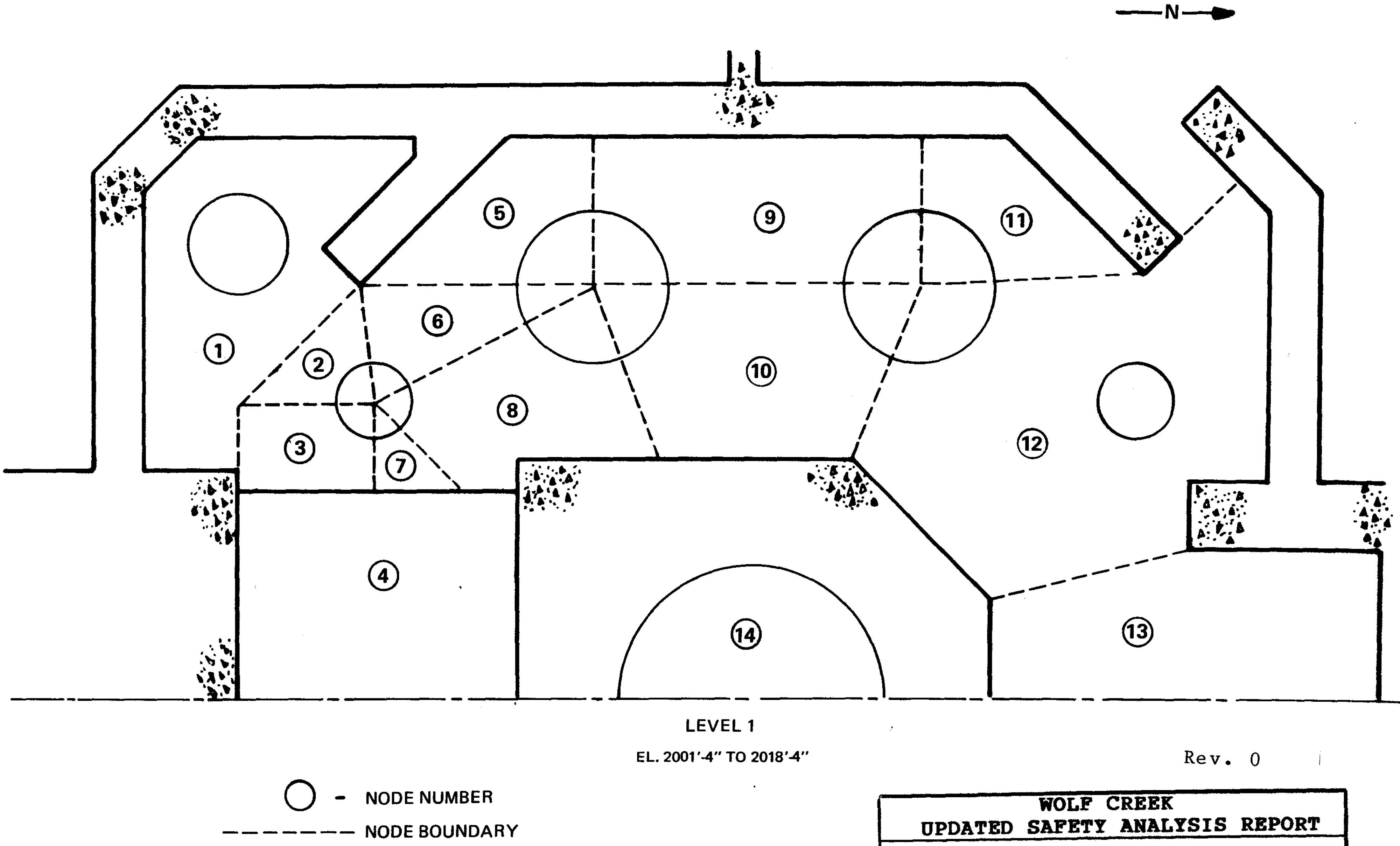

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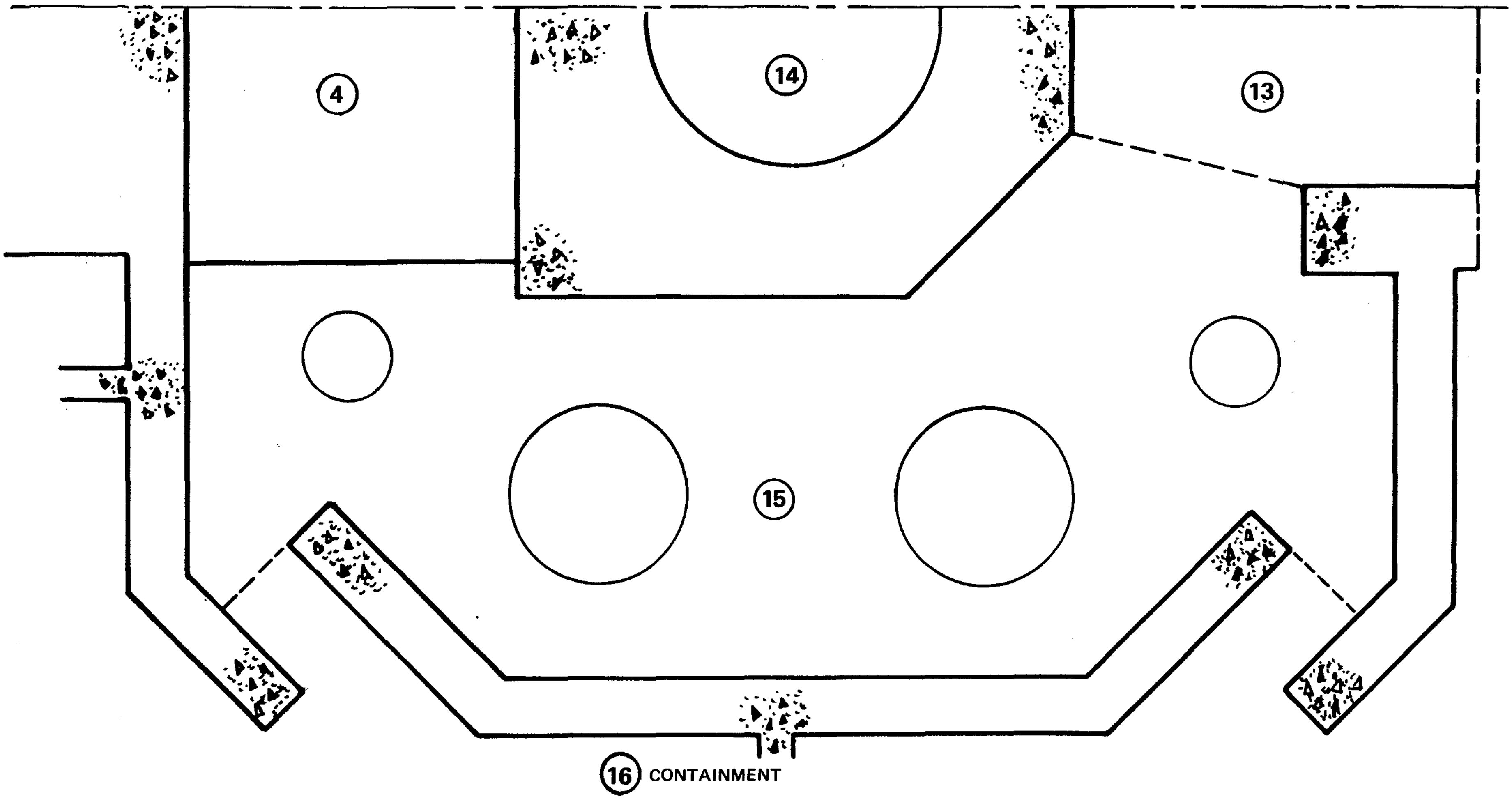
Figure 6.2.1-43

Steam Generator Loop Compartment Analysis, Nodalization Scheme - Level 1



LEVEL 1

EL. 2001'-4" TO 2018'-4"

○ NODE NUMBER

– – – – NODE BOUNDARY

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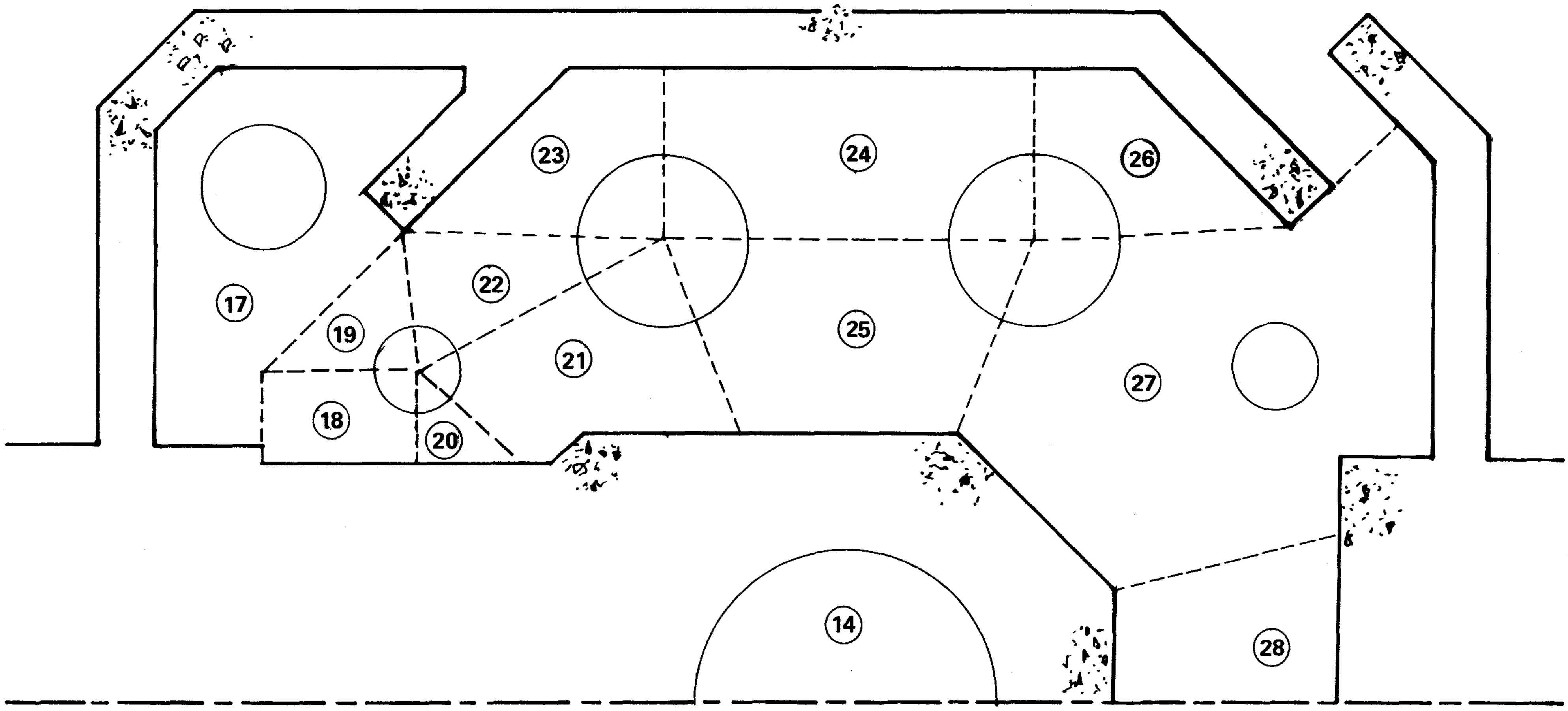
FIGURE 6.2.1-44

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS NODALIZATION SCHEME - LEVEL 1



LEVEL 2
EL. 2018'-4" TO 2025'-0"

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FIGURE 6.2.1-45

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, NODALIZATION SCHEME - LEVEL 2

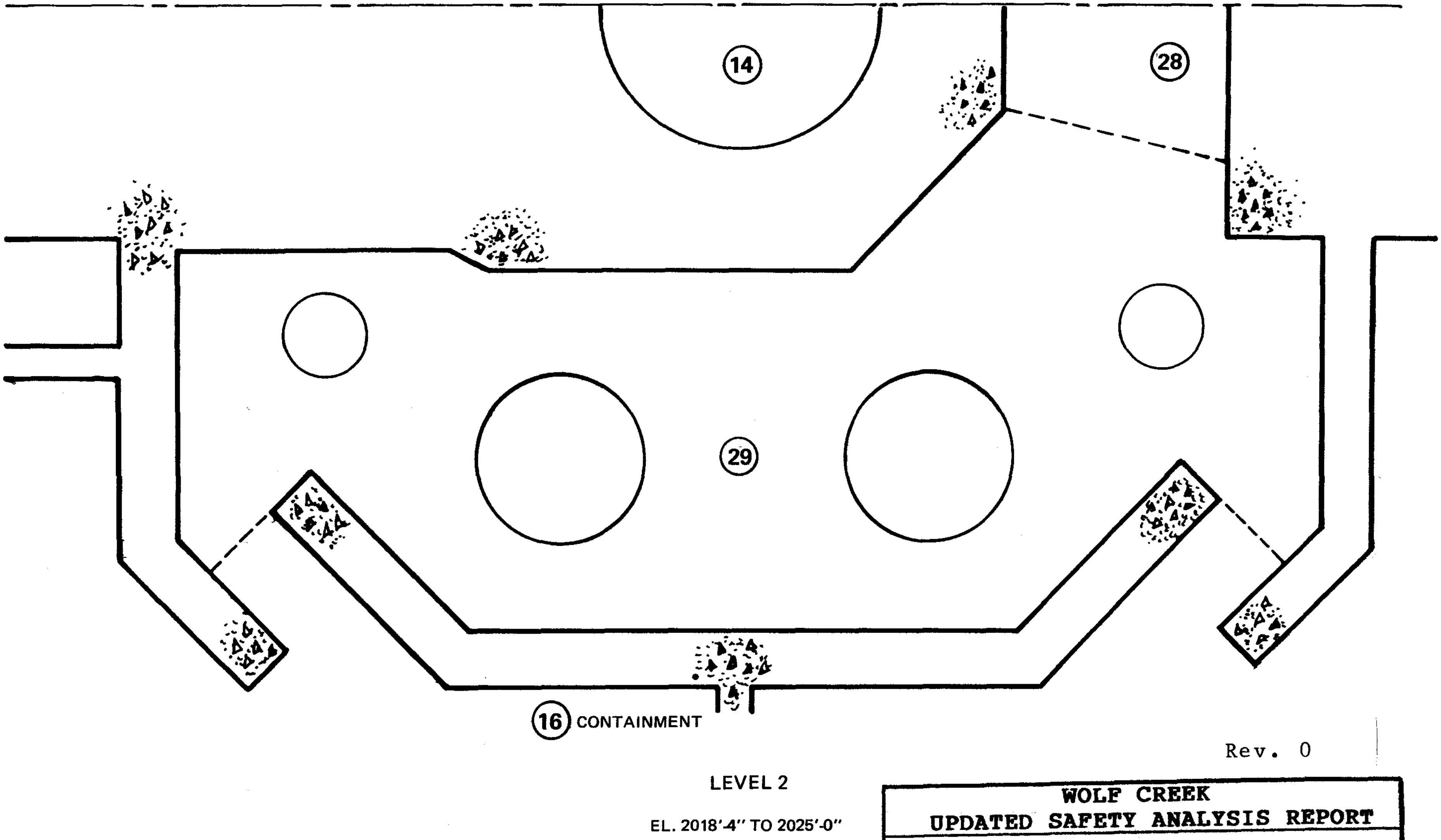

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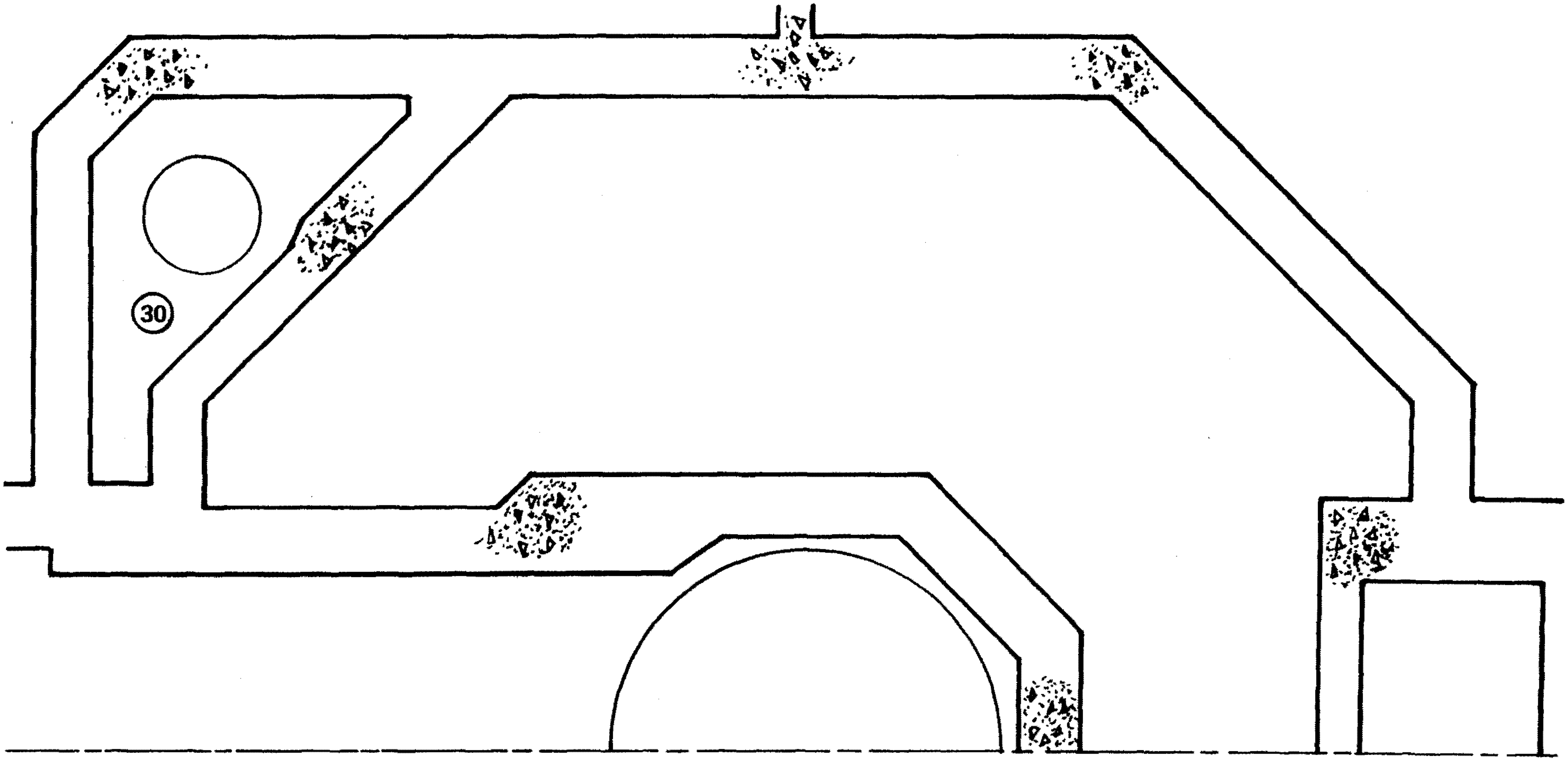
FIGURE 6.2.1-46

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, NODALIZATION SCHEME - LEVEL 2



LEVEL 2A
PRESSURIZER COMPT. ONLY

EL. 2025'-0" TO 2029'-6 1/4"

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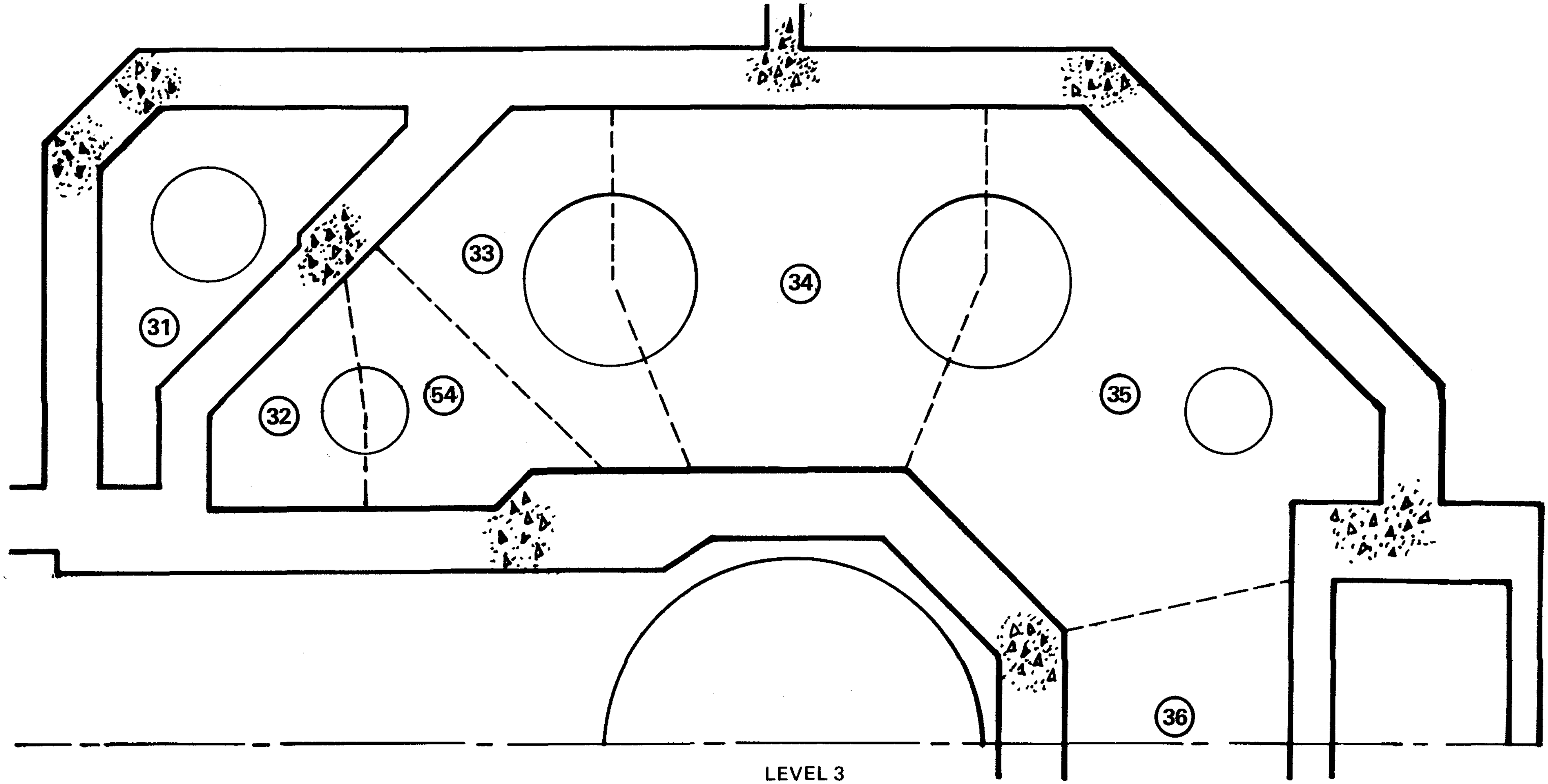
FIGURE 6.2.1-47

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, NODALIZATION SCHEME - LEVEL 2A



LEVEL 3

EL. 2025'0" TO 2045'6"

(EL. 2029'-6 1/4" TO 2044'-6" IN PRESSURIZER COMPT.)

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FIGURE 6.2.1-48

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, NODALIZATION SCHEME - LEVEL 3

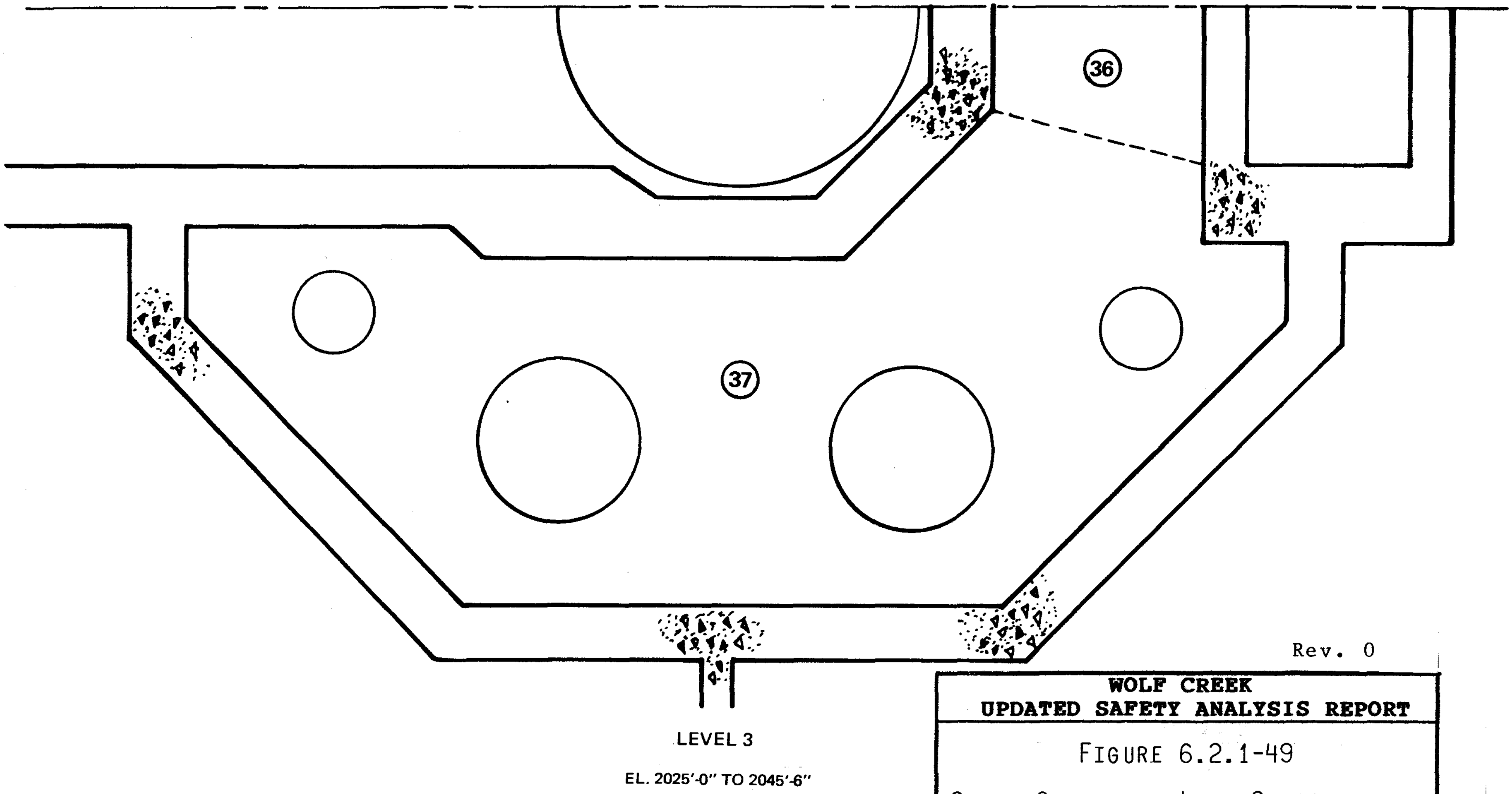

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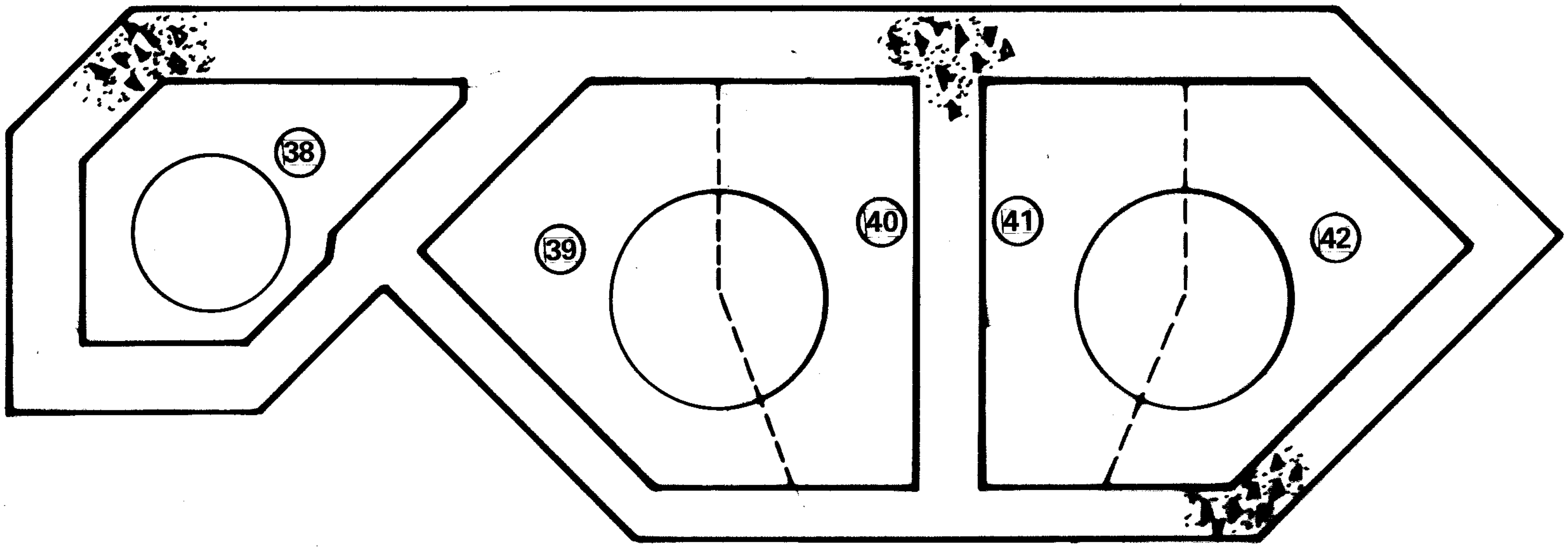
FIGURE 6.2.1-49

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, NODALIZATION SCHEME - LEVEL 3



LEVEL 4

EL. 2045'-6" TO 2060'-0"

(EL. 2044'-6" TO 2060'-0" IN PRESSURIZER COMPT.)

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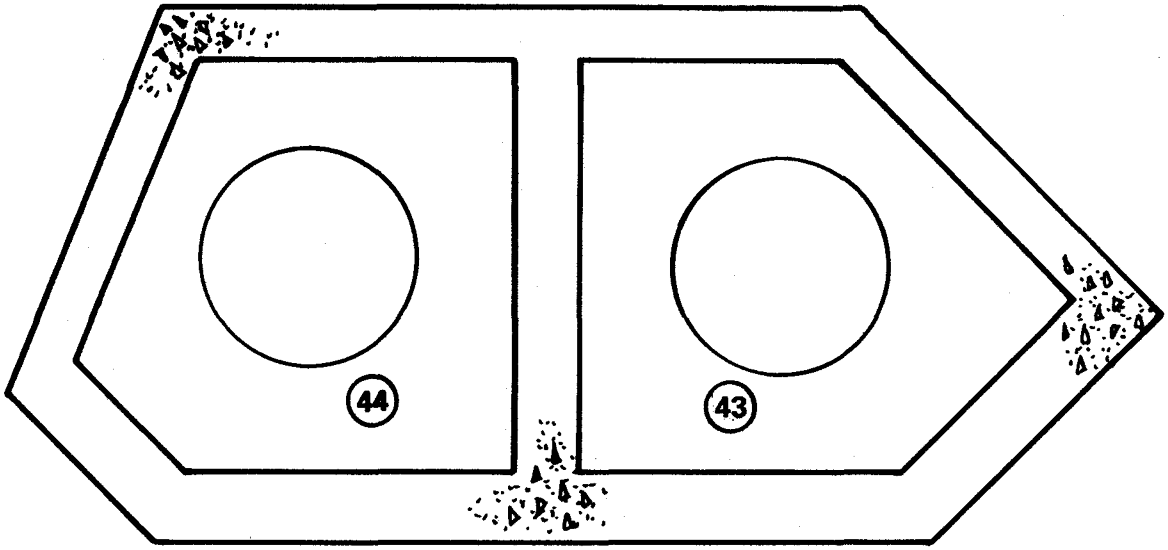
Figure 6.2.1-50

Steam Generator Loop
Compartment Analysis

Nodalization Scheme - Level 4



LEVEL 4

EL. 2045'-6" TO 2060'-0"

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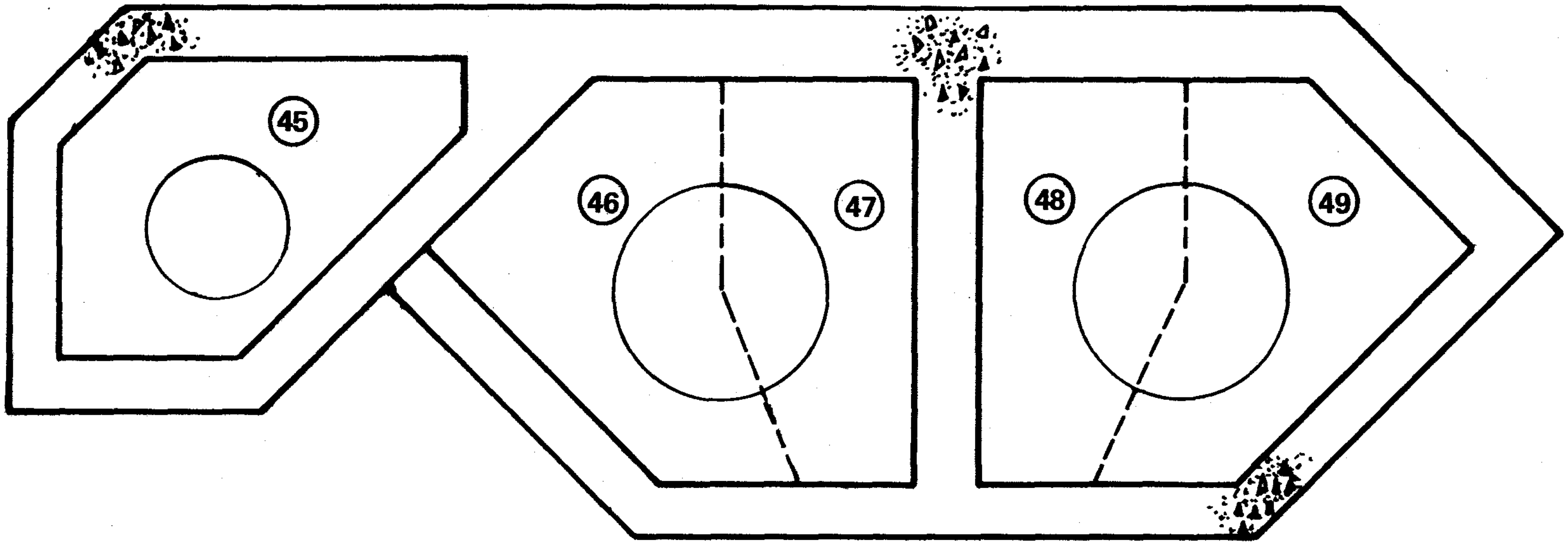
FIGURE 6.2.1-51

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, NODALIZATION SCHEME - LEVEL 4



LEVEL 5

EL. 2060'-0" TO 2068'-8"

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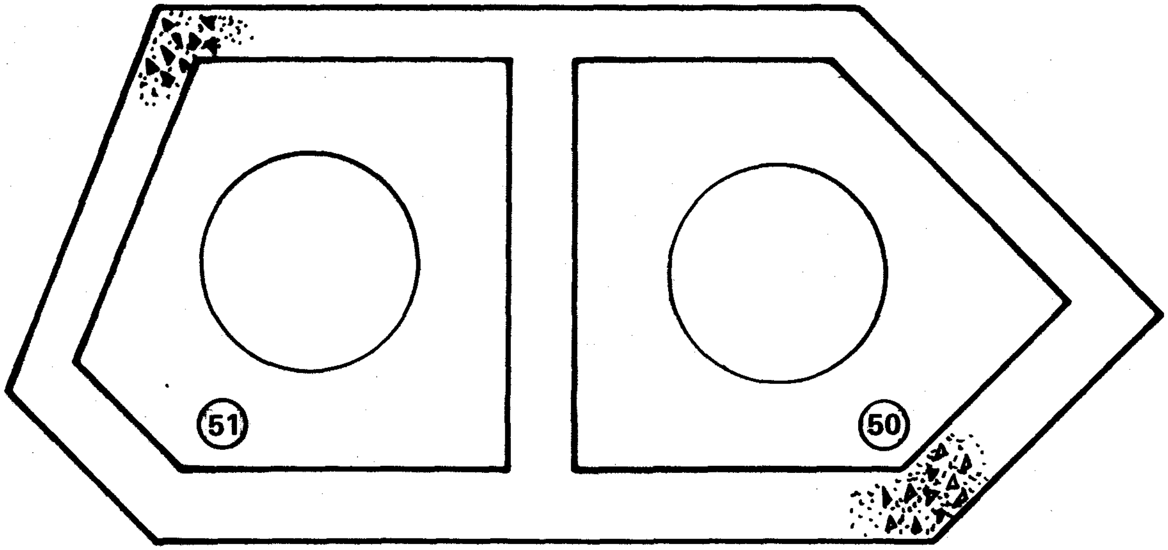
FIGURE 6.2.1-52

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, NODALIZATION SCHEME - LEVEL 5



LEVEL 5

EL. 2060'-0" TO 2068'-8"

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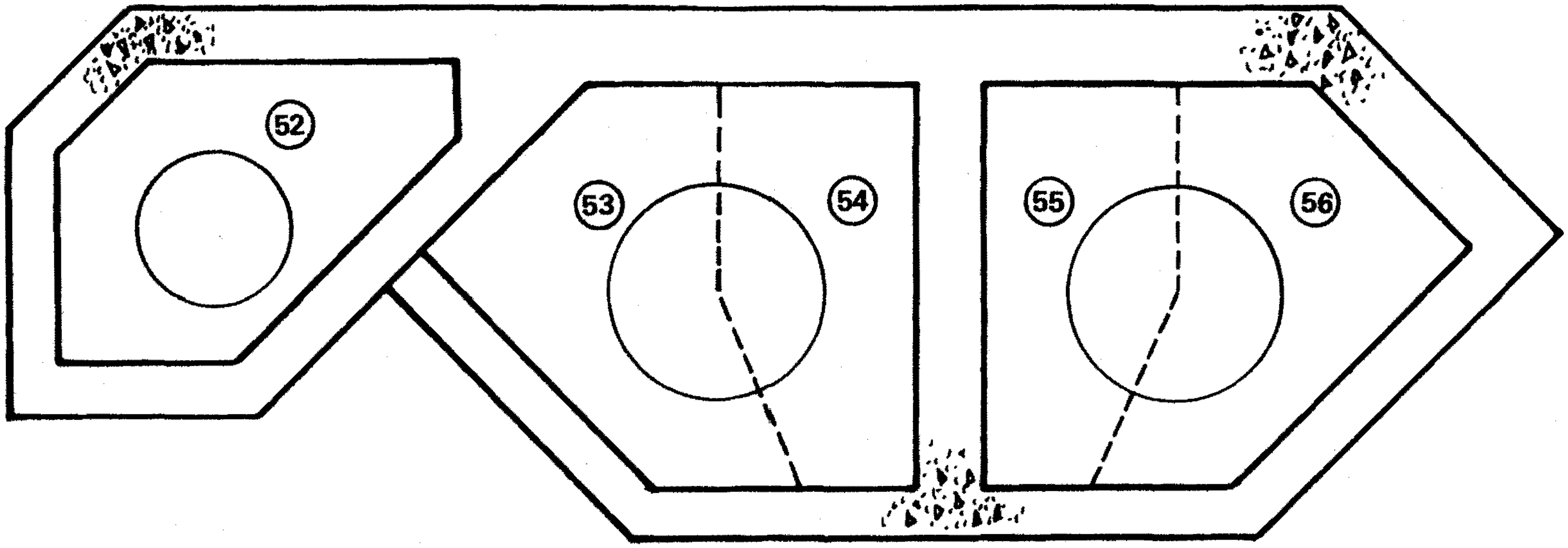
FIGURE 6.2.1-53

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, NODALIZATION SCHEME - LEVEL 5



LEVEL 6

EL. 2068'-8" TO 2086'-0 3/4"

(EL. 2068'8" TO 2090'4" IN PRESSURIZER COMPT.)

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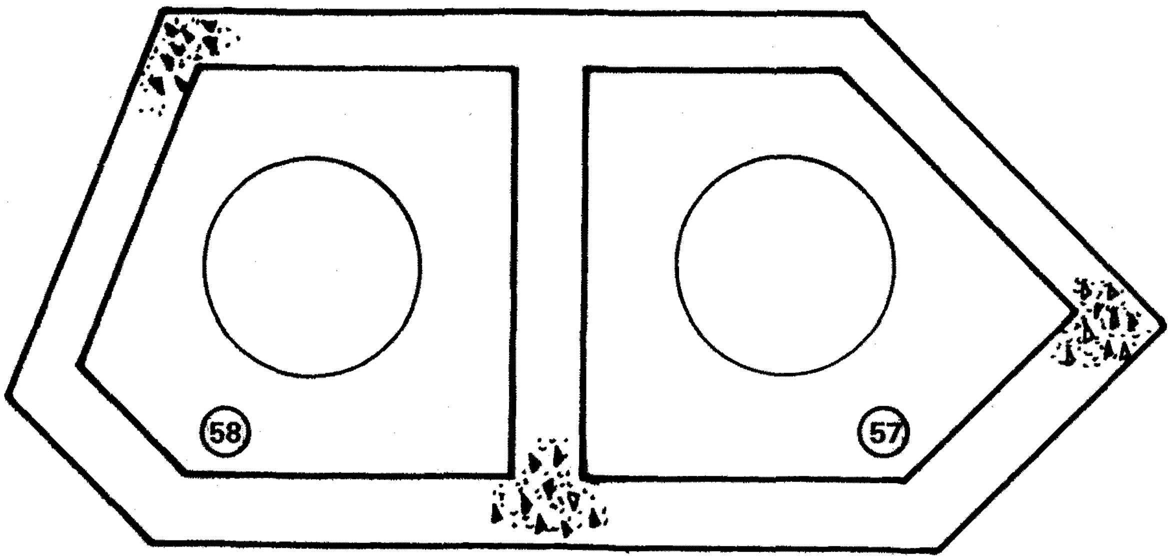
FIGURE 6.2-1-54

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, NODALIZATION SCHEME - LEVEL 6



LEVEL 6

EL. 2068'-8" TO 2086'-0 3/4"

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FIGURE 6.2.1-55

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, NODALIZATION SCHEME - LEVEL 6

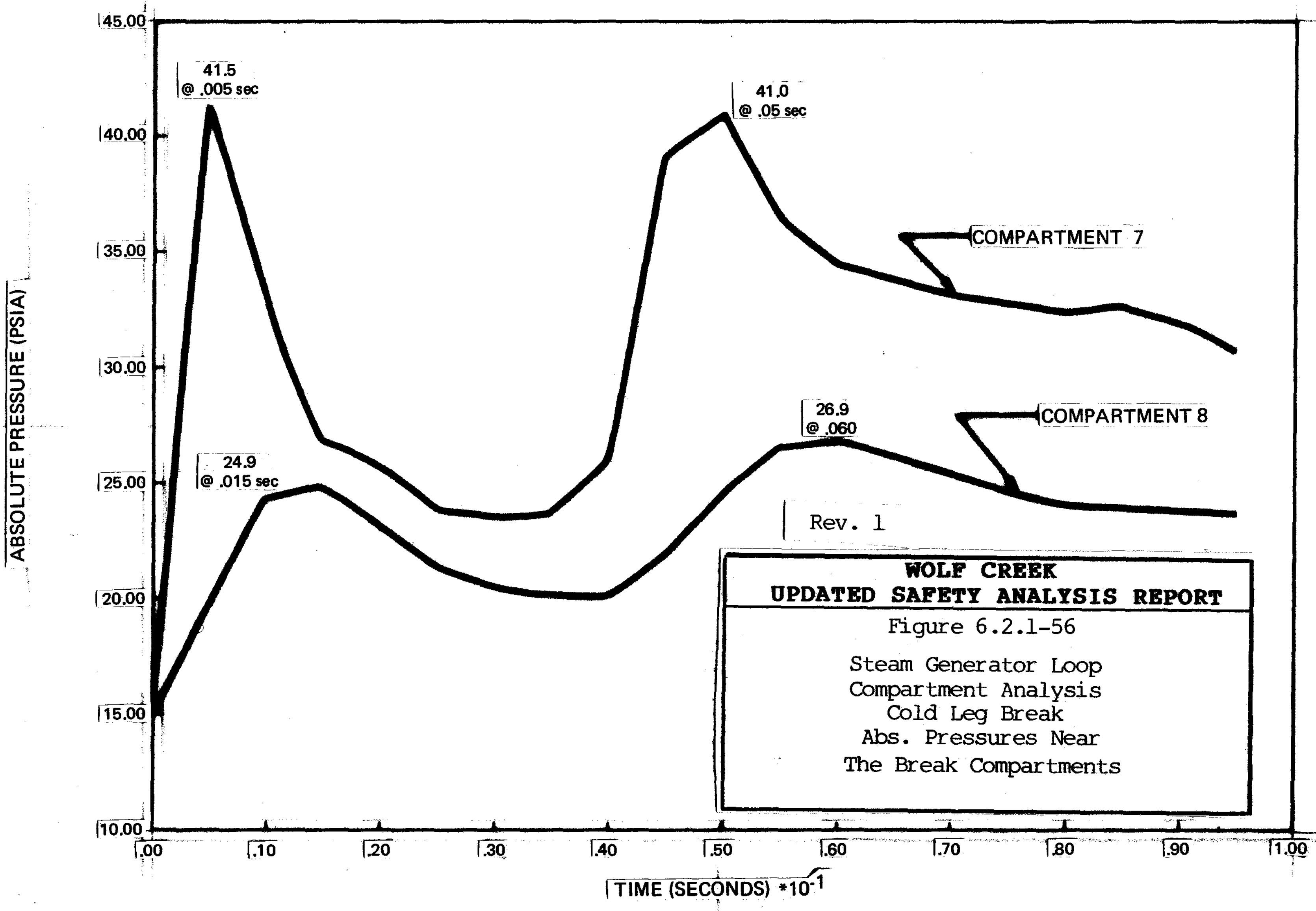

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Figure 6.2.1-56

Steam Generator Loop
Compartment Analysis
Cold Leg Break
Abs. Pressures Near
The Break Compartments

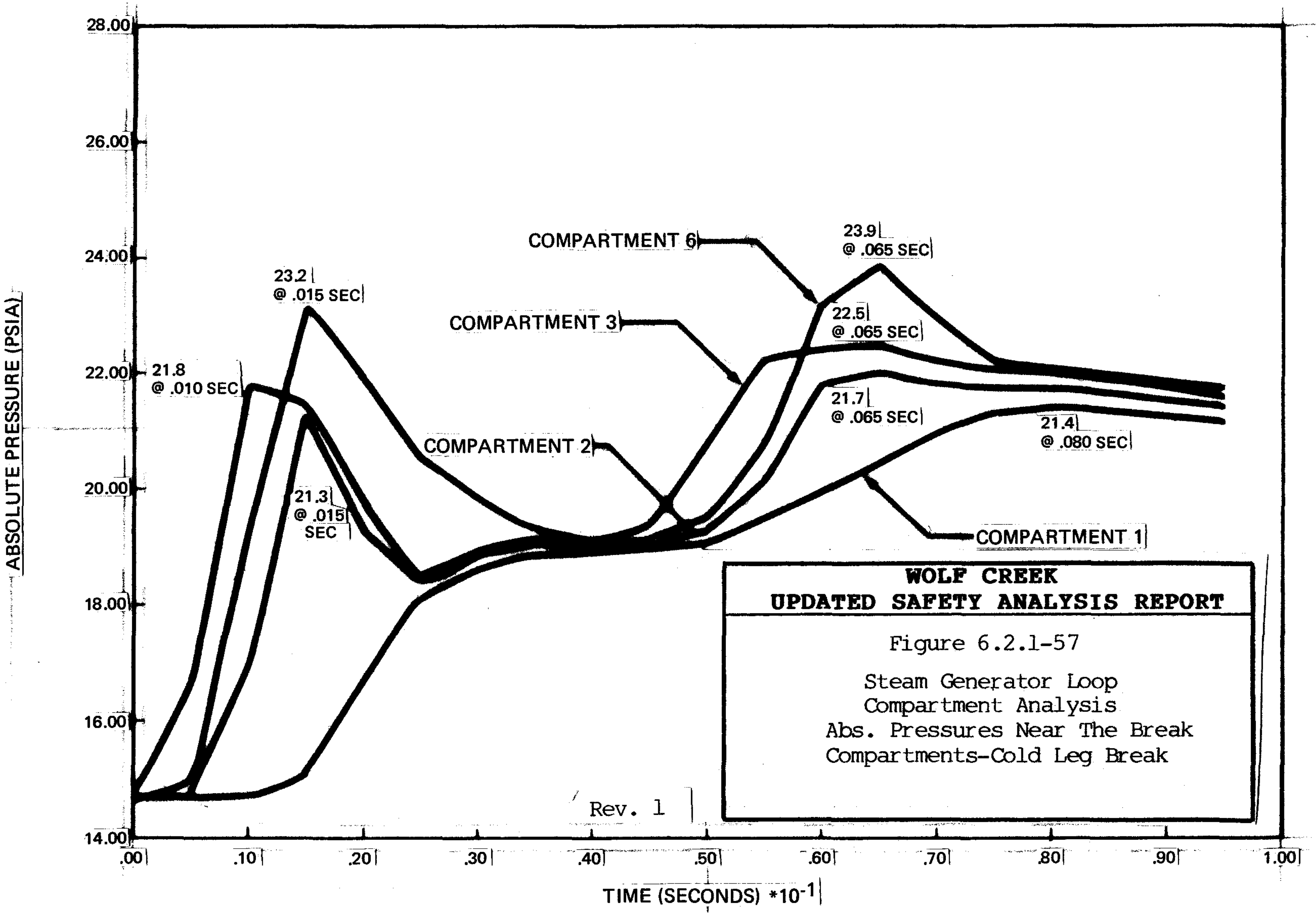

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Figure 6.2.1-57

Steam Generator Loop
Compartment Analysis
Abs. Pressures Near The Break
Compartments-Cold Leg Break

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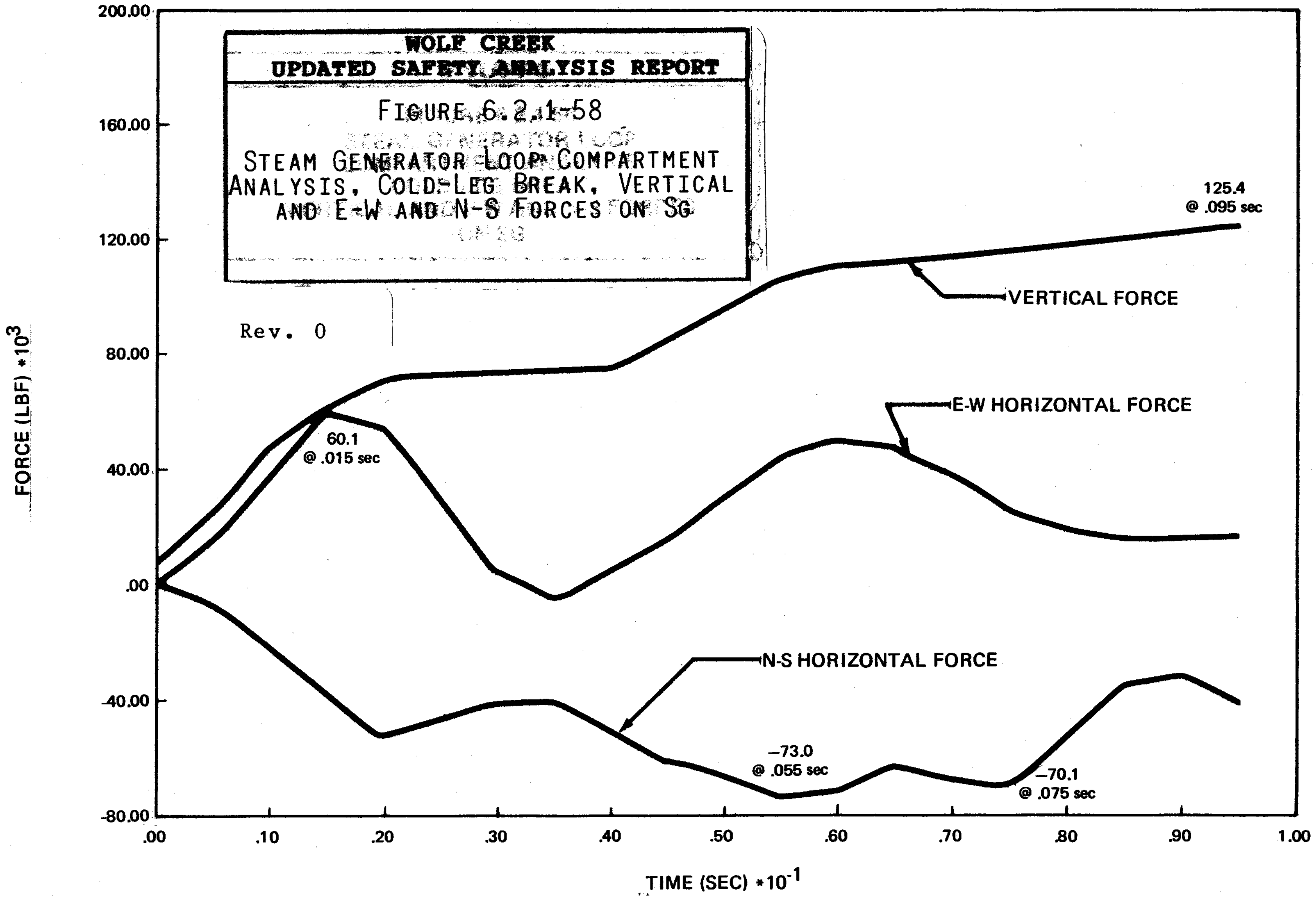

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FIGURE 6.2.1-58

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, COLD-LEG BREAK, VERTICAL AND E-W AND N-S FORCES ON SG

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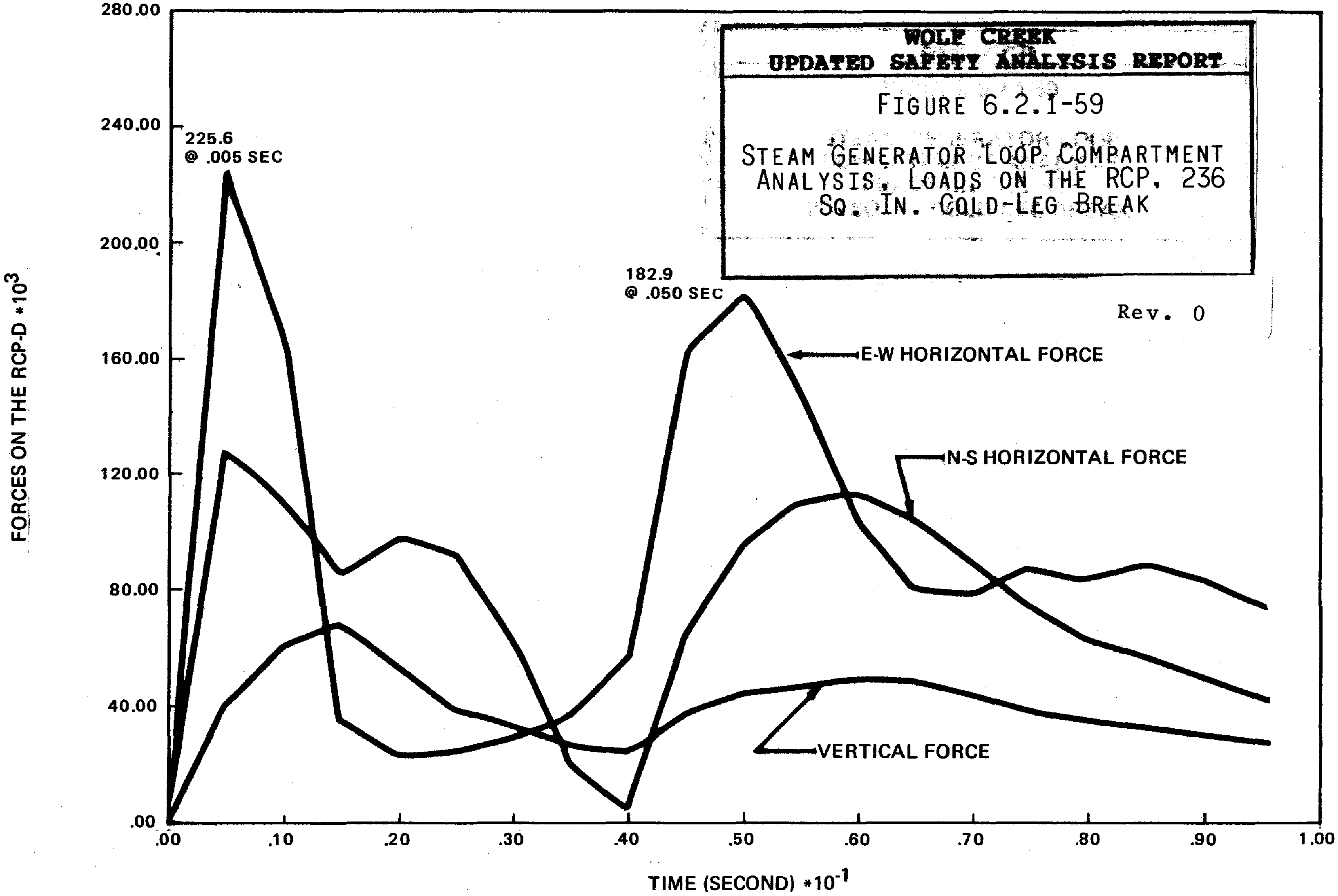

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FIGURE 6.2.1-59

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, LOADS ON THE RCP, 236 SQ. IN. COLD-LEG BREAK

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Figure 6.2.1-60

Steam Generator Loop Compartment Analysis, 236 in.^{2} Cold Leg Break Direction of Peak Horizontal Forces on Reactor Coolant Pump and Steam Generator

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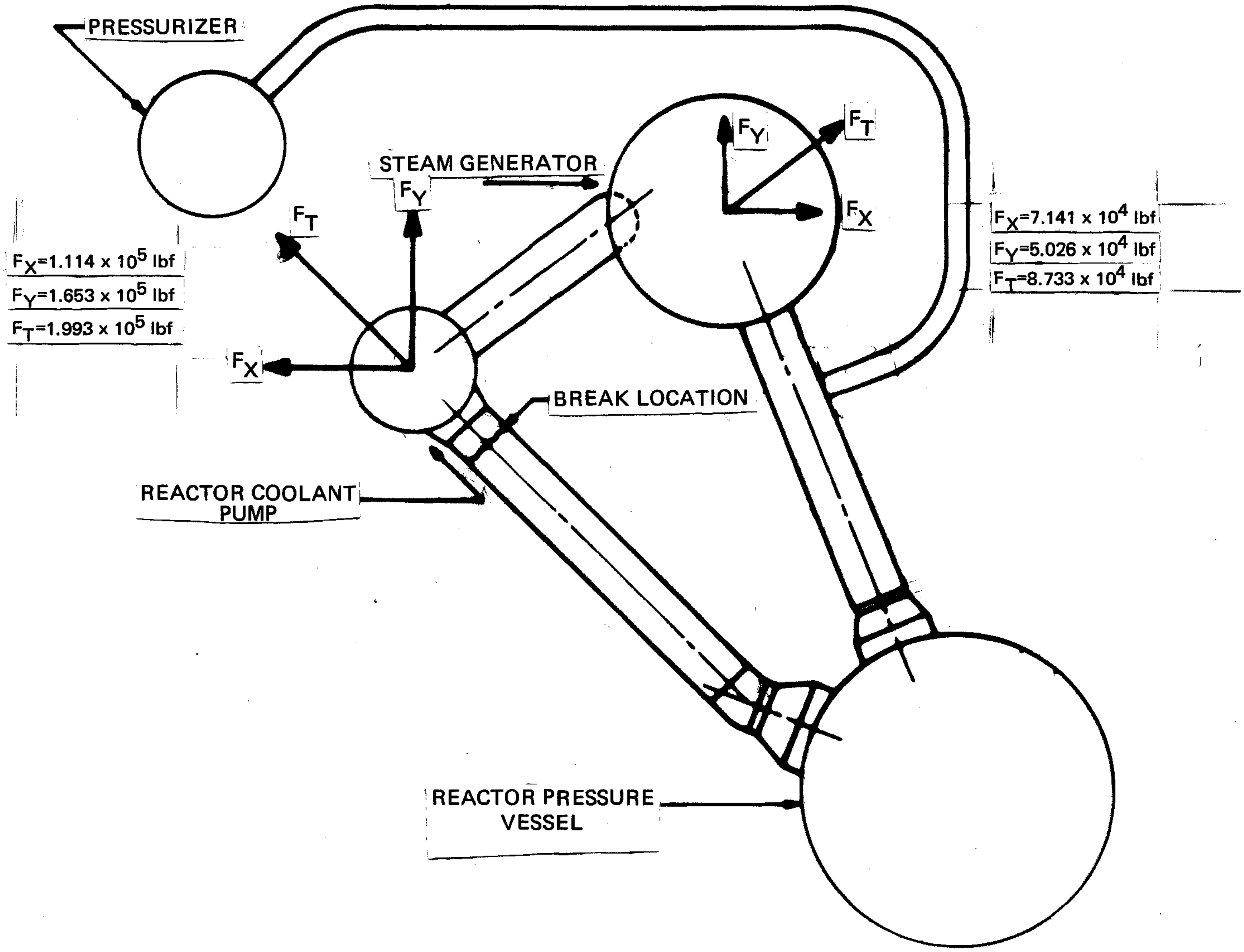

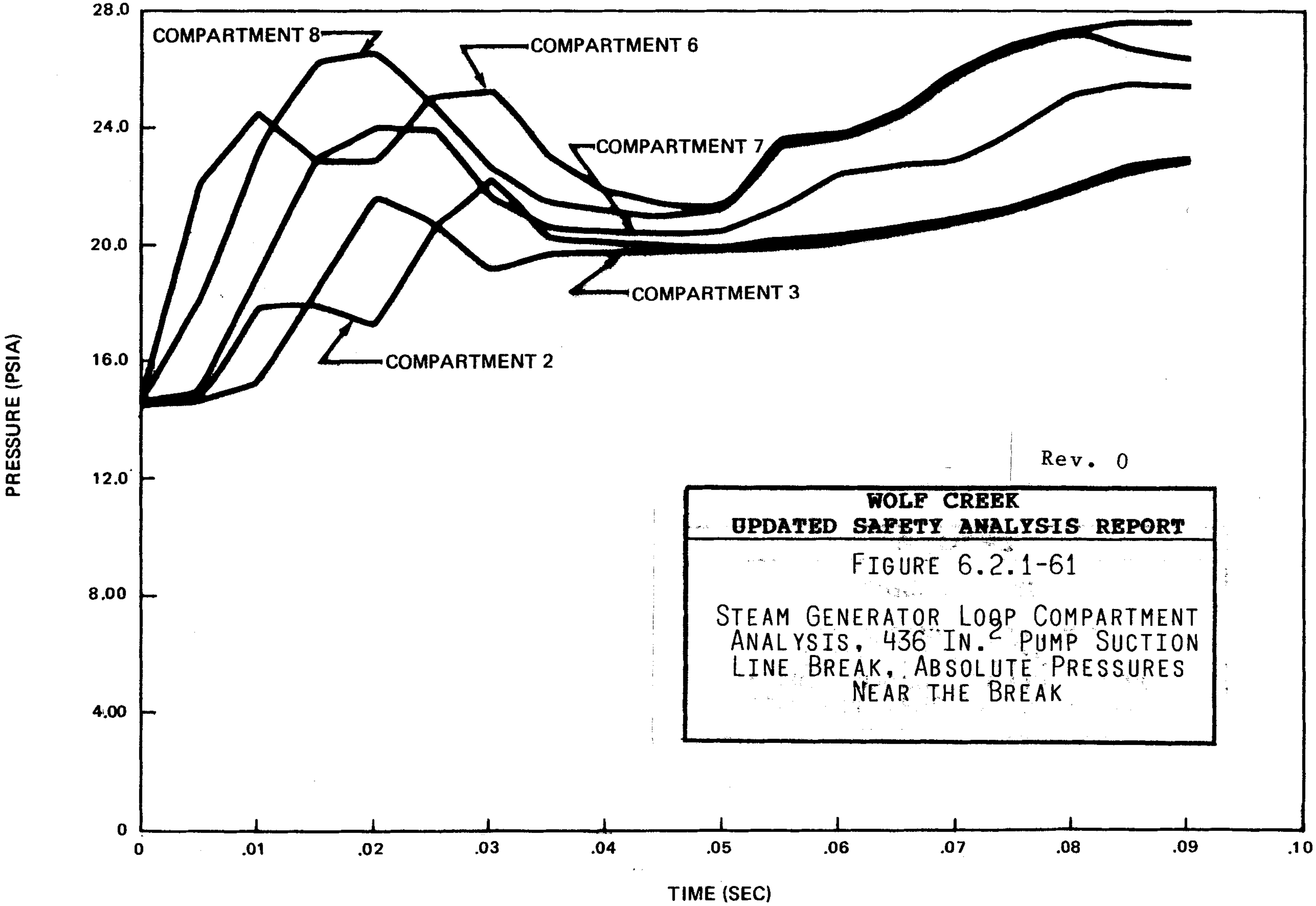

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FIGURE 6.2.1-61

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, 436 IN.^{2} PUMP SUCTION LINE BREAK, ABSOLUTE PRESSURES NEAR THE BREAK

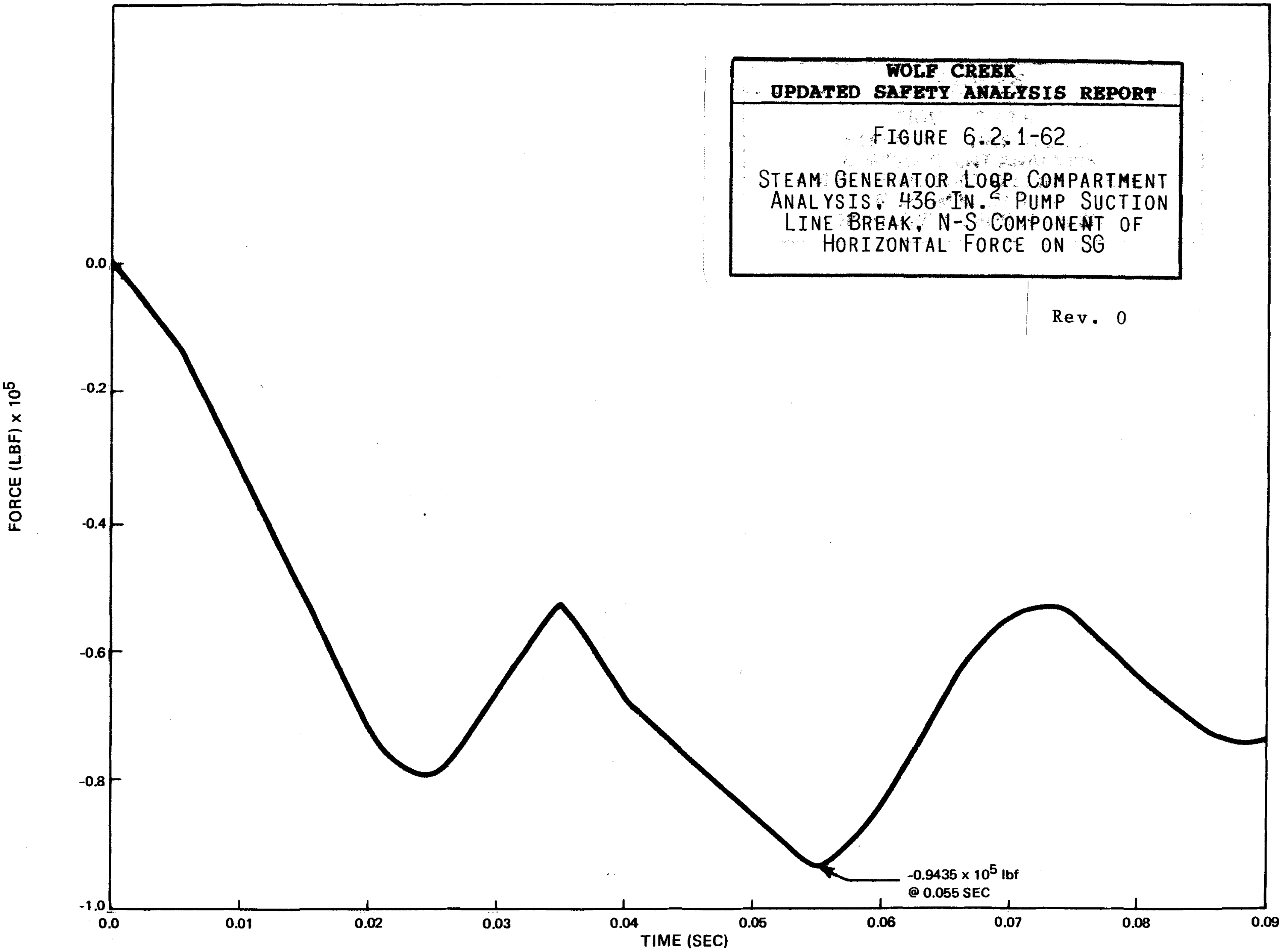

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FIGURE 6.2.1-62

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, 436 IN.^{2} PUMP SUCTION LINE BREAK, N-S COMPONENT OF HORIZONTAL FORCE ON SG

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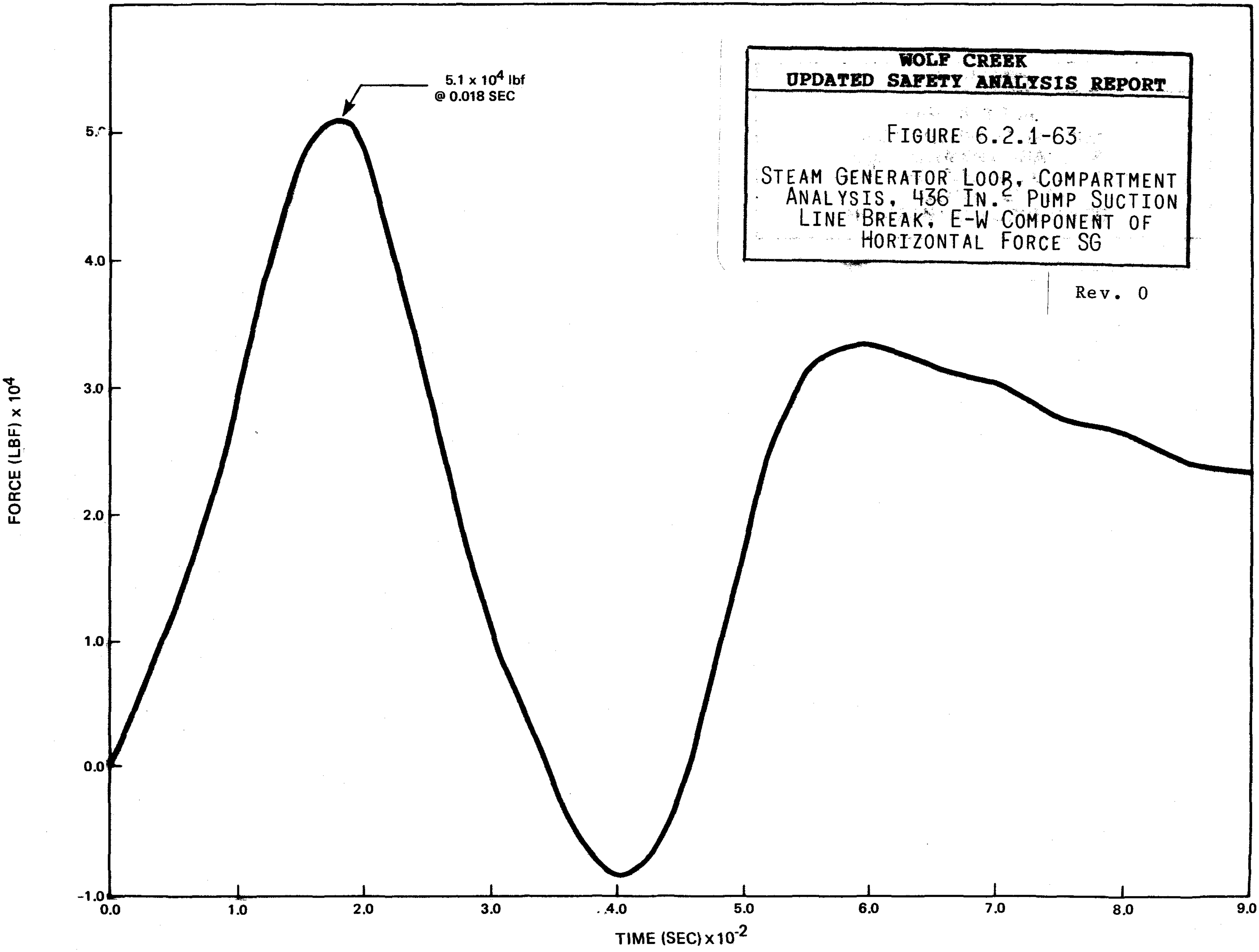

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FIGURE 6.2.1-63

STEAM GENERATOR LOOP, COMPARTMENT ANALYSIS, 436 IN.^{2} PUMP SUCTION LINE BREAK, E-W COMPONENT OF HORIZONTAL FORCE SG

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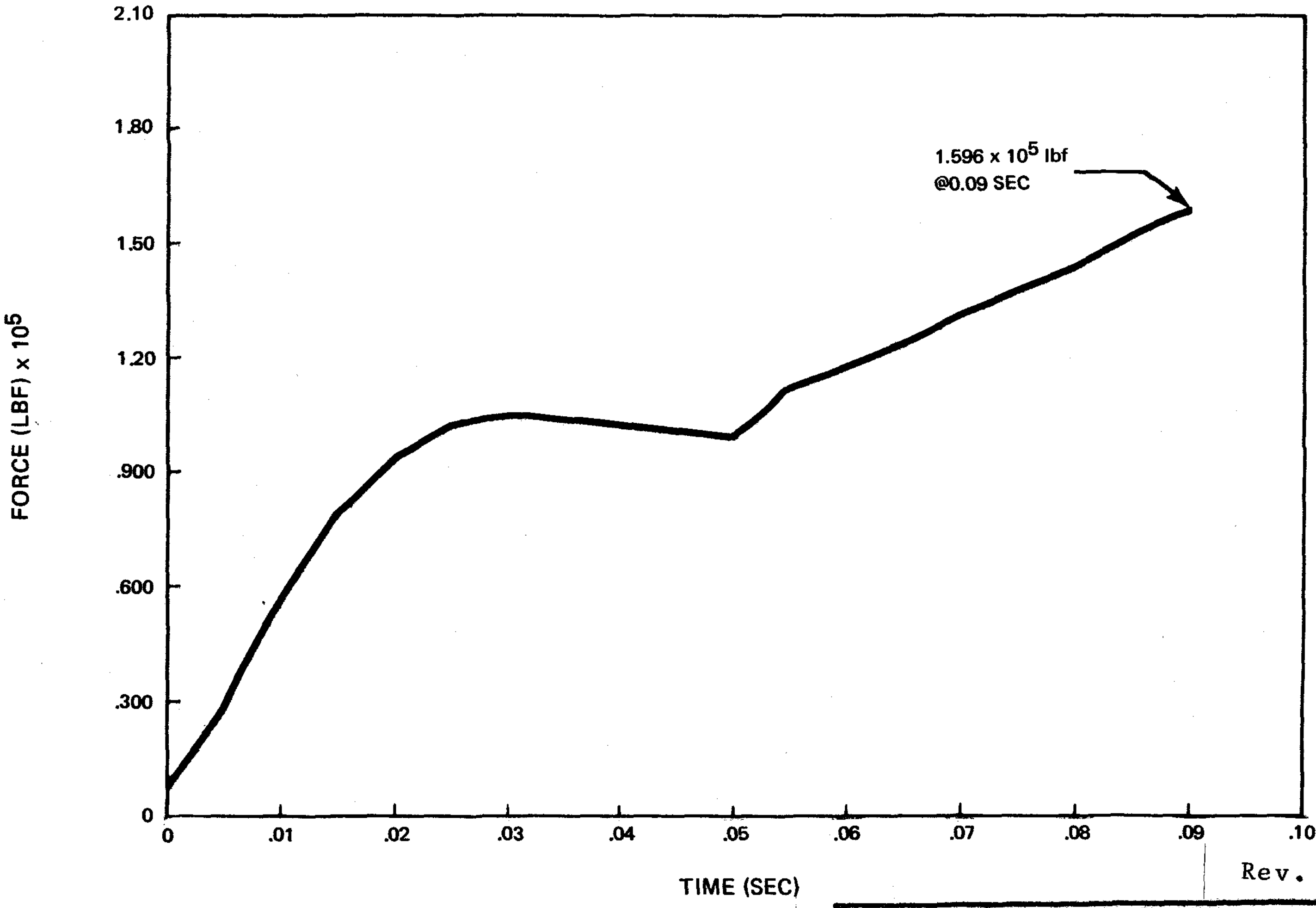

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FIGURE 6.2.1-64

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, 436 IN.^{2} PUMP SUCTION LINE BREAK, VERTICAL FORCE ON SG

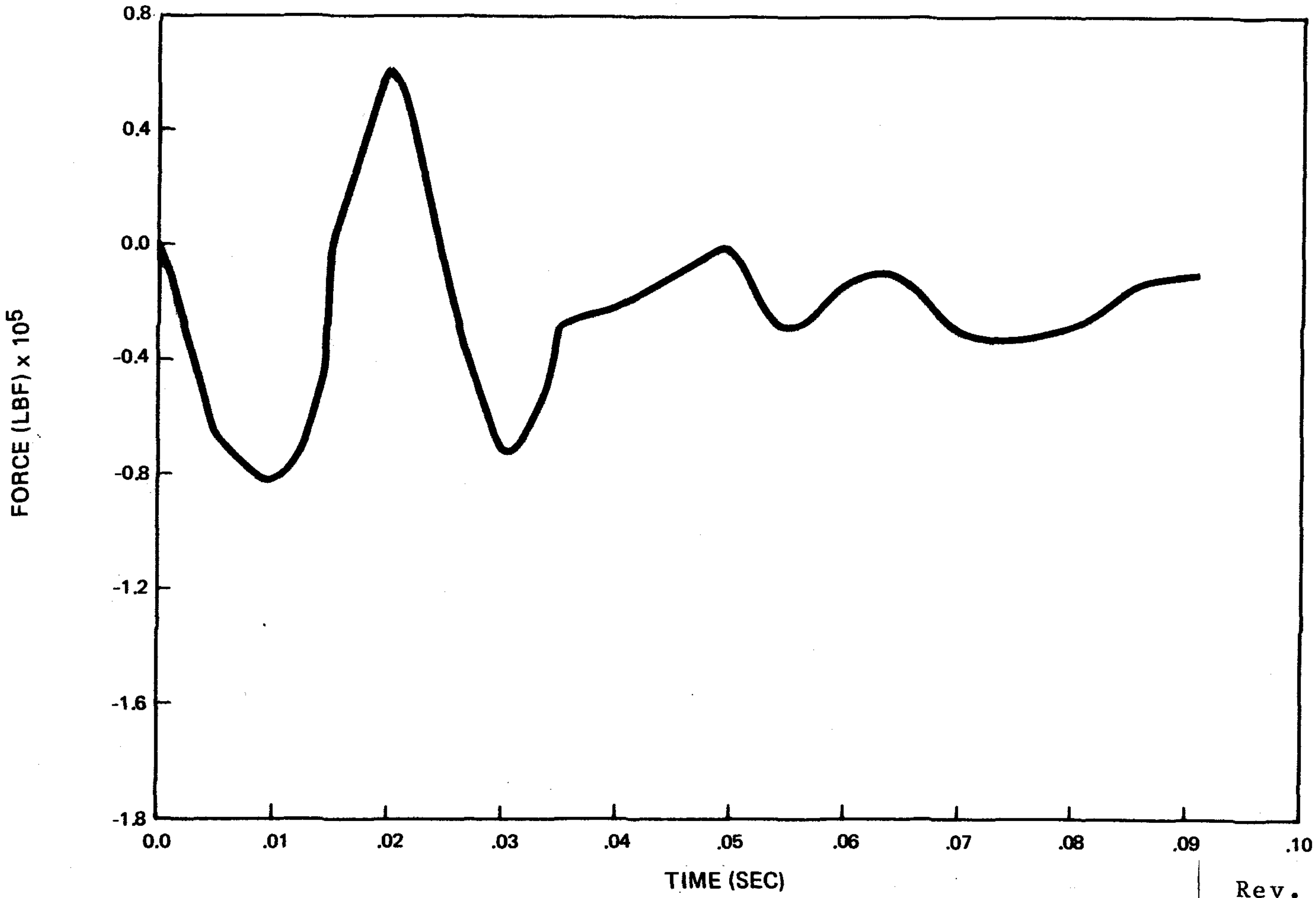

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FIGURE 6.2.1-65

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, 436 IN.^{2} PUMP SUCTION LINE BREAK, N-S COMPONENT OF HORIZONTAL FORCE ON RCP

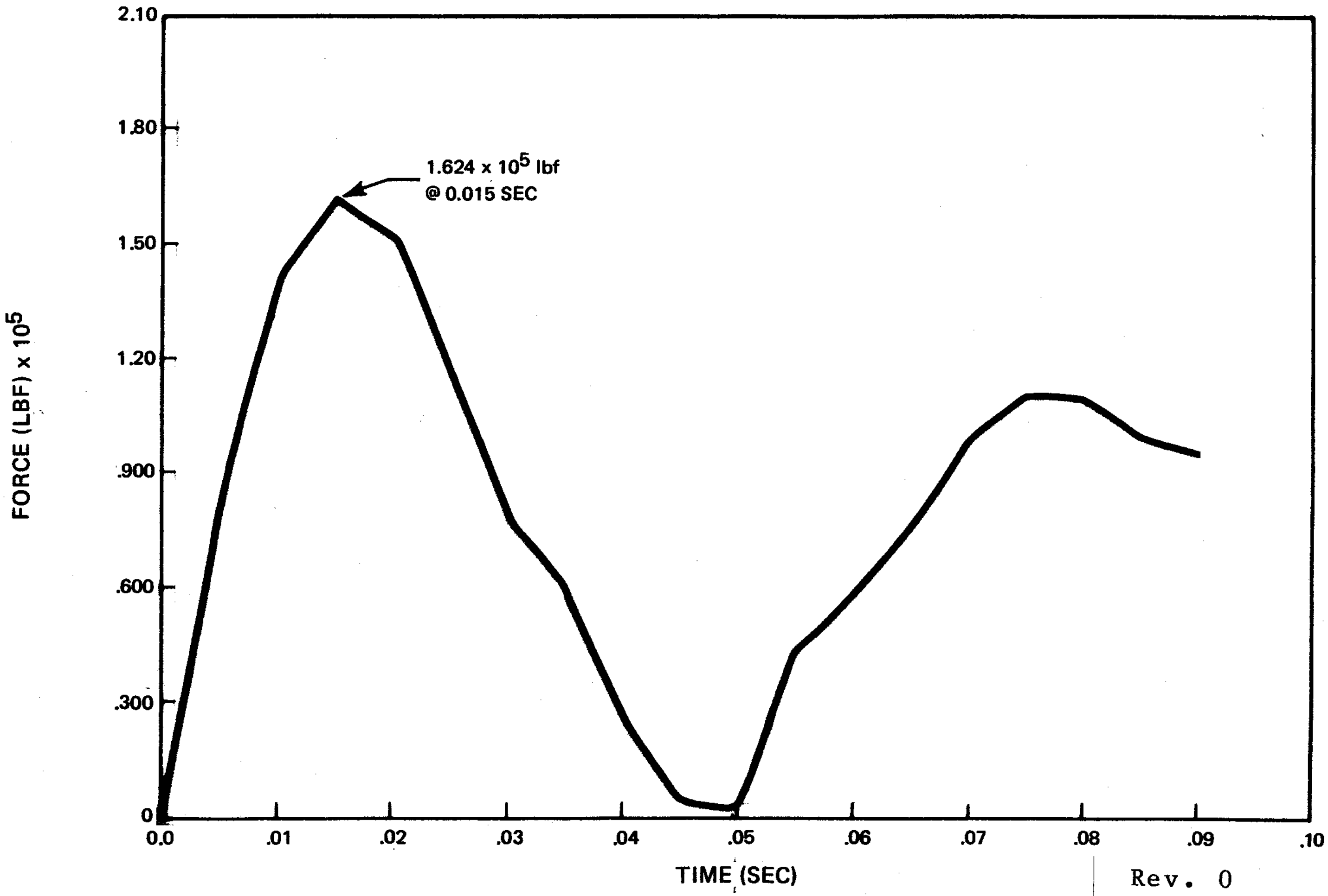

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FIGURE 6.2.1-66

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, 436 IN.^{2} PUMP SUCTION LINE BREAK E-W COMPONENT OF HORIZONTAL FORCE ON RCP

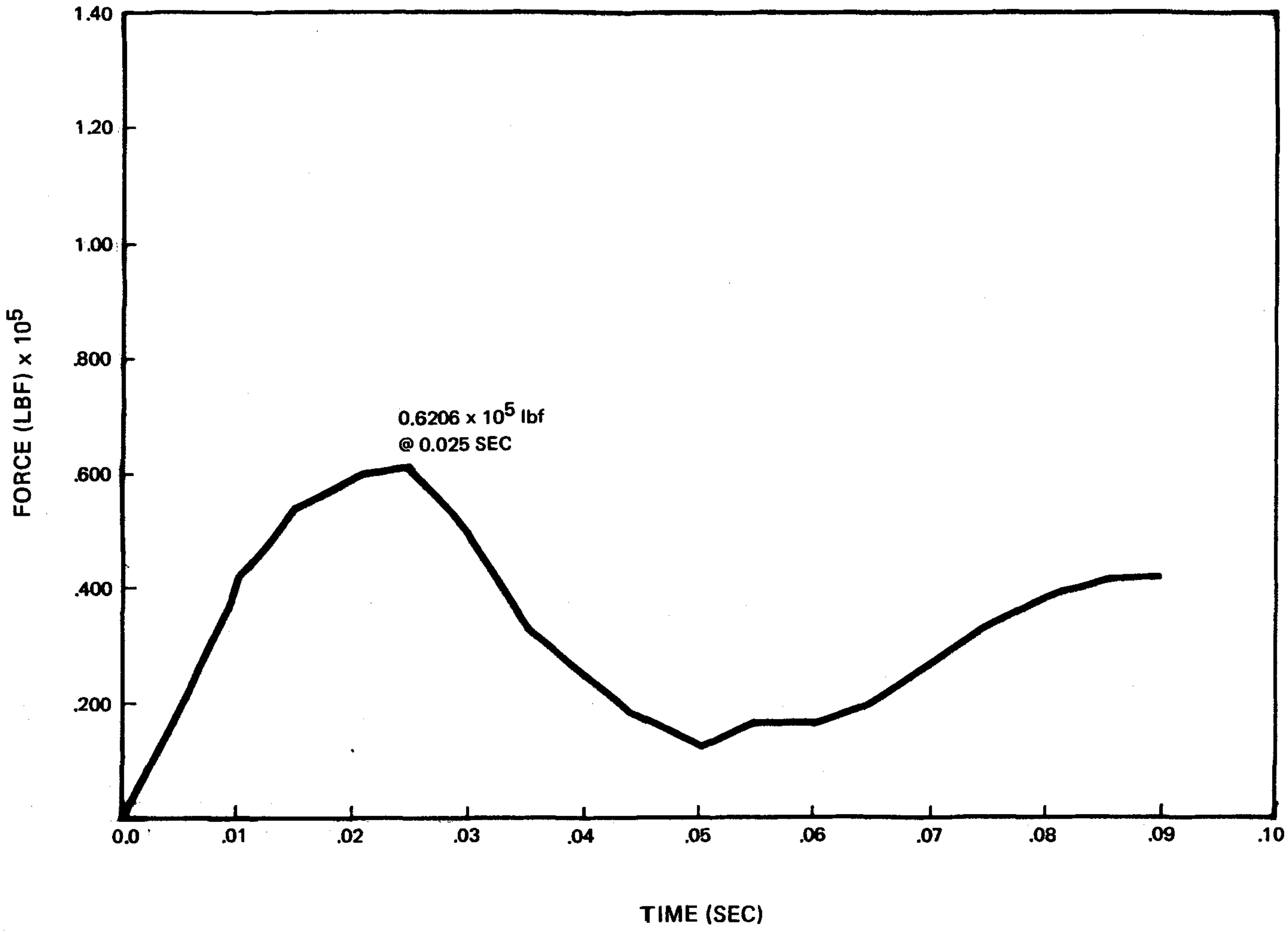

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FIGURE 6.2.1-67

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, 436 IN.^{2} PUMP SUCTION LINE BREAK, VERTICAL FORCE ON RCP

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FIGURE 6.2.1-68

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, 436 IN.^{2} PUMP SUCTION LINE BREAK, DIRECTION OF PEAK HORIZONTAL FORCES ON REACTOR COOLANT PUMP AND STEAM GENERATOR

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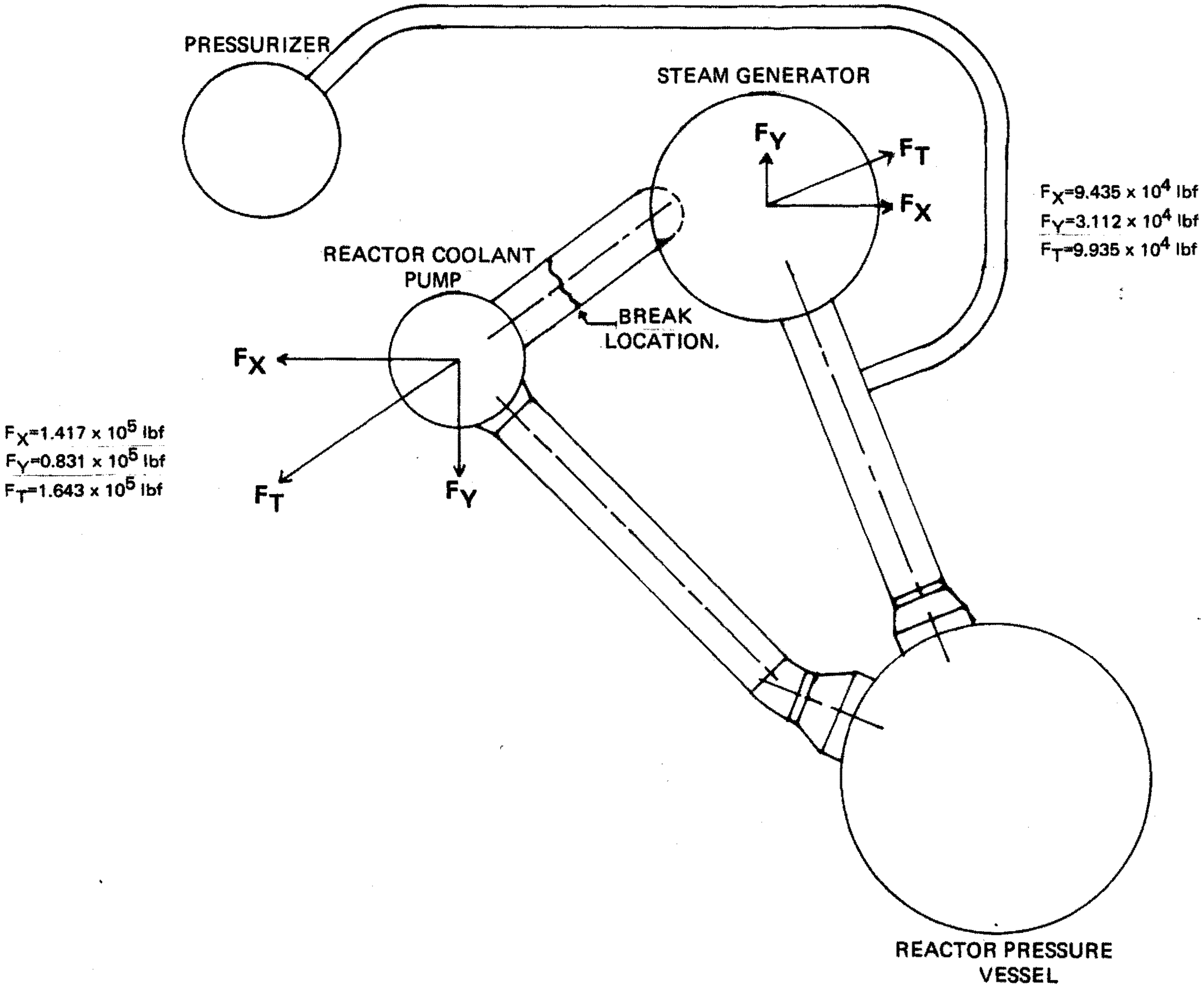

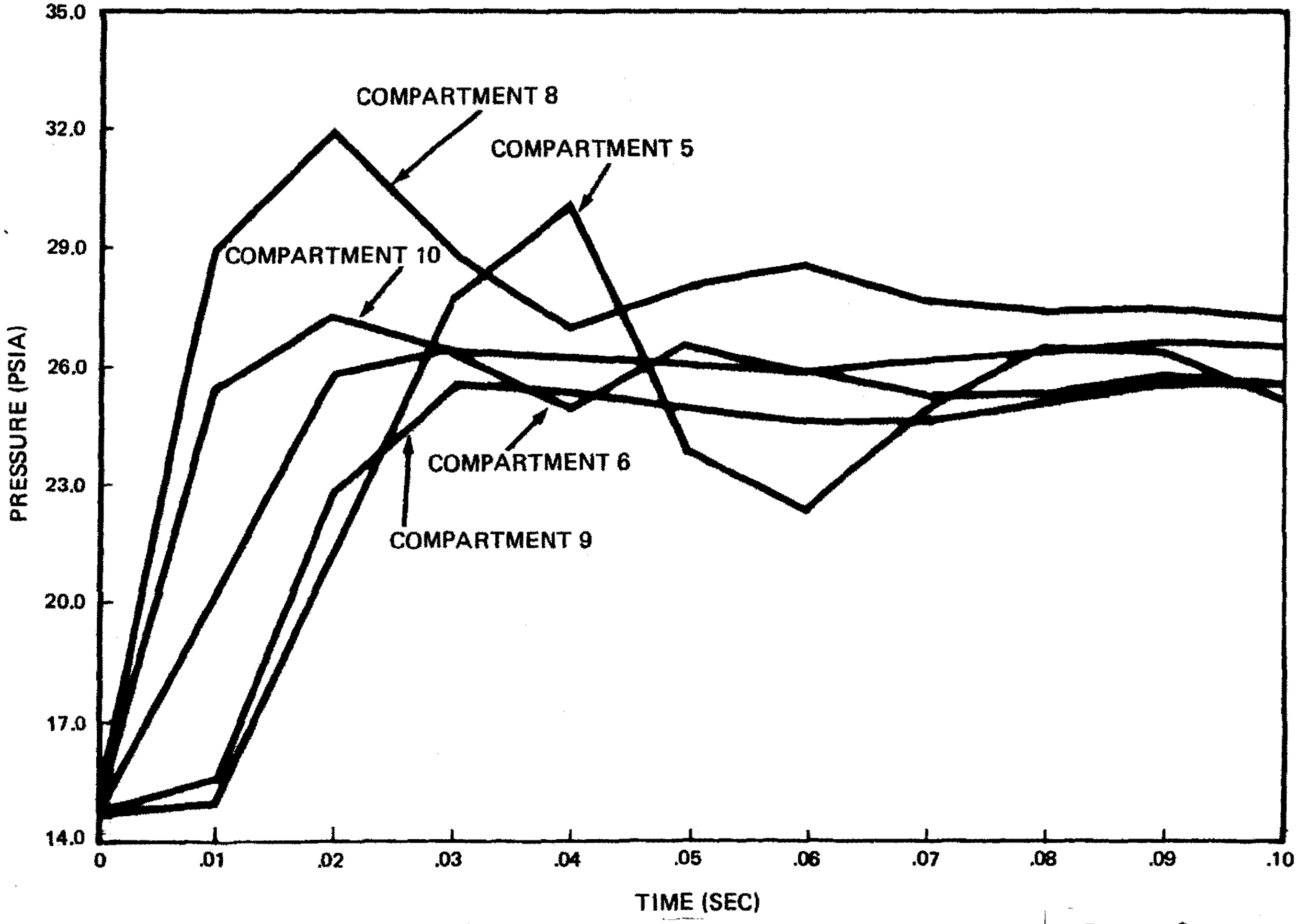

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FIGURE 6.2.1-69

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, 736 IN.^{2} HOT-LEG BREAK, ABSOLUTE PRESSURE NEAR THE BREAK

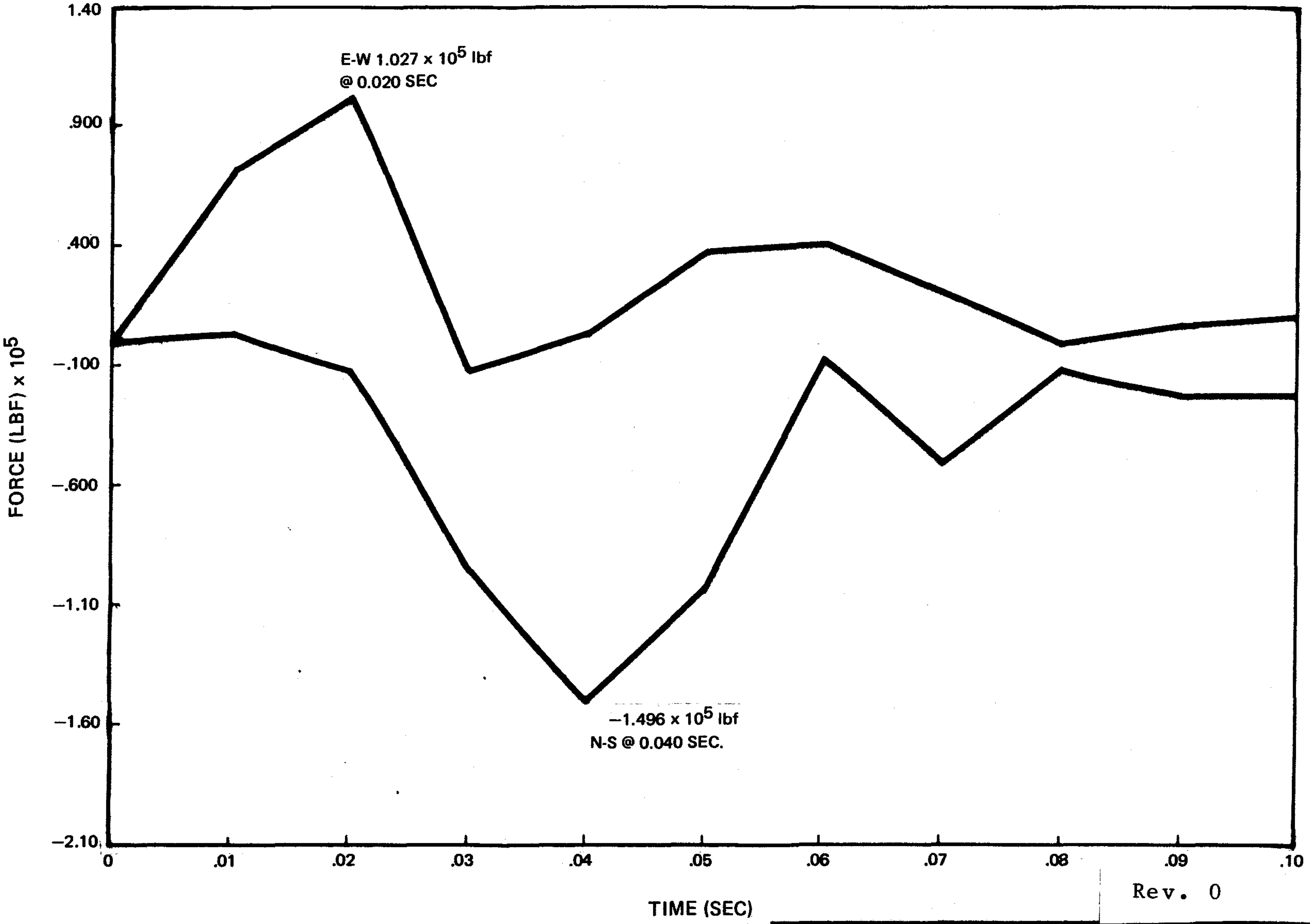

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FIGURE 6.2.1-70

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, 763 IN.^{2} HOT-LEG BREAK, HORIZONTAL FORCES ON SG

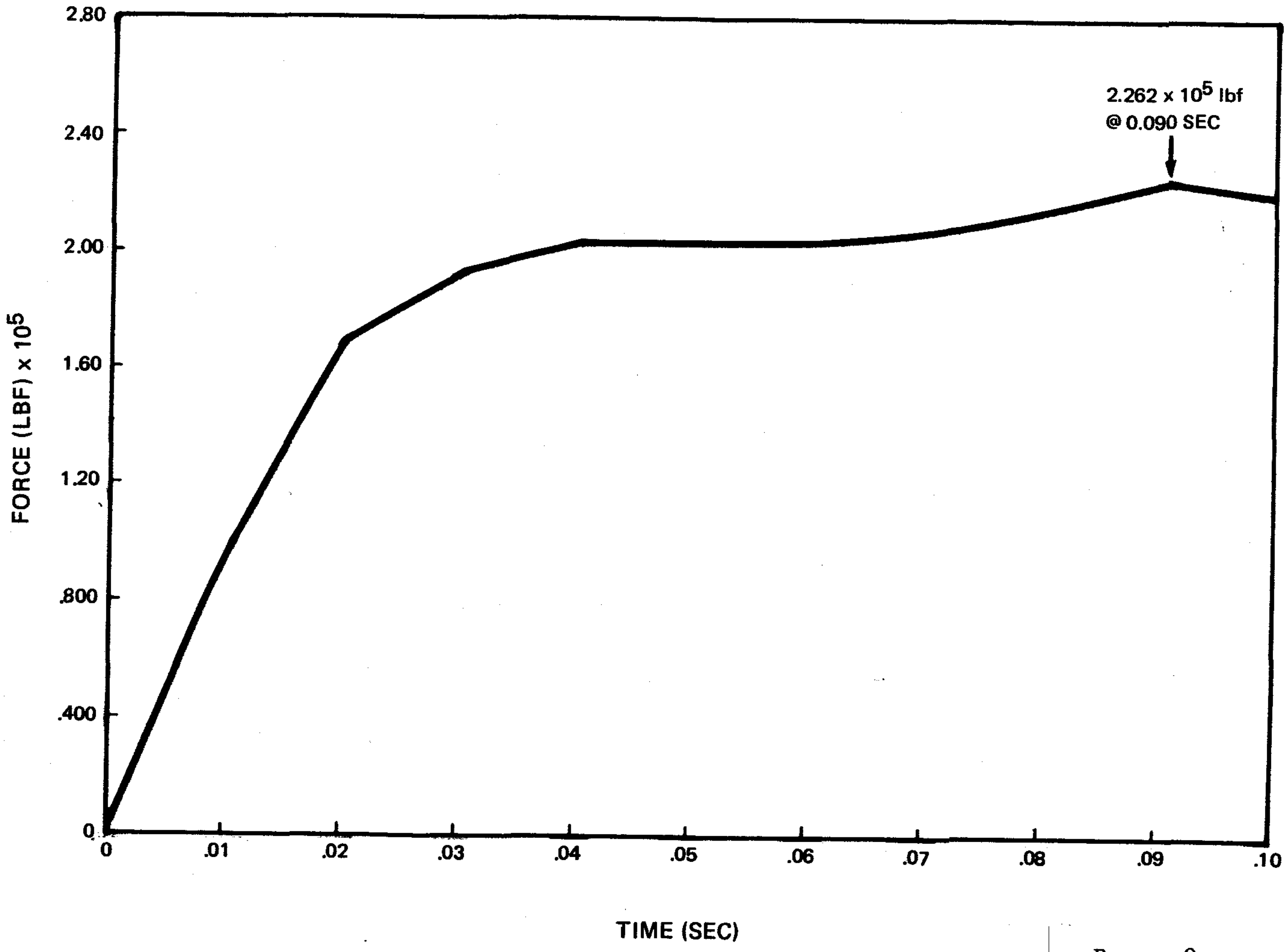

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FIGURE 6.2.1-71

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, 763 IN.^{2} HOT-LEG BREAK, VERTICAL FORCES ON SG

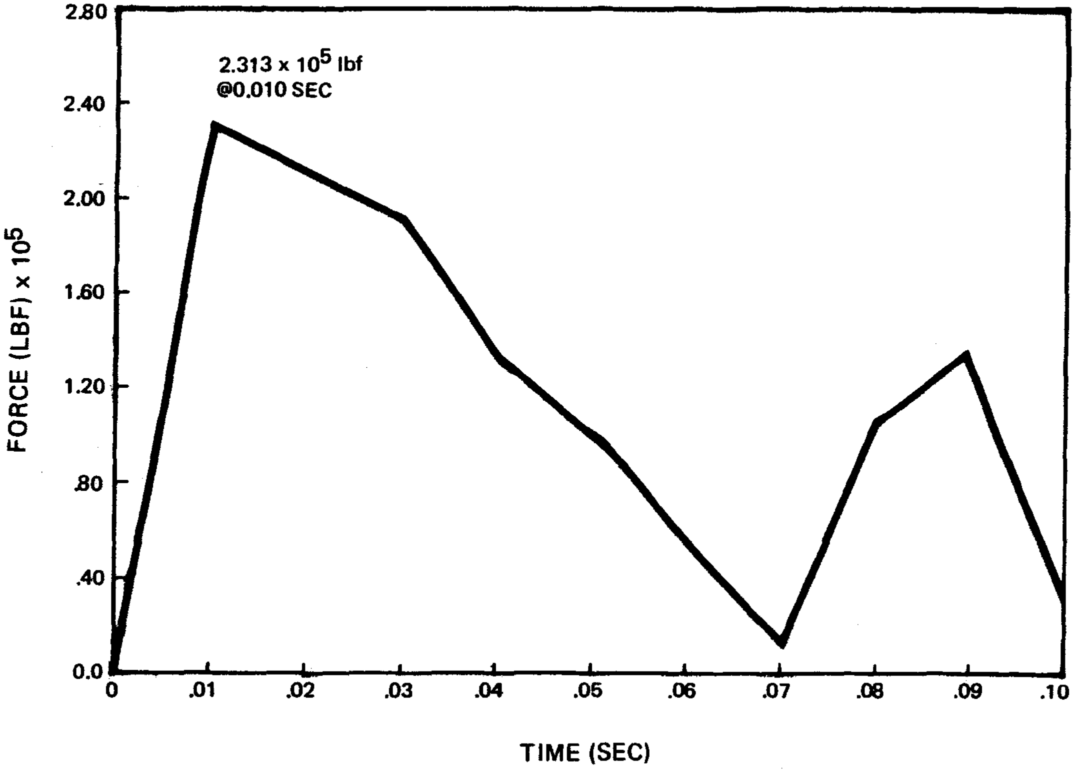

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FIGURE 6.2.1-72

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, 763 IN.^{2} HOT-LEG BREAK, N-S COMPONENT OF HORIZONTAL FORCE ON RCP

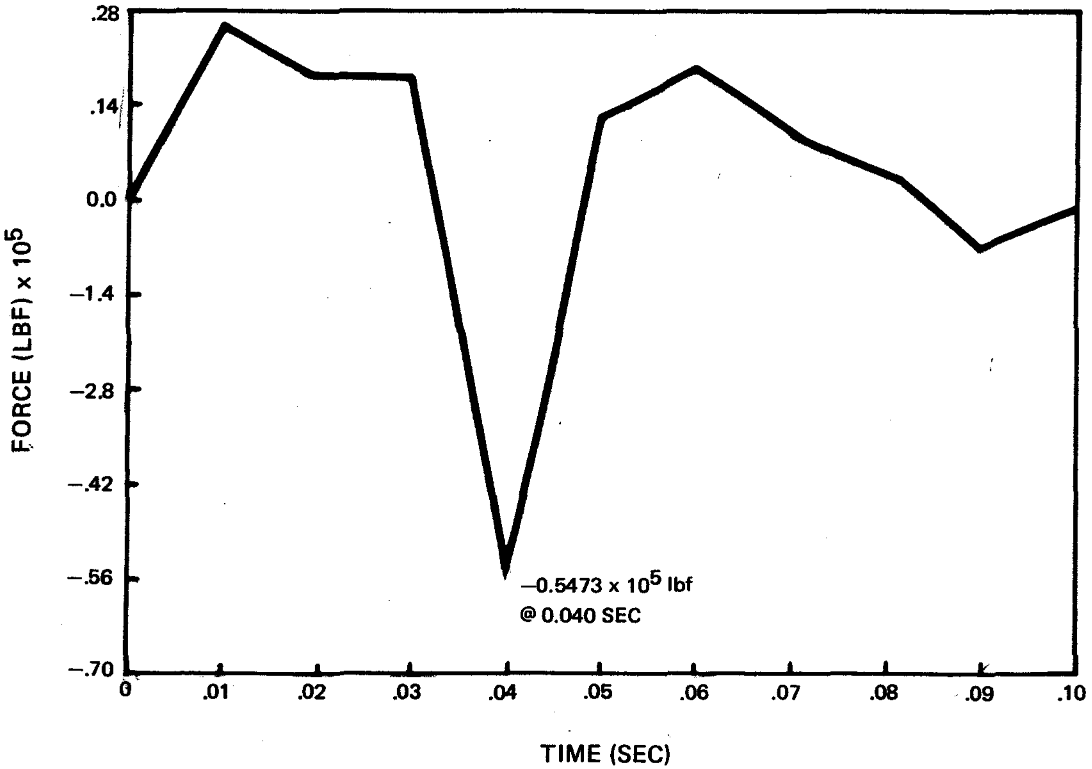

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FIGURE 6.2.1-73

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, 763 IN.^{2} HOT-LEG BREAK, E-W COMPONENT OF HORIZONTAL FORCE ON RCP

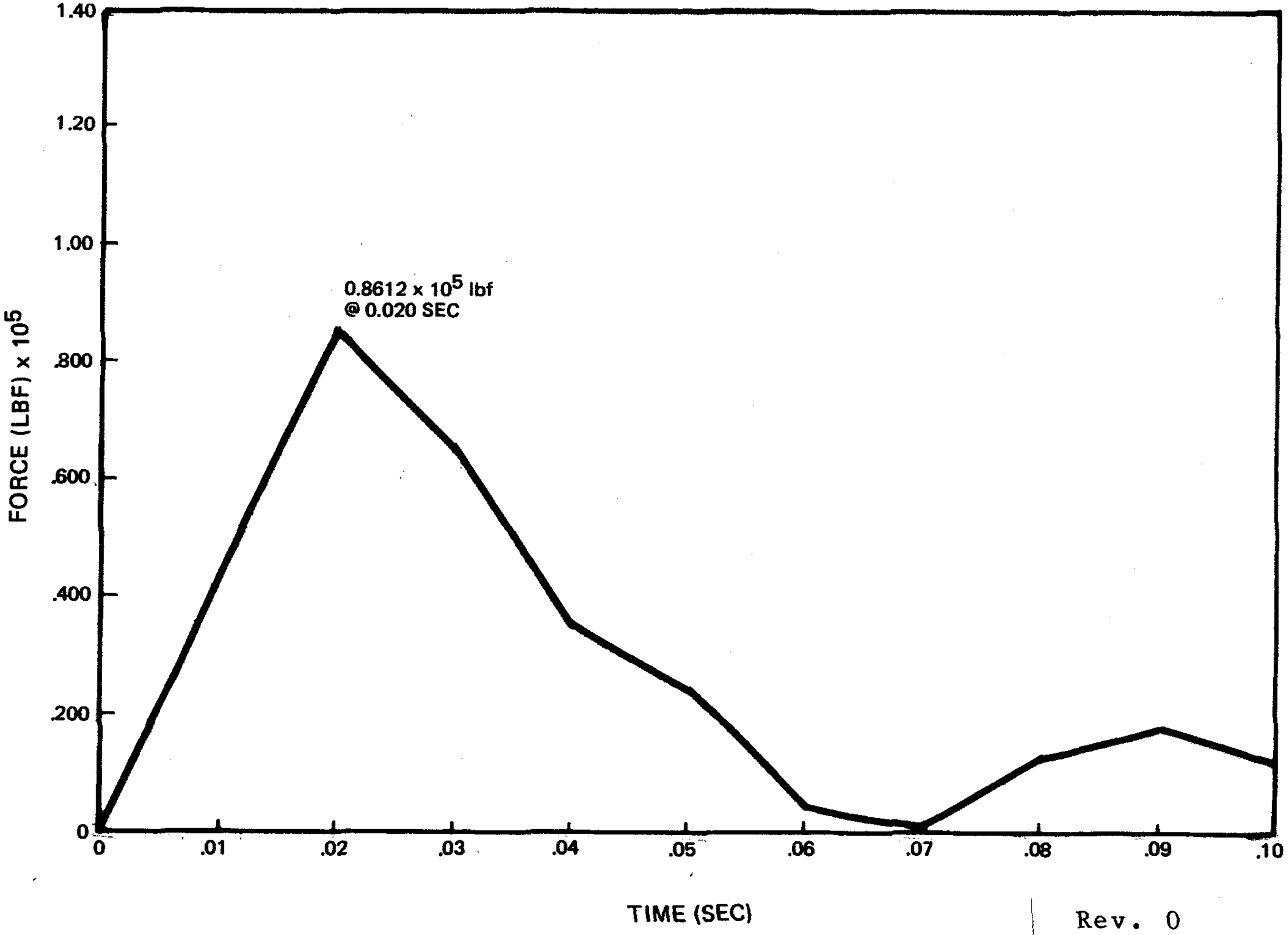

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FIGURE 6.2.1-74

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, 763 IN.^{2} HOT-LEG BREAK, VERTICAL FORCE ON RCP

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FIGURE 6.2.1-75

STEAM GENERATOR LOOP COMPARTMENT ANALYSIS, 763 IN.^{2} HOT-LEG BREAK, DIRECTION OF PEAK HORIZONTAL FORCES ON REACTOR COOLANT PUMP AND STEAM GENERATOR

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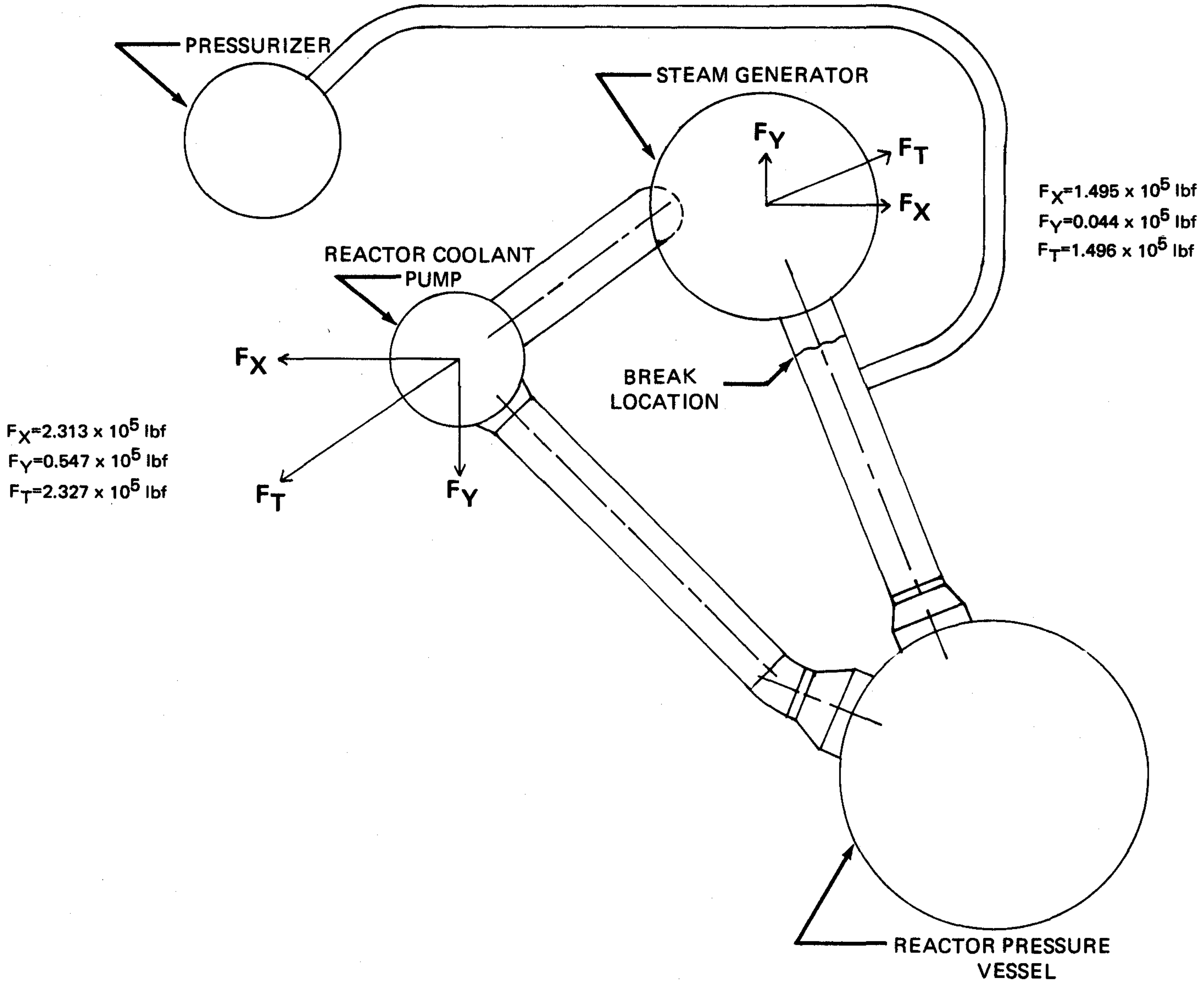

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FIGURE 6.2.1-76

PRESSURIZER COMPARTMENT ANALYSIS NODALIZATION SCHEME - ELEVATION VIEW

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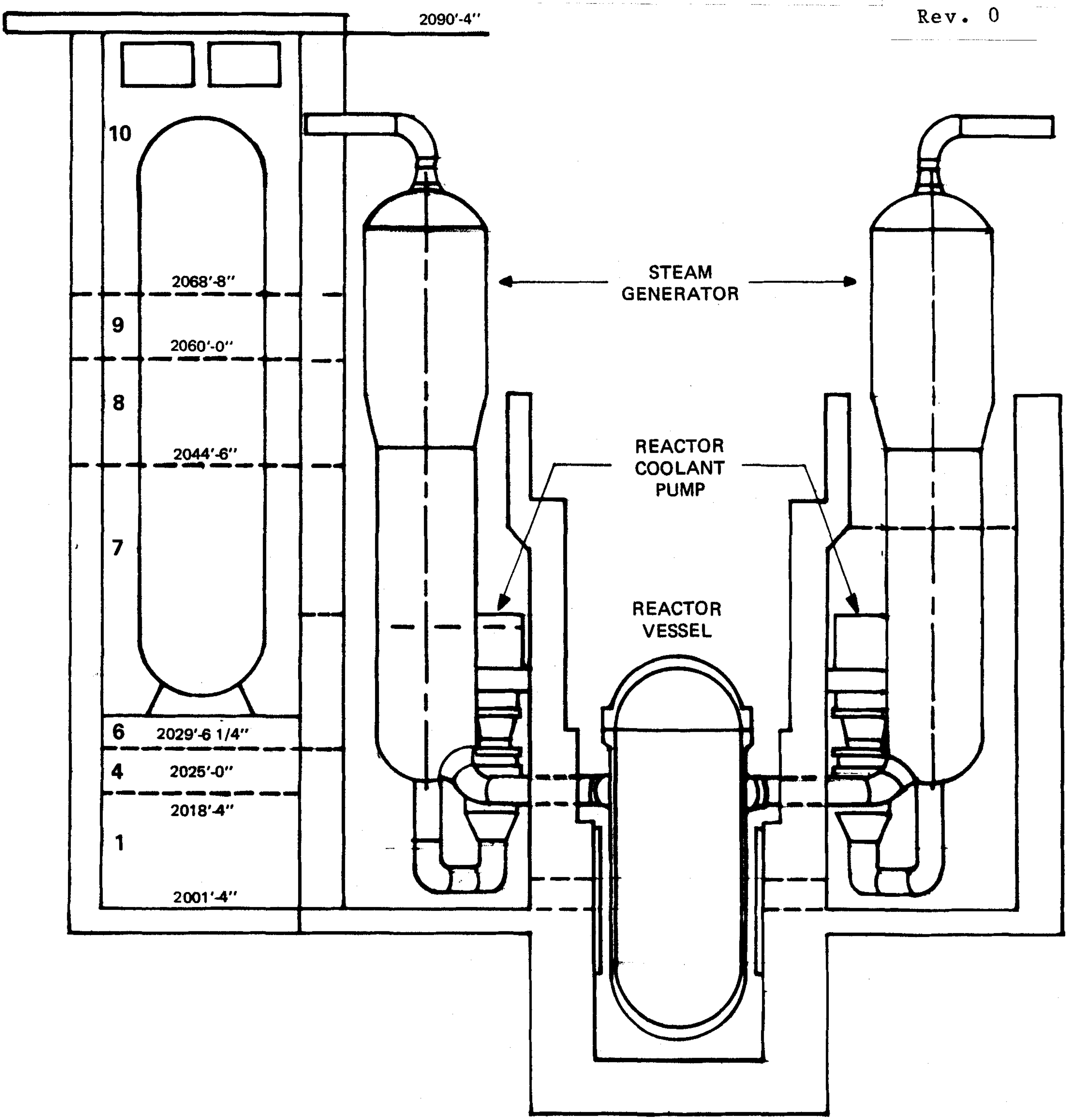

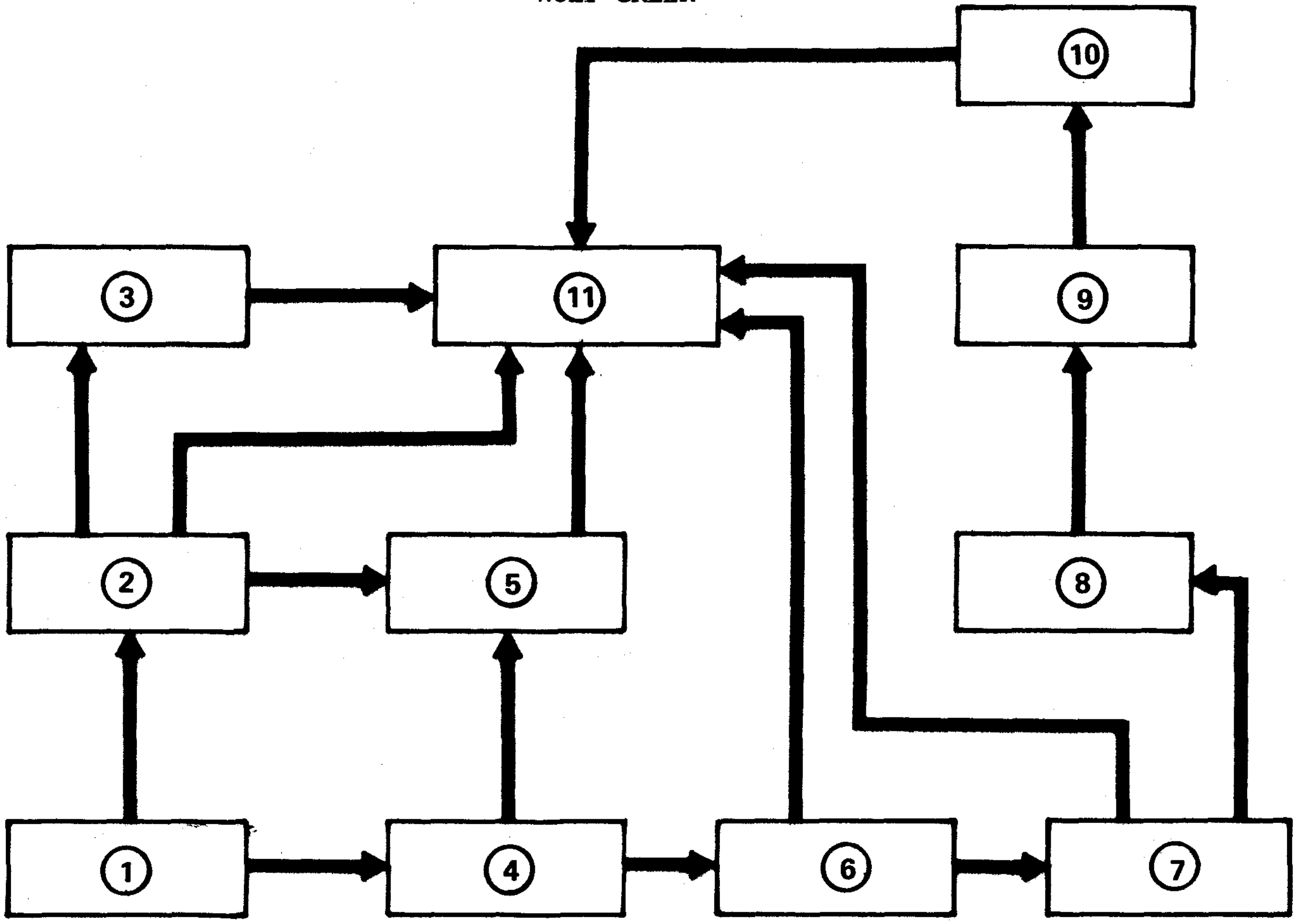

FOR NODE VOLUMES AND VENT PATH AREAS, FLOW COEFFICENTS AND l/a's, REFER TO TABLES 6.2.1-26 AND 6.2.1-27

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FIGURE 6.2.1-77

FLOW DIAGRAM PRESSURIZER COMPARTMENT ANALYSIS

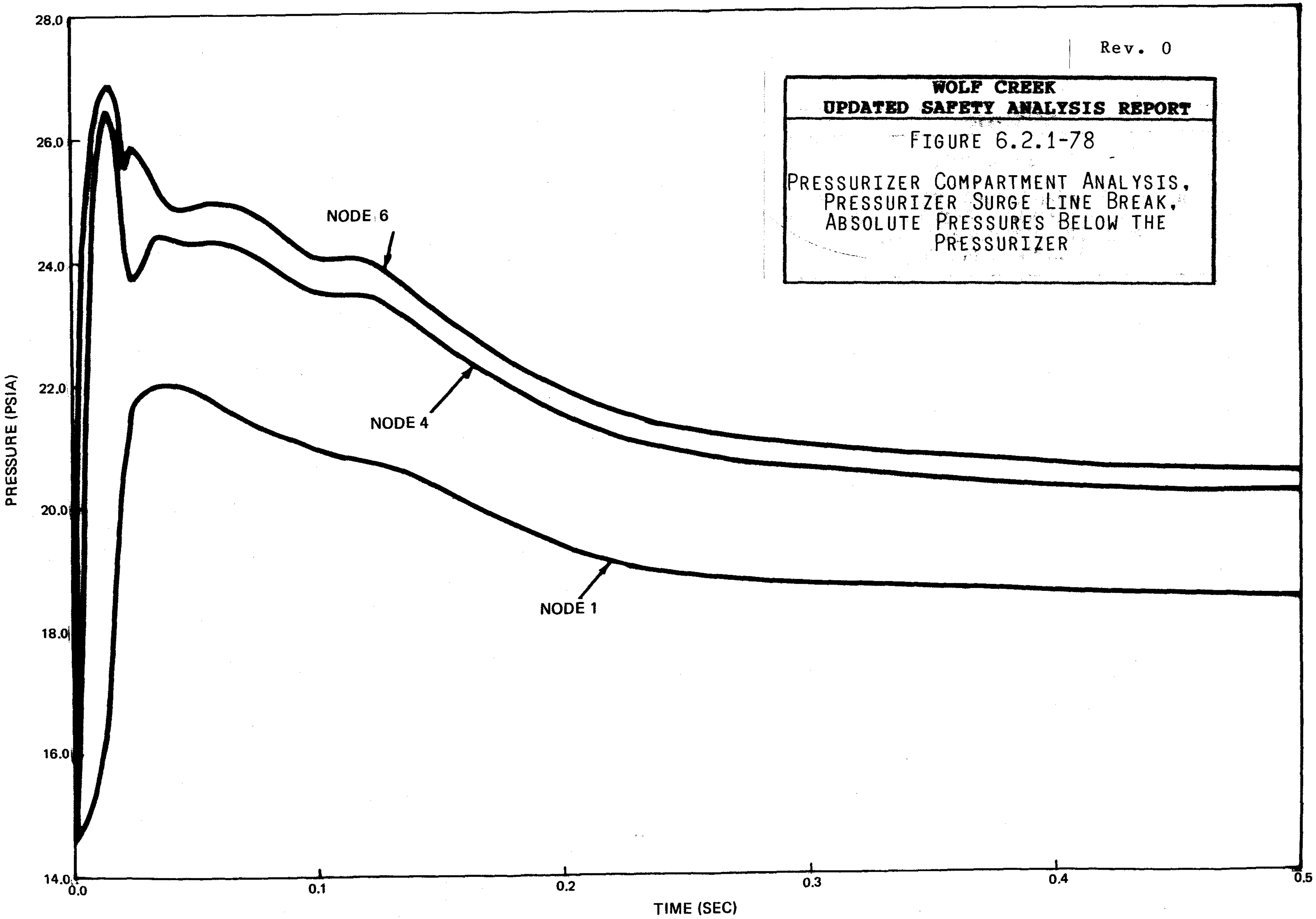

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FIGURE 6.2.1-78

PRESSURIZER COMPARTMENT ANALYSIS, PRESSURIZER SURGE LINE BREAK, ABSOLUTE PRESSURES BELOW THE PRESSURIZER

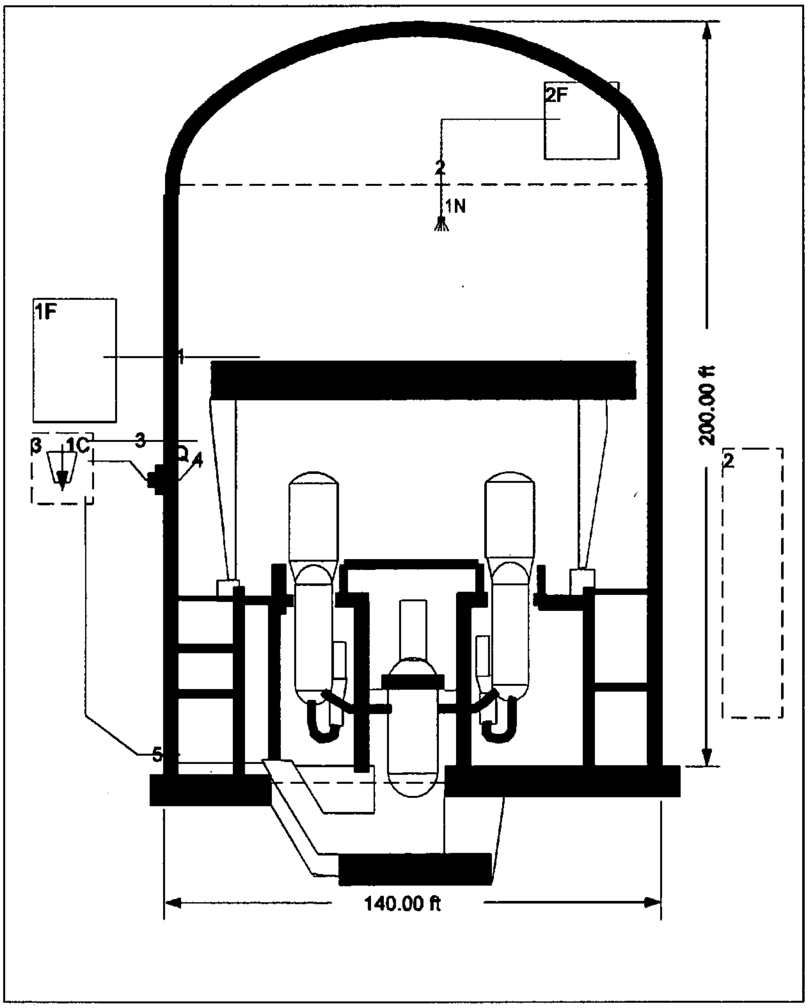

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FIGURE 6.2.1-79

A SIMPLIFIED SCHEMATIC OF THE WOLF CREEK CONTAINMENT

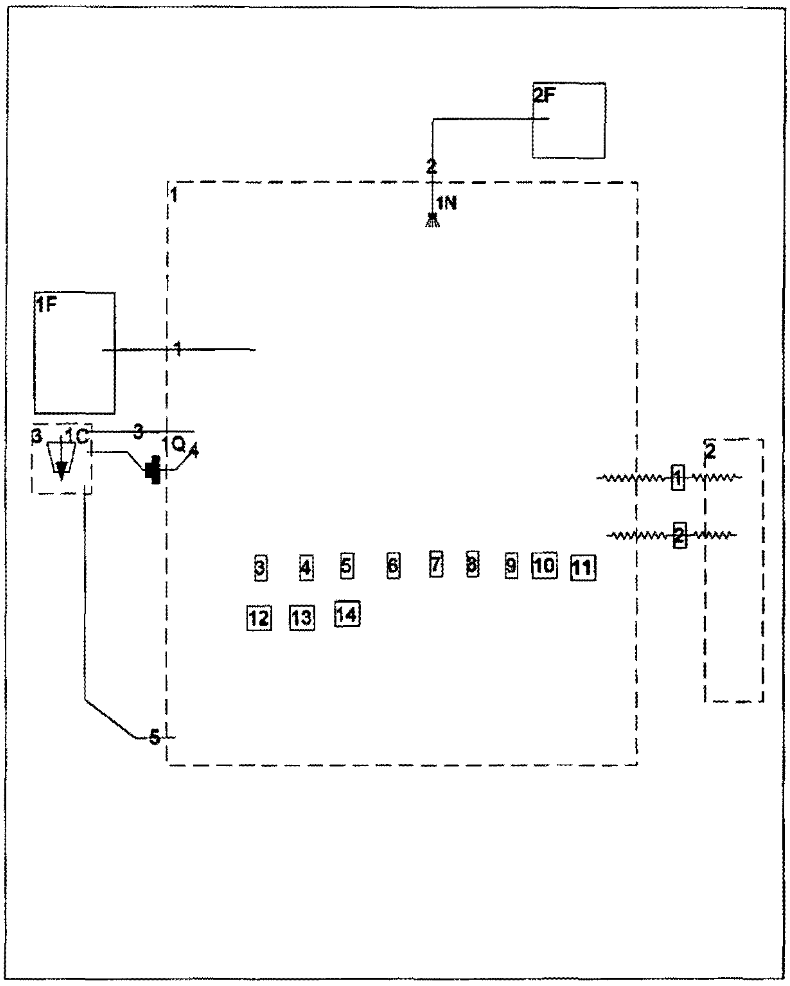

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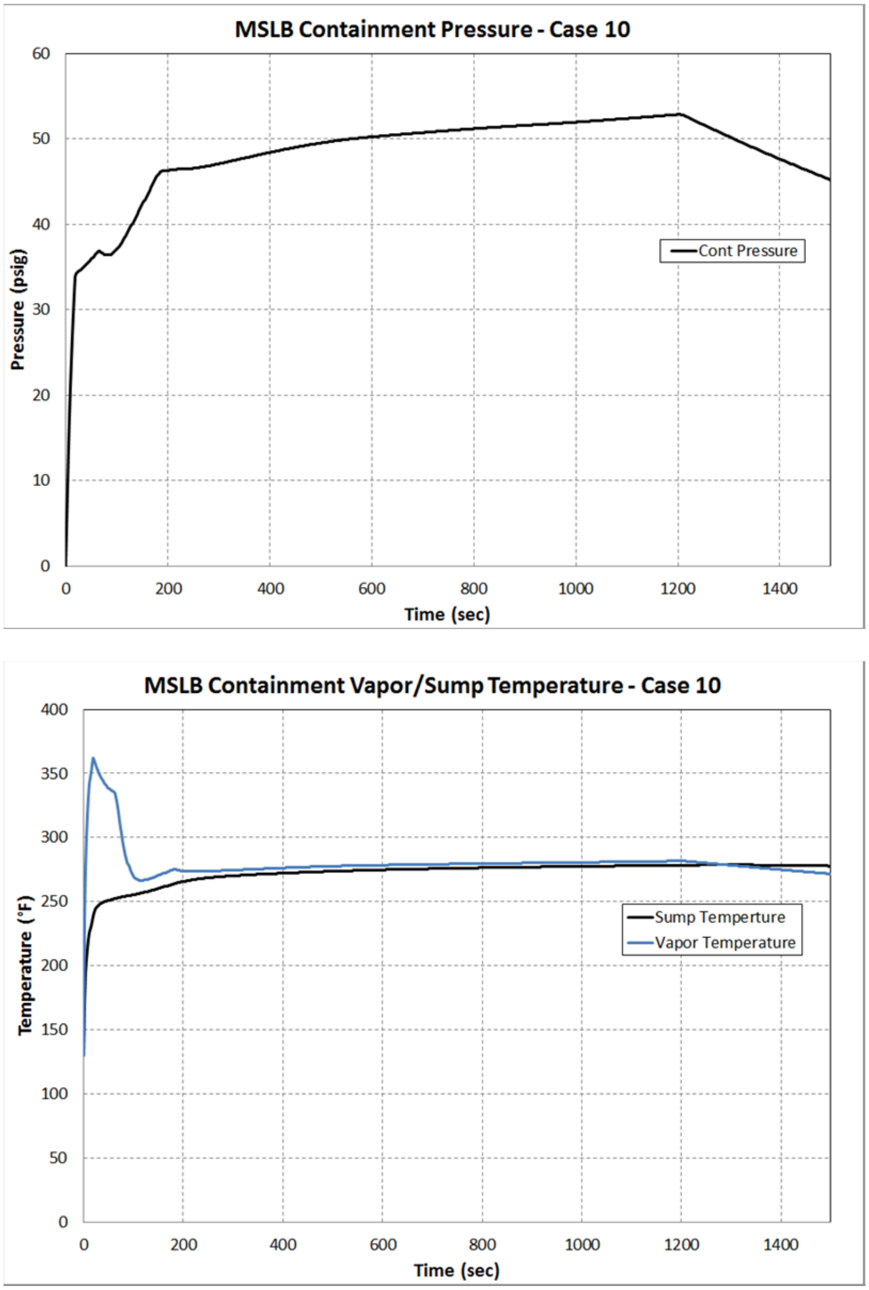
FIGURE 6.2.1-80

WOLF CREEK GOTHIC
CONTAINMENT MODEL FOR
MSLB EVENTS



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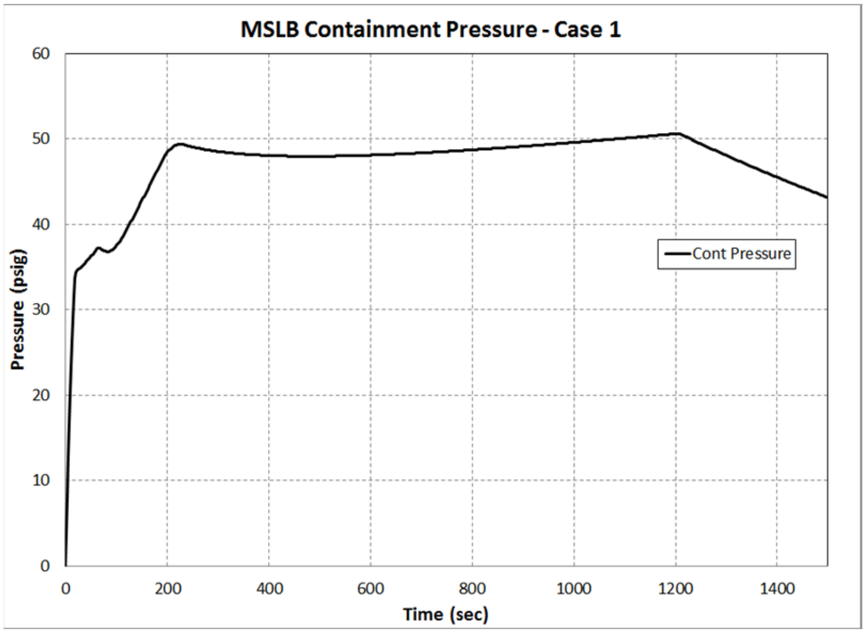
WOLF CREEK

FIGURE 6.2.1-81:
Containment Pressure, Vapor Temperature and Sump Water Temperature Response To A Postulated MSLB – Case 10 Scenario



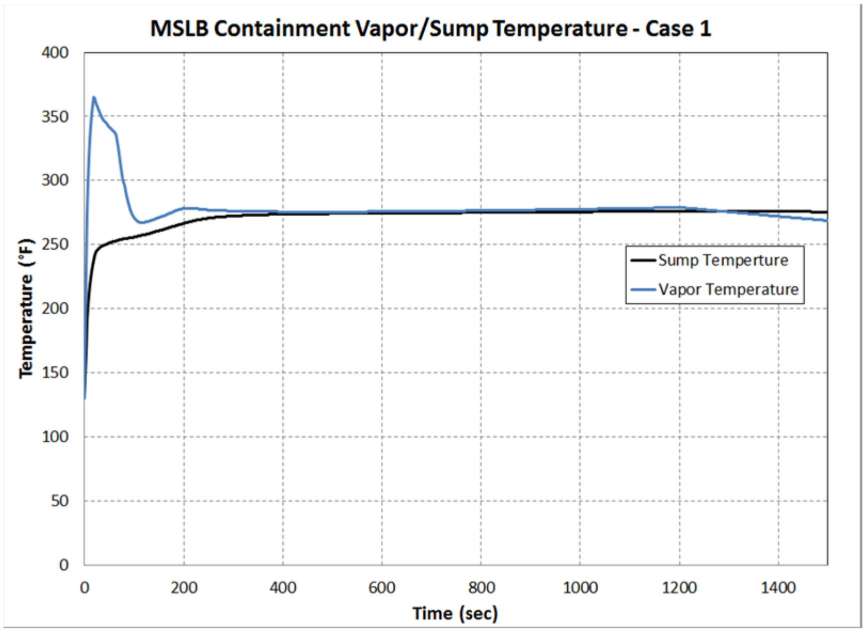


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FIGURE 6.2.1-82:
Containment Pressure, Vapor Temperature and Sump Water Temperature Response To A Postulated MSLB – Case 1 Scenario

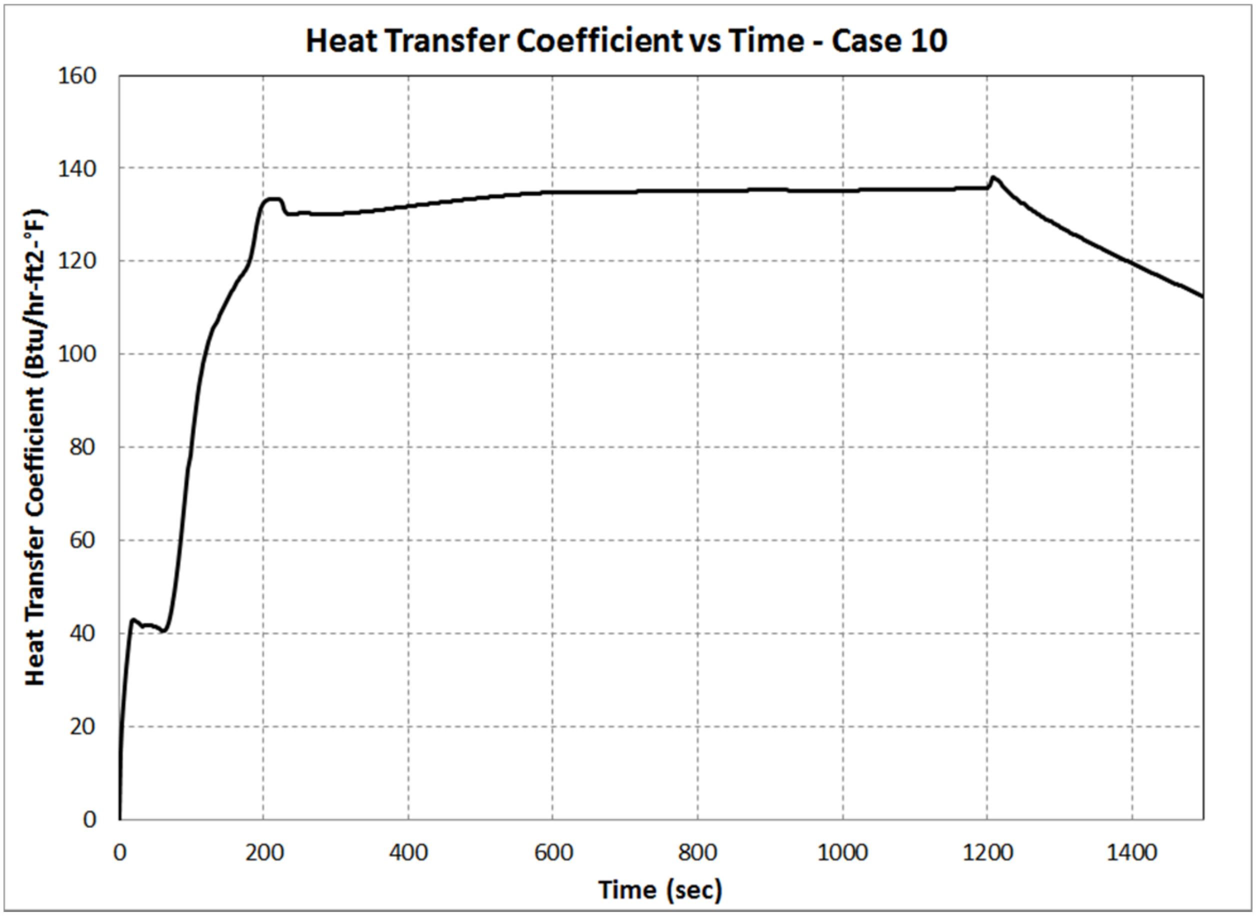

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FIGURE 6.2.1-83:
Heat Transfer Coefficient vs Time,
Limiting Containment Pressure
Scenario – MSLB Case 10

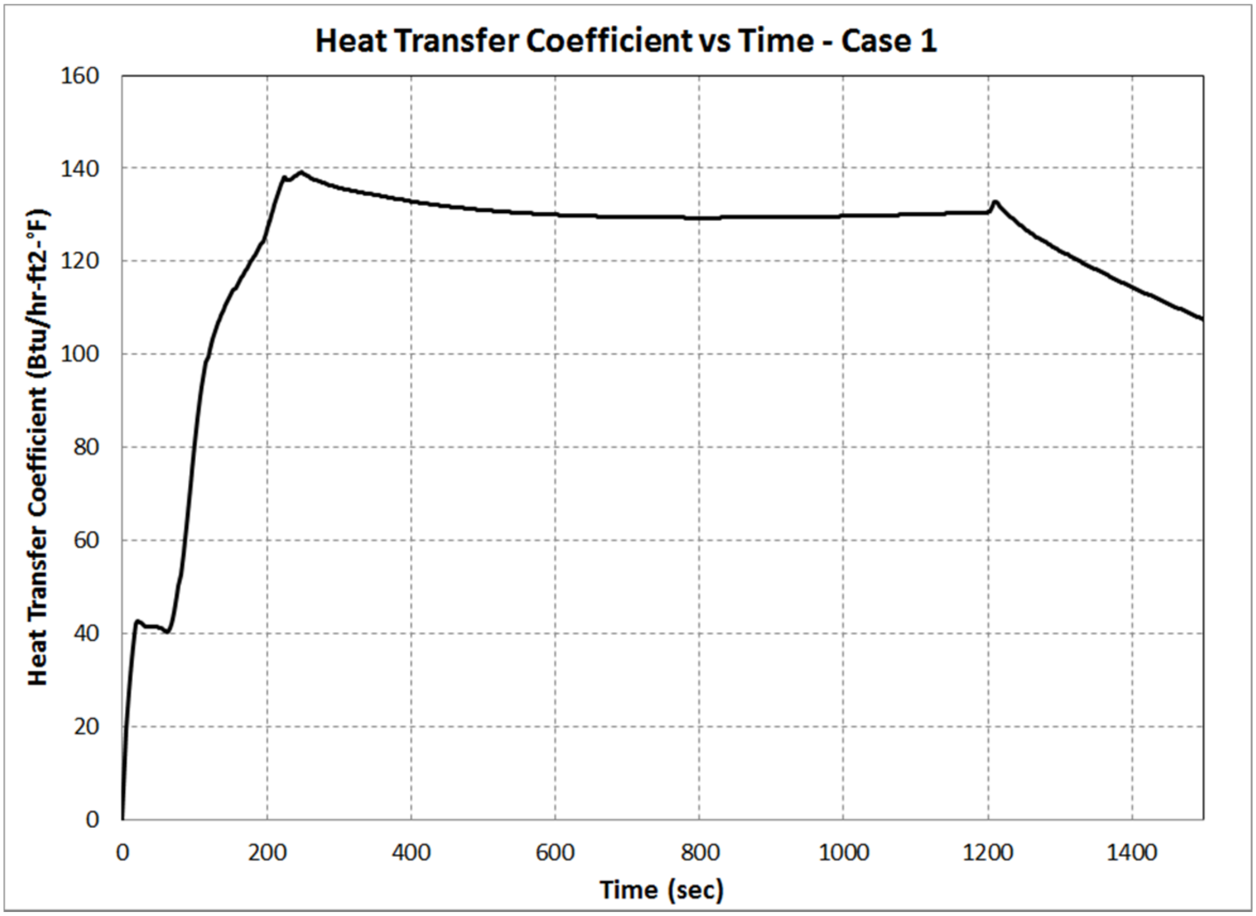

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FIGURE 6.2.1-84:
Heat Transfer Coefficient vs Time,
Limiting Containment Temperature
Scenario – MSLB Case 1

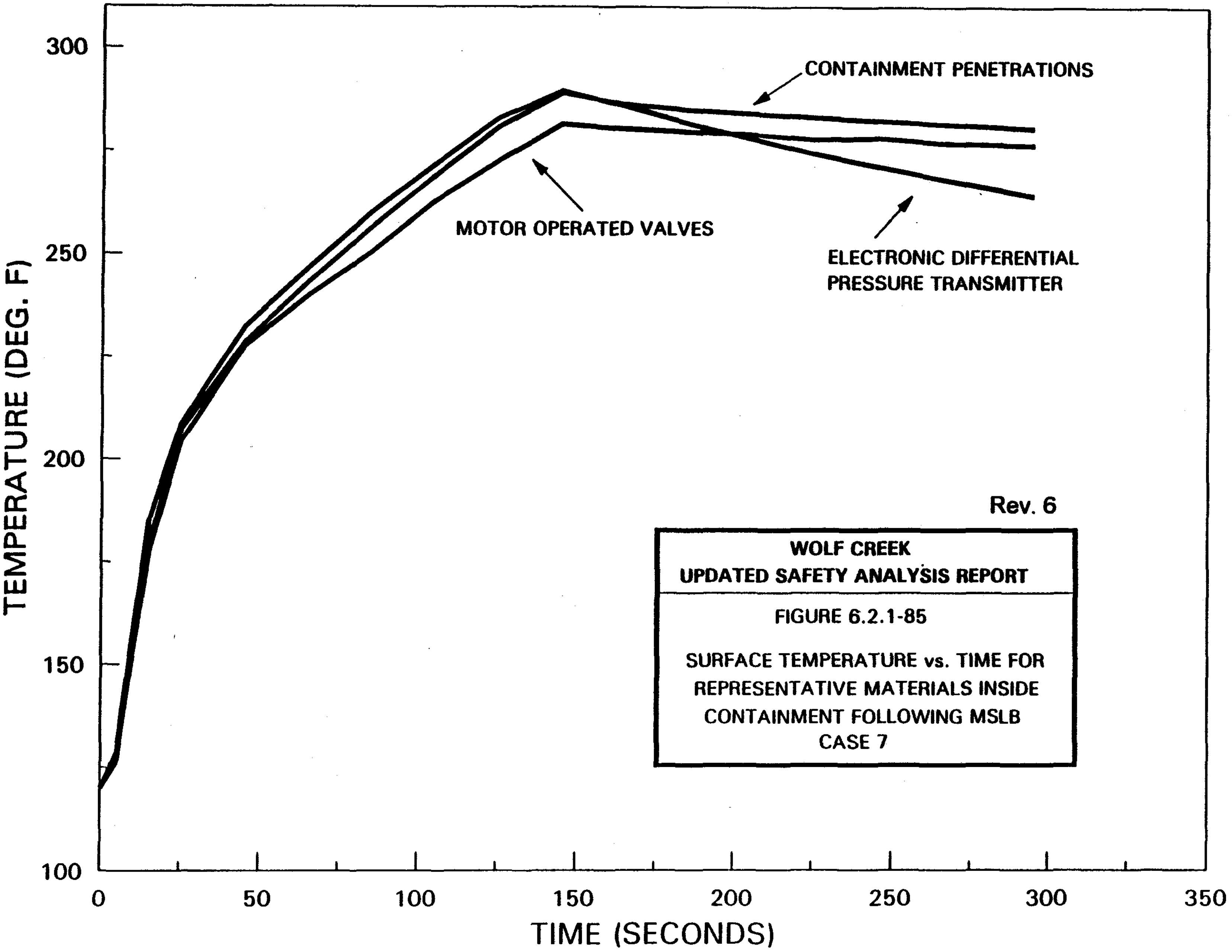

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FIGURE 6.2.1-85

SURFACE TEMPERATURE vs. TIME FOR REPRESENTATIVE MATERIALS INSIDE CONTAINMENT FOLLOWING MSLB CASE 7

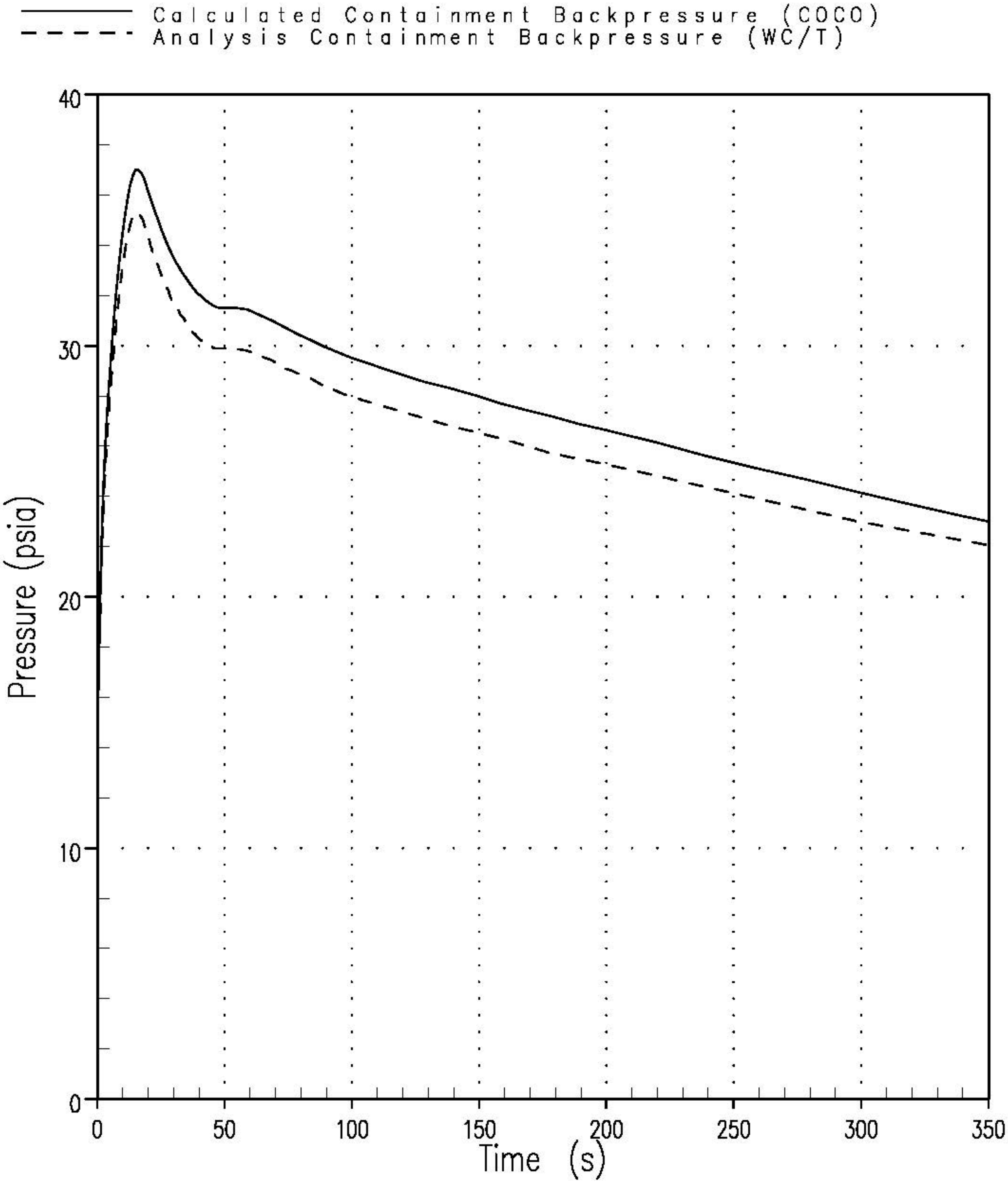

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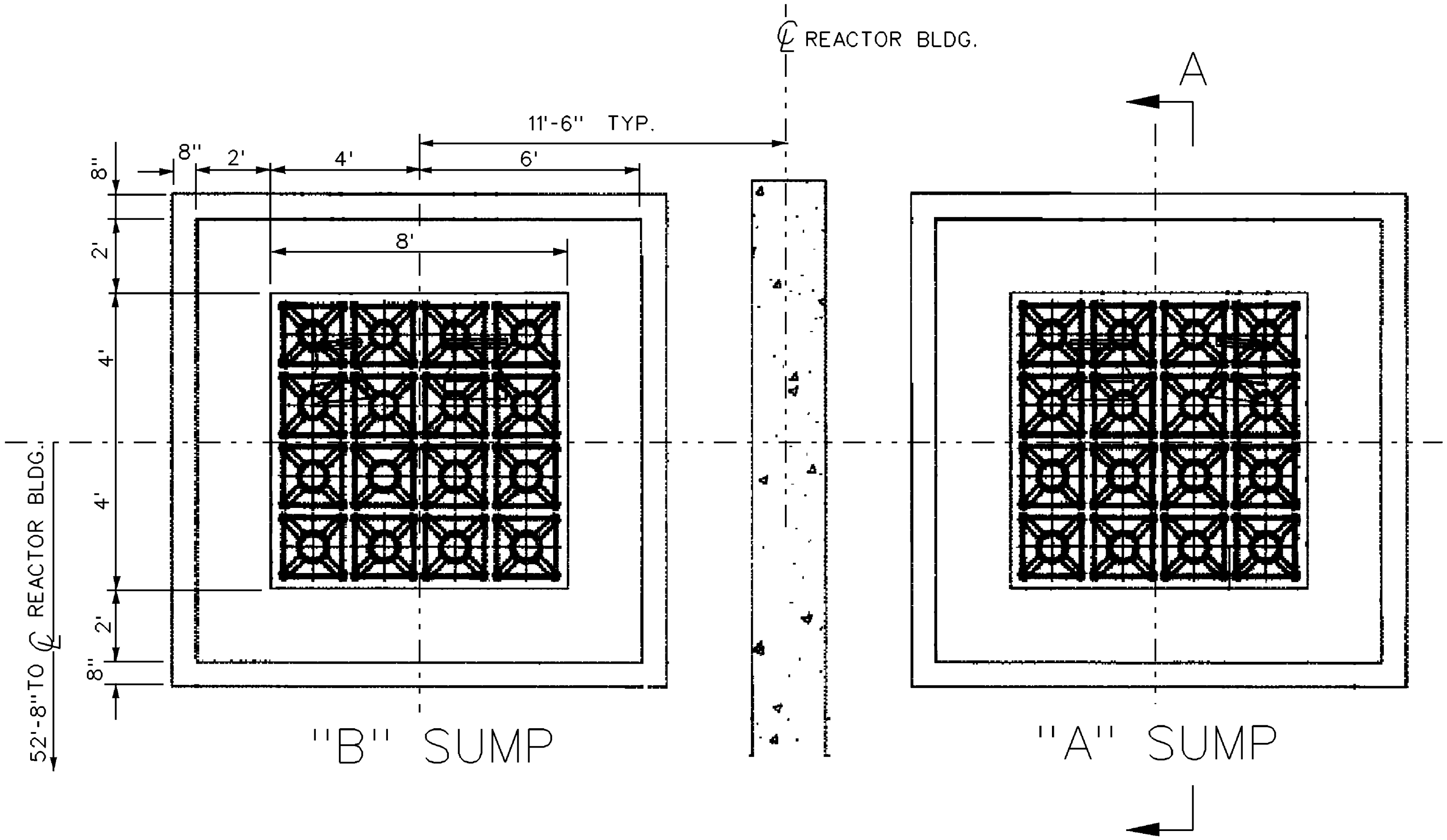
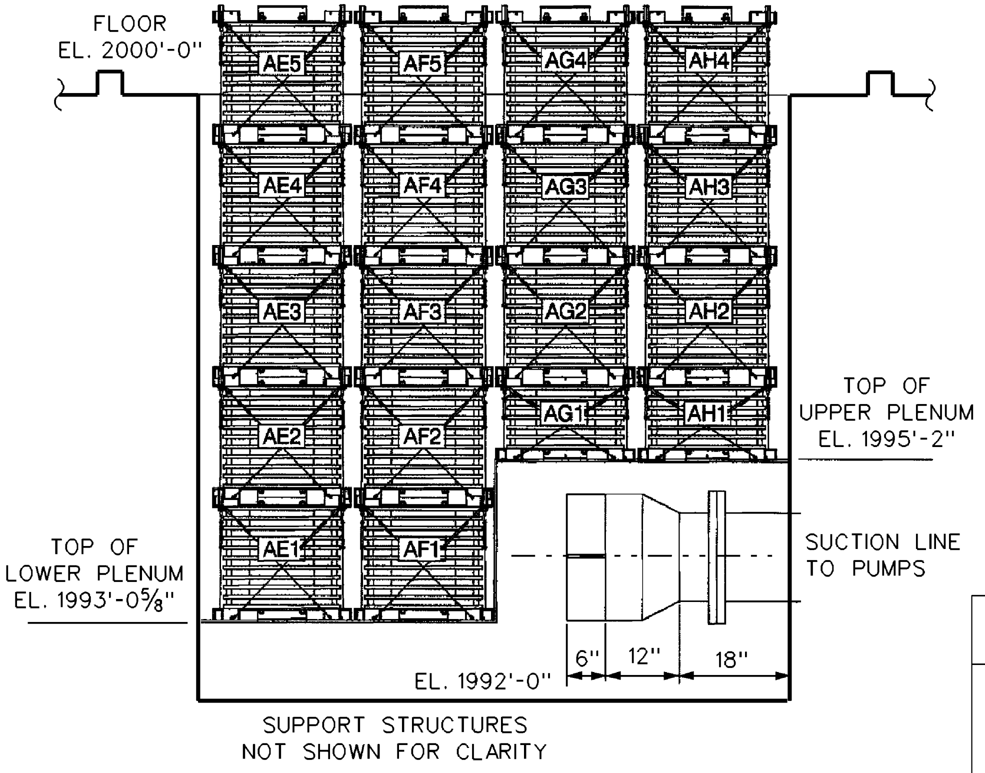
FIGURE 6.2.1-86
Analysis vs. Calculated
Containment Backpressure





SECTION A

REV.20

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FIGURE 6.2.2-3

RECIRCULATION SUMP STRAINER ARRANGEMENT

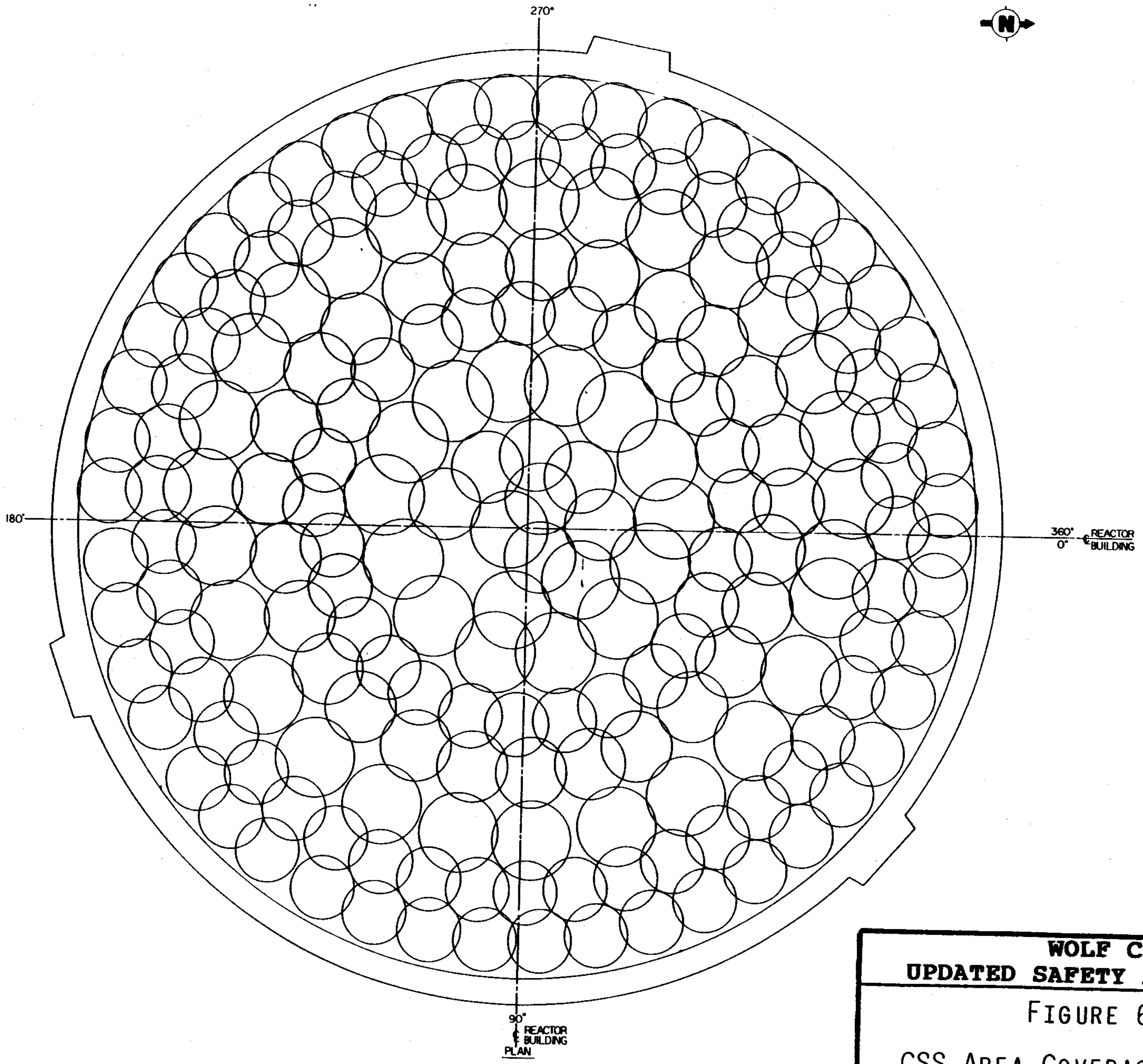

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FIGURE 6.2.2-4

CSS AREA COVERAGE AT OPERATING DECK OF CONTAINMENT

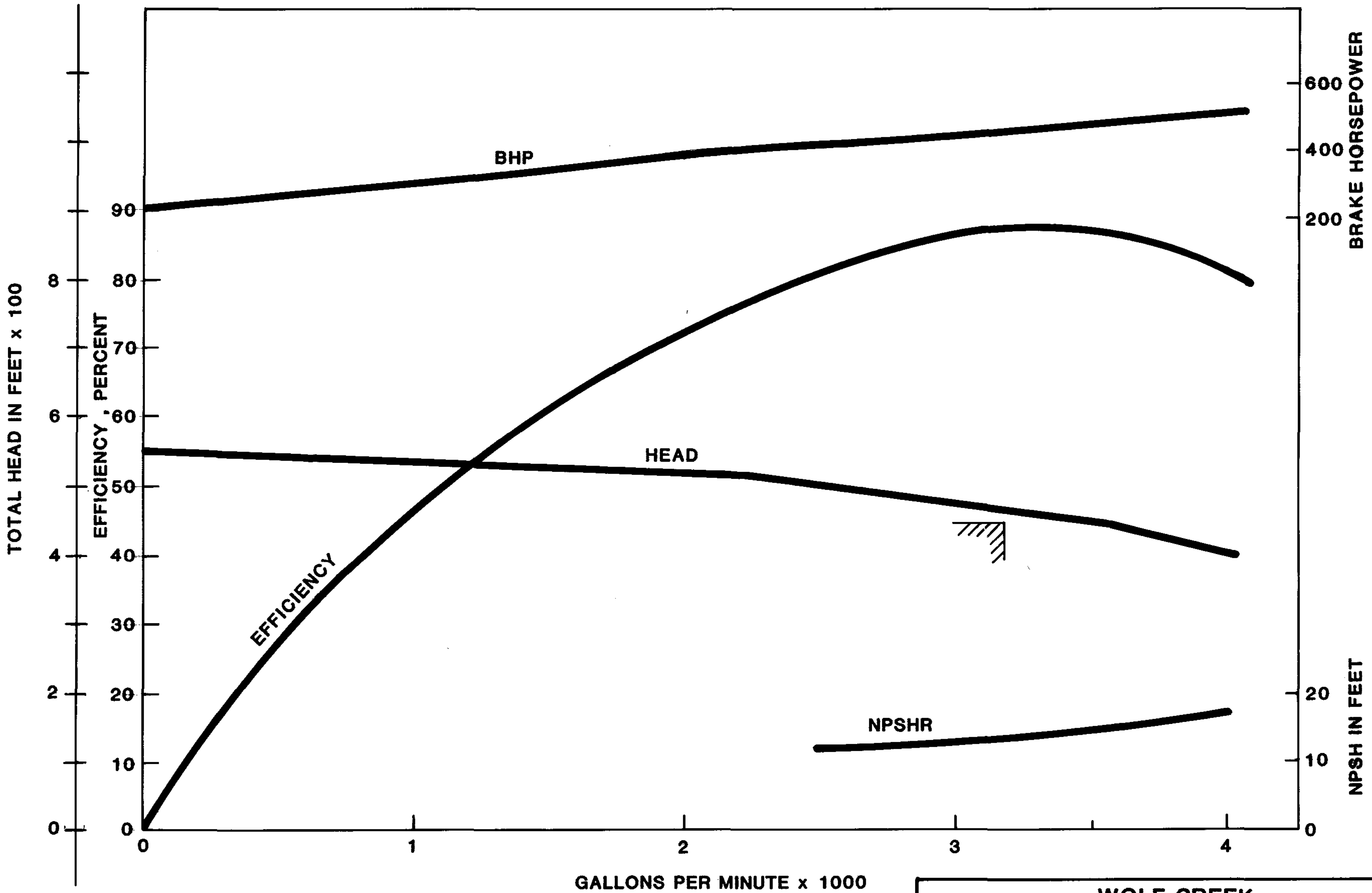

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FIGURE 6.2.2-5

CSS PUMP PERFORMANCE CURVE

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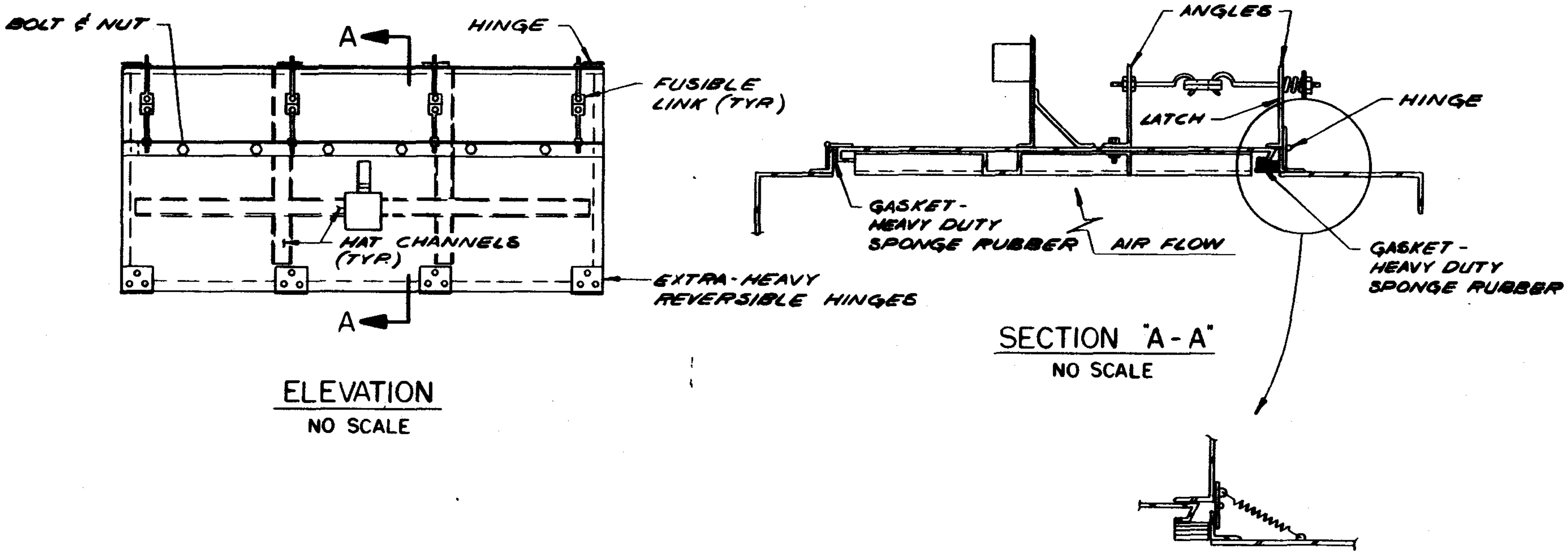

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FIGURE 6.2.2-6

TYPICAL DETAIL OF FUSIBLE LINK PLATES ON CONTAINMENT AIR COOLER

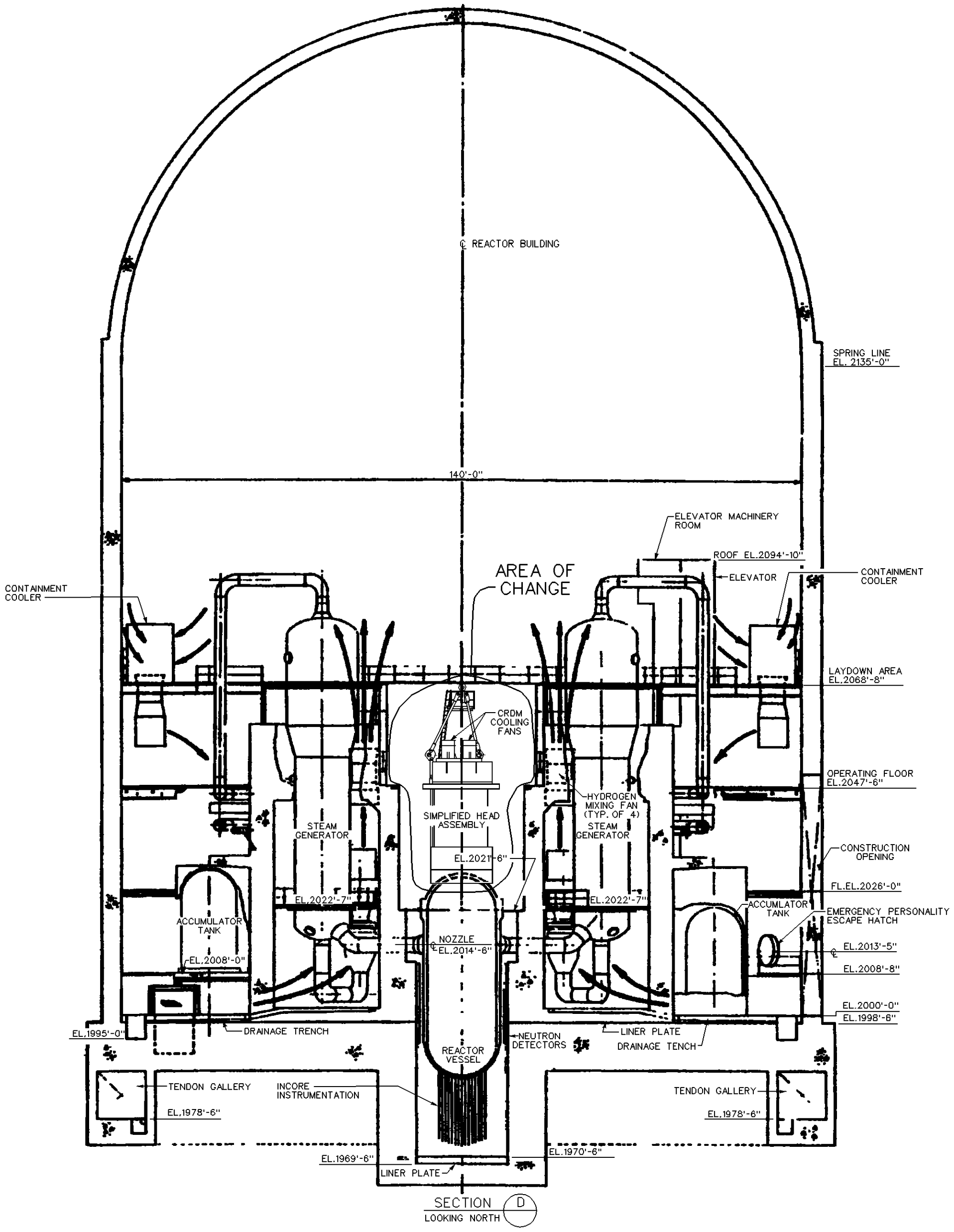

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FIGURE 6.2.2-7

EXPECTED INTERNAL AIR FLOW
PATTERN IN CONTAINMENT POST LOCA

VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: STEAM

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 40.0ft

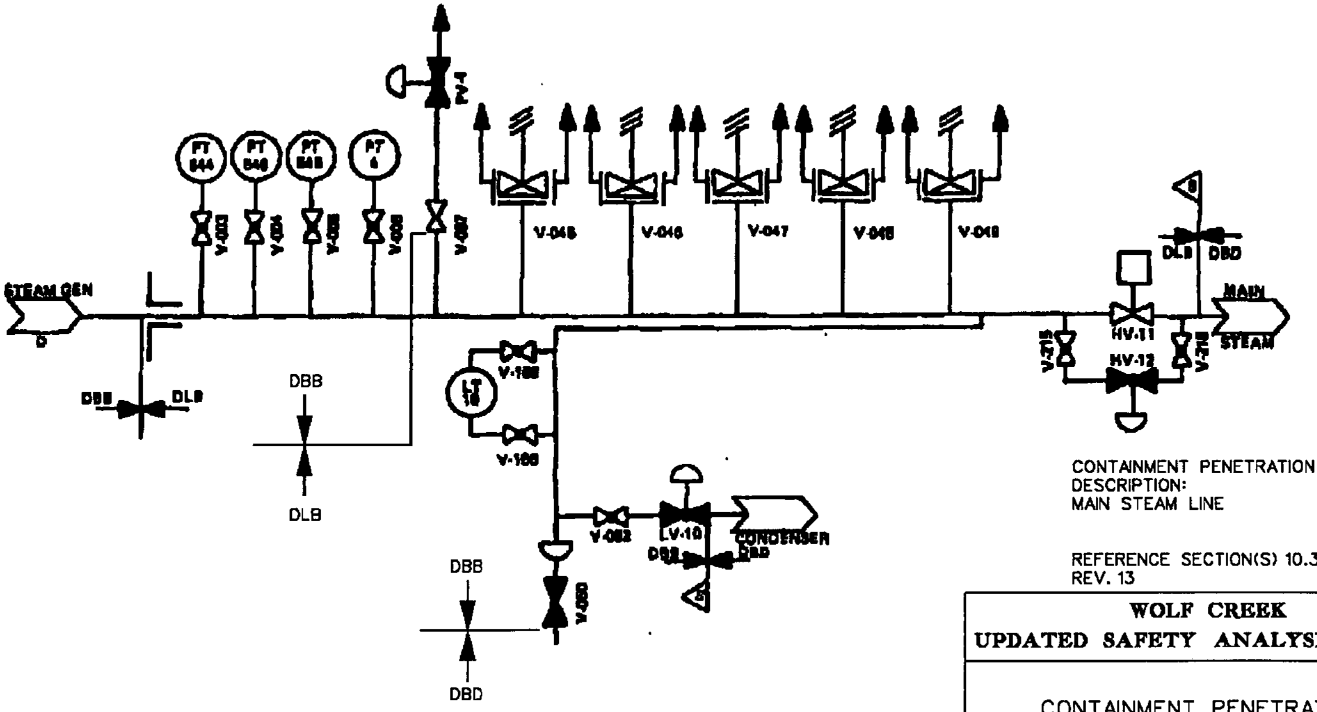
APPLICABLE GDC NO. NONE

GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED. THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

AS SHOWN ON FIGURE 10.3-1, THE STEAM GENERATOR SHELL EXTENDS TO THE VENT VALVES ON THE CONDENSATE POTS FOR THE MAIN STEAM FLOW TRANSMITTERS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.



CONTAINMENT PENETRATION NO. P-1
DESCRIPTION:
MAIN STEAM LINE

REFERENCE SECTION(S) 10.3
REV. 13

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: STEAM

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 37.9ft

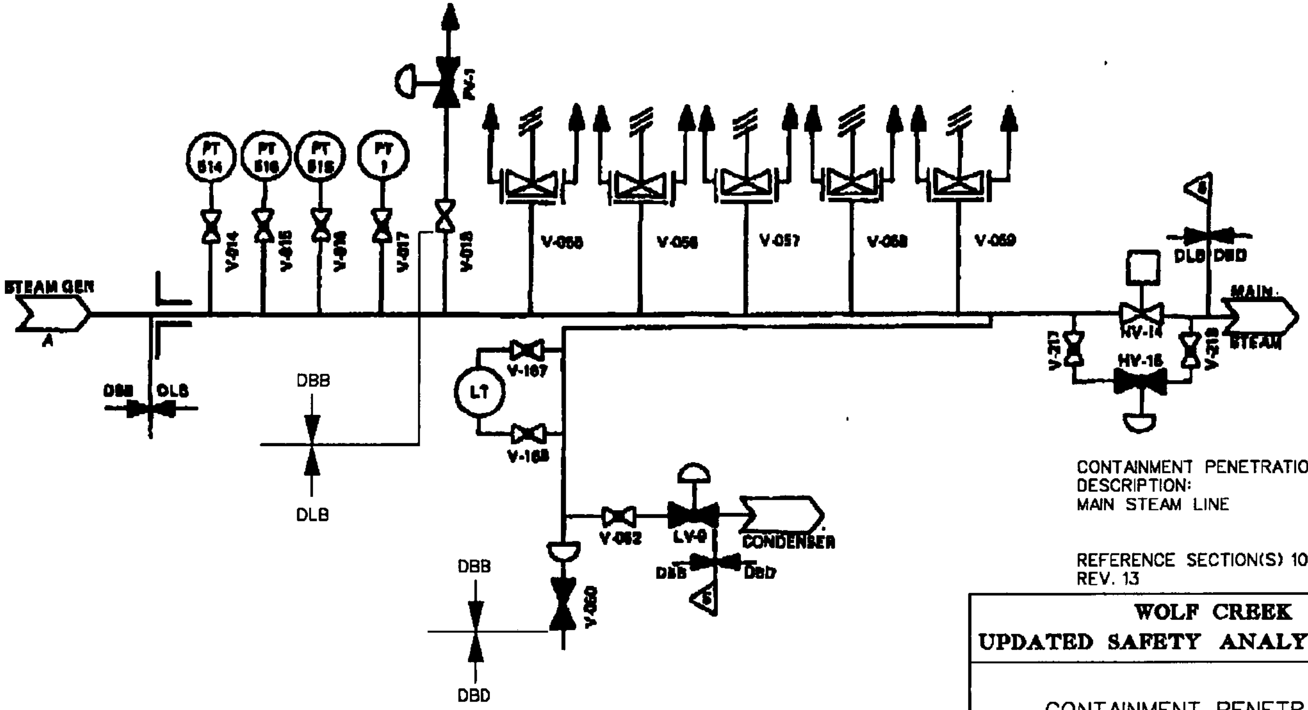
APPLICABLE GDC NO. NONE

GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED. THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

AS SHOWN ON FIGURE 10.3-1, THE STEAM GENERATOR SHELL EXTENDS TO THE VENT VALVES ON THE CONDENSATE POTS FOR THE MAIN STEAM FLOW TRANSMITTERS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.



CONTAINMENT PENETRATION NO. P-2
DESCRIPTION:
MAIN STEAM LINE

REFERENCE SECTION(S) 10.3
REV. 13

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: STEAM

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 37.9ft

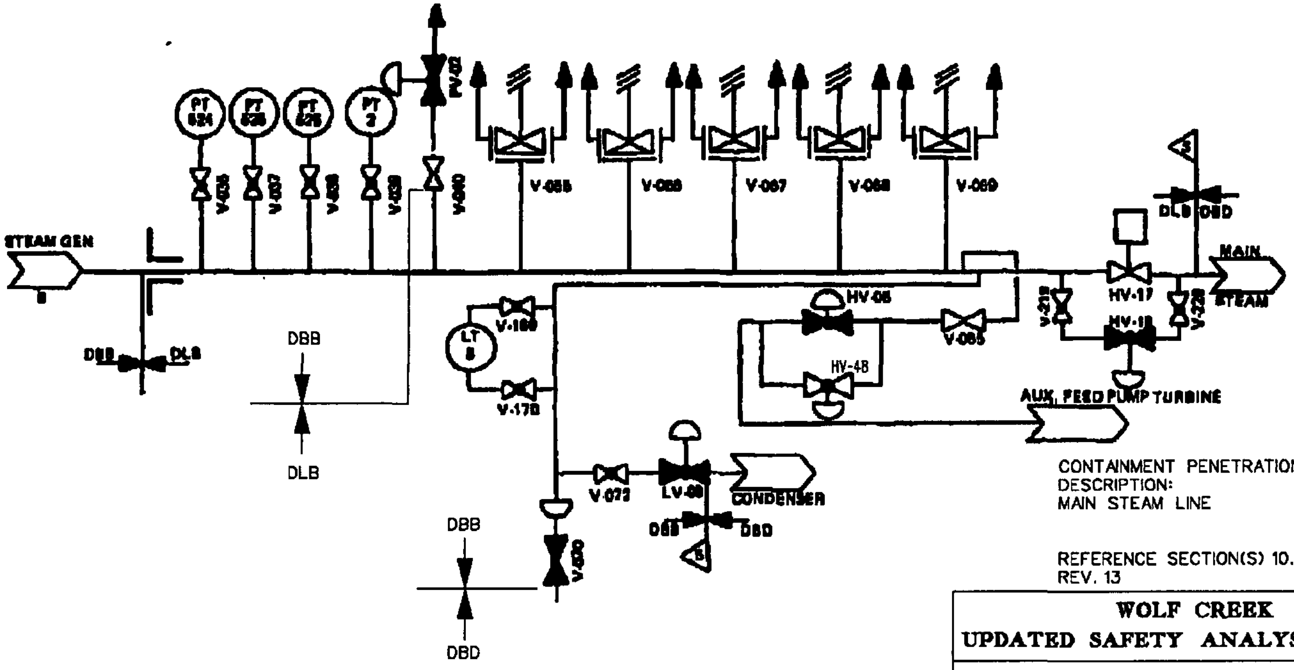
APPLICABLE GDC NO. NONE

GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED. THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

AS SHOWN ON FIGURE 10.3-1, THE STEAM GENERATOR SHELL EXTENDS TO THE VENT VALVES ON THE CONDENSATE POTS FOR THE MAIN STEAM FLOW TRANSMITTERS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.



CONTAINMENT PENETRATION NO. P-3
DESCRIPTION:
MAIN STEAM LINE

REFERENCE SECTION(S) 10.3
REV. 13

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: STEAM

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 40.0ft

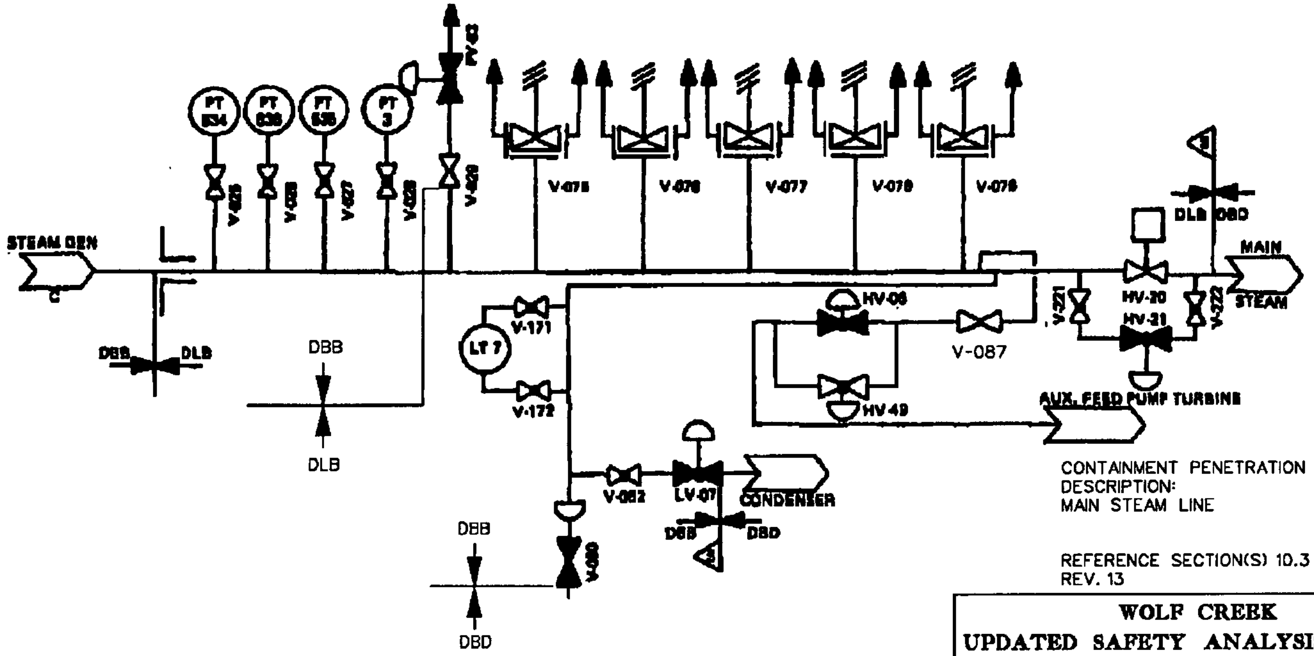
APPLICABLE GDC NO. NONE

GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED. THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

AS SHOWN ON FIGURE 10.3-1, THE STEAM GENERATOR SHELL EXTENDS TO THE VENT VALVES ON THE CONDENSATE POTS FOR THE MAIN STEAM FLOW TRANSMITTERS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.



CONTAINMENT PENETRATION NO. P-4
DESCRIPTION:
MAIN STEAM LINE

REFERENCE SECTION(S) 10.3
REV. 13

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UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 15ft

APPLICABLE GDC NO. NONE

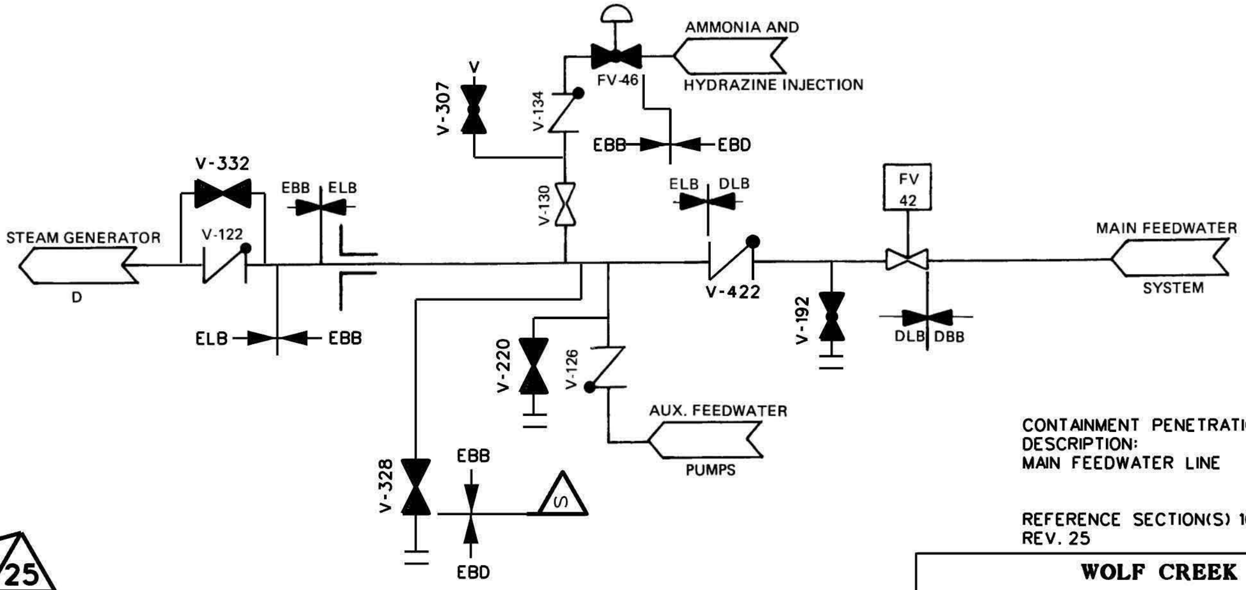
GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED. THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.

ASSETS AEV0120, AEV0121, AEV0122, AND AEV0123 HAVE VALVE DISCS, HINGE PINS AND BUSHINGS REMOVED.

25



CONTAINMENT PENETRATION NO. P-5
DESCRIPTION:
MAIN FEEDWATER LINE

REFERENCE SECTION(S) 10.4.7
REV. 25

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 13.4 FT

APPLICABLE GDC NO. NONE

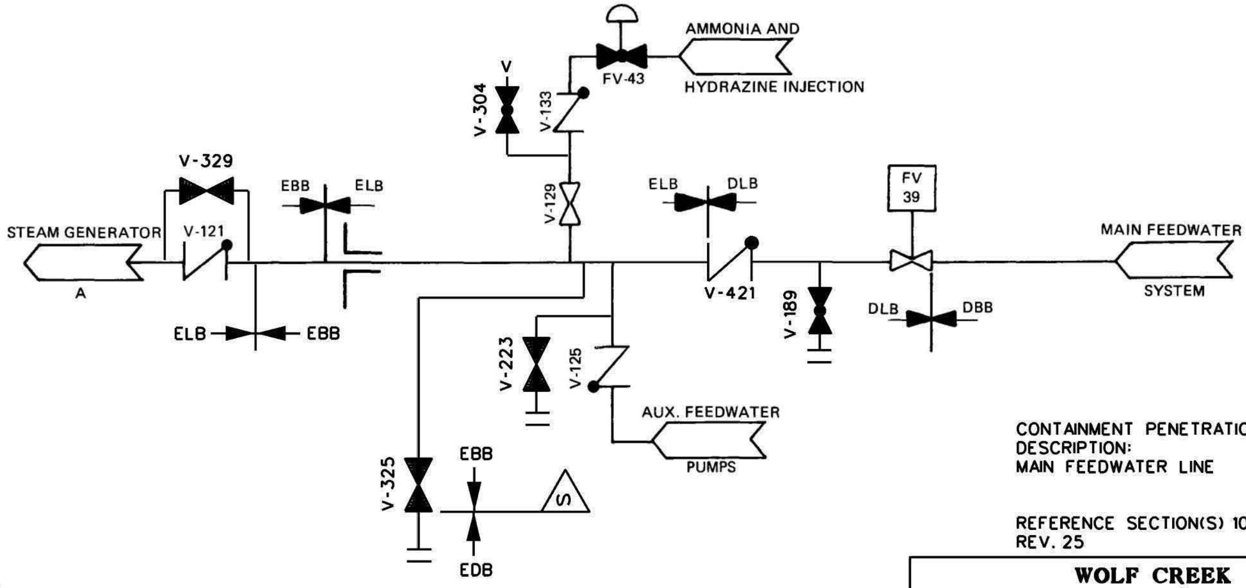
GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED. THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.

ASSETS AEV0120, AEV0121, AEV0122, AND AEV0123 HAVE VALVE DISCS, HINGE PINS AND BUSHINGS REMOVED.

25



CONTAINMENT PENETRATION NO. P-6
DESCRIPTION:
MAIN FEEDWATER LINE

REFERENCE SECTION(S) 10.4.7
REV. 25

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 13.4 FT

APPLICABLE GDC NO. NONE

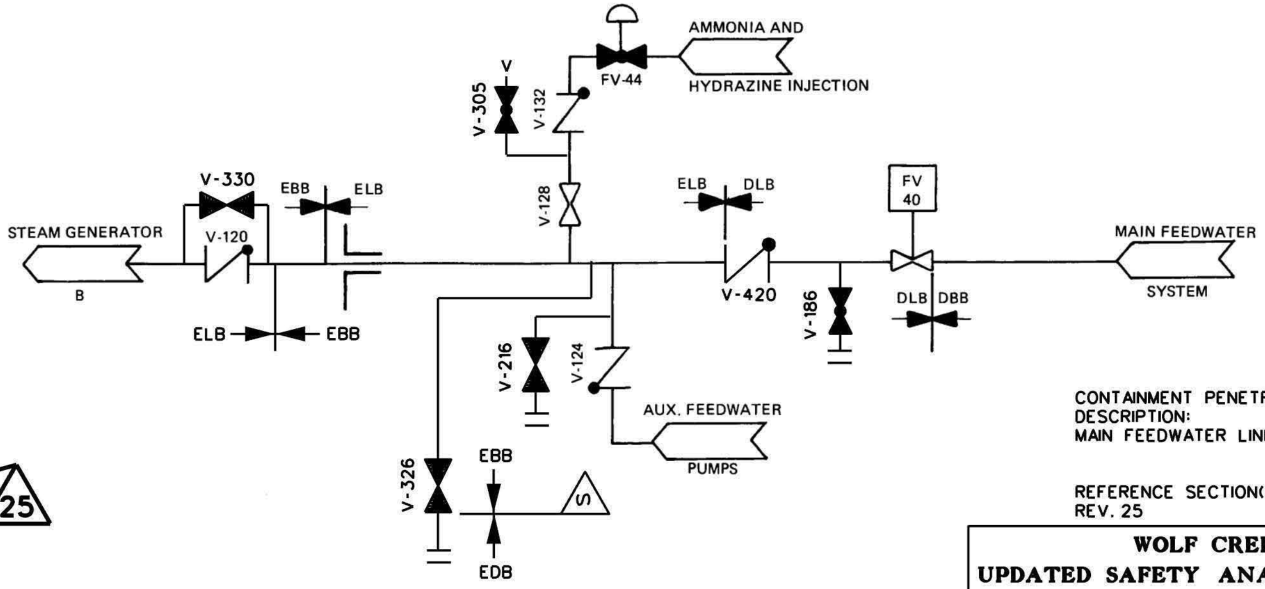
GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED. THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.

ASSETS AEV0120, AEV0121, AEV0122, AND AEV0123 HAVE VALVE DISCS, HINGE PINS AND BUSHINGS REMOVED.

25



CONTAINMENT PENETRATION NO. P-7
DESCRIPTION:
MAIN FEEDWATER LINE

REFERENCE SECTION(S) 10.4.7
REV. 25

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 15.2 FT

APPLICABLE GDC NO. NONE

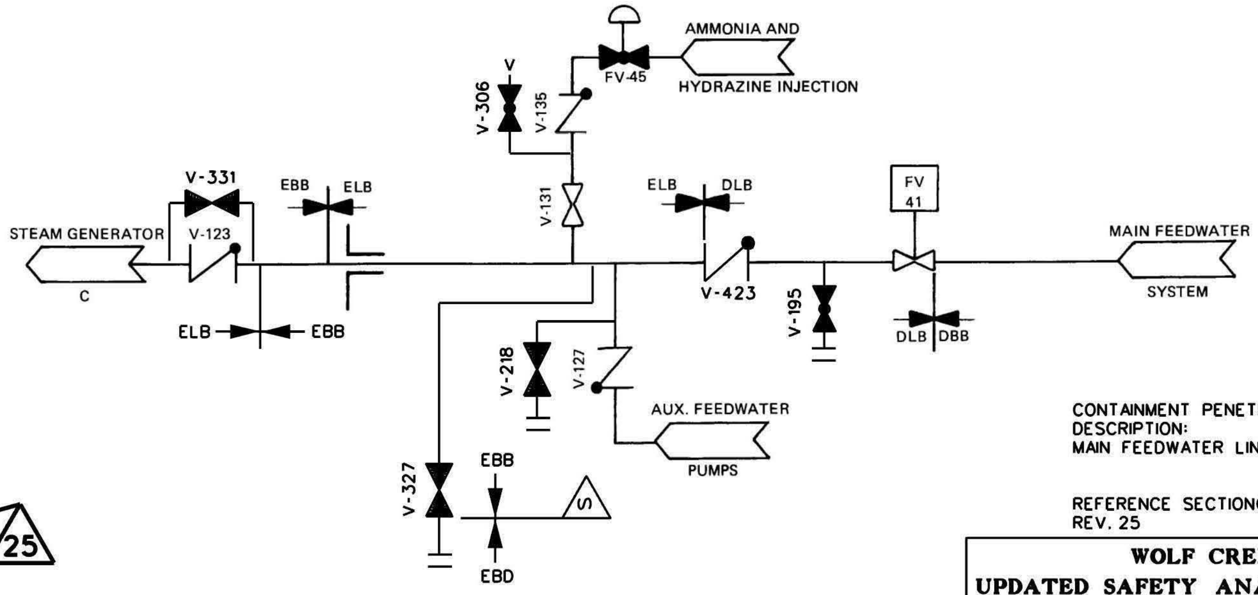
GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED. THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.

ASSETS AEV0120, AEV0121, AEV0122, AND AEV0123 HAVE VALVE DISCS, HINGE PINS AND BUSHINGS REMOVED.

25



CONTAINMENT PENETRATION NO. P-8
DESCRIPTION:
MAIN FEEDWATER LINE

REFERENCE SECTION(S) 10.4.7
REV. 25

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

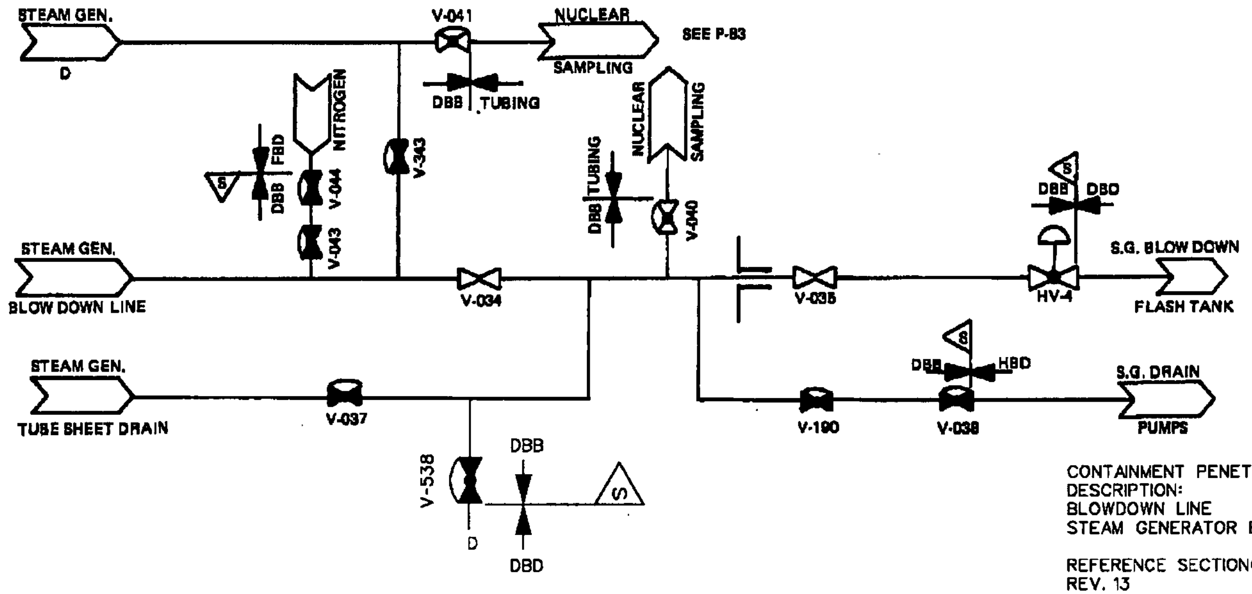
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 8.5 FT

APPLICABLE GDC NO. NONE

GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED. THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.



CONTAINMENT PENETRATION NO. P-9
DESCRIPTION:
BLOWDOWN LINE
STEAM GENERATOR BLOWDOWN SYSTEM

REFERENCE SECTION(S) 10.4.8
REV. 13

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

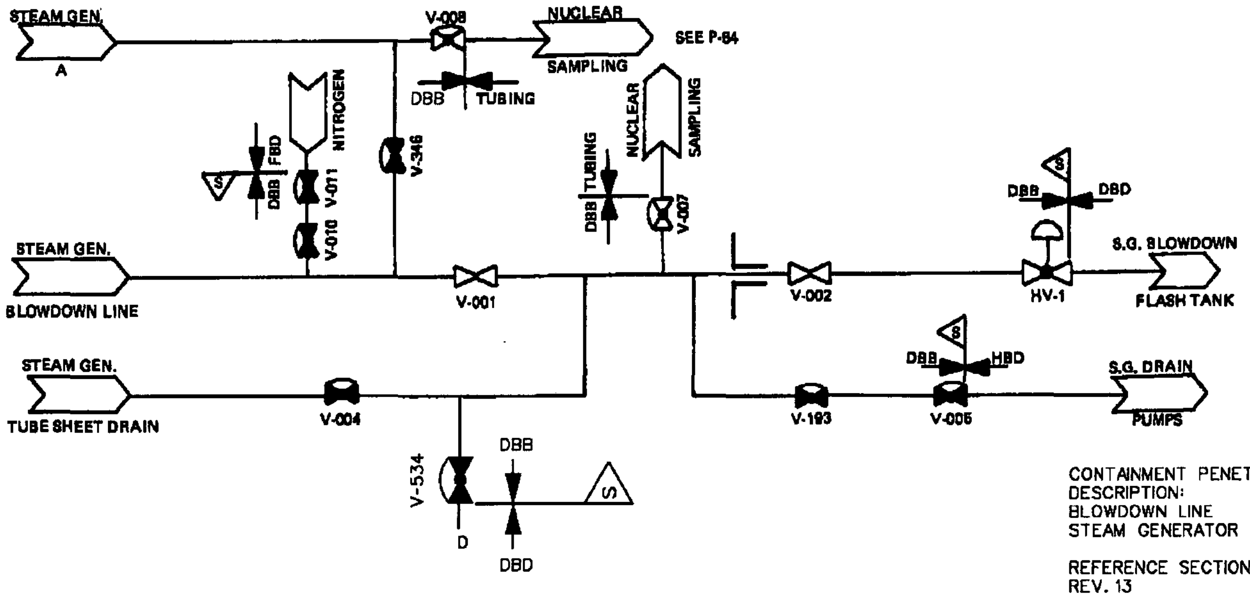
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 5.8 FT

APPLICABLE GDC NO. NONE

GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED. THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.



CONTAINMENT PENETRATION NO. P-10
DESCRIPTION:
BLOWDOWN LINE
STEAM GENERATOR BLOWDOWN SYSTEM

REFERENCE SECTION(S) 10.4.8
REV. 13

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UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

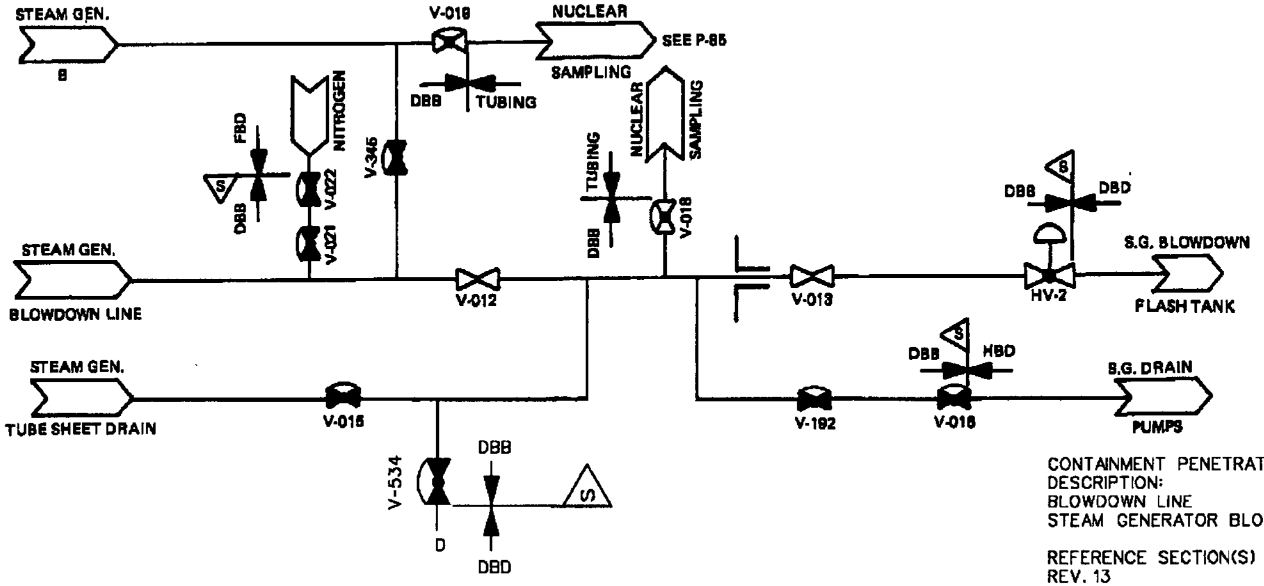
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 5.3 FT

APPLICABLE GDC NO. NONE

GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED. THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.



CONTAINMENT PENETRATION NO. P-11
DESCRIPTION:
BLOWDOWN LINE
STEAM GENERATOR BLOWDOWN SYSTEM

REFERENCE SECTION(S) 10.4.8
REV. 13

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

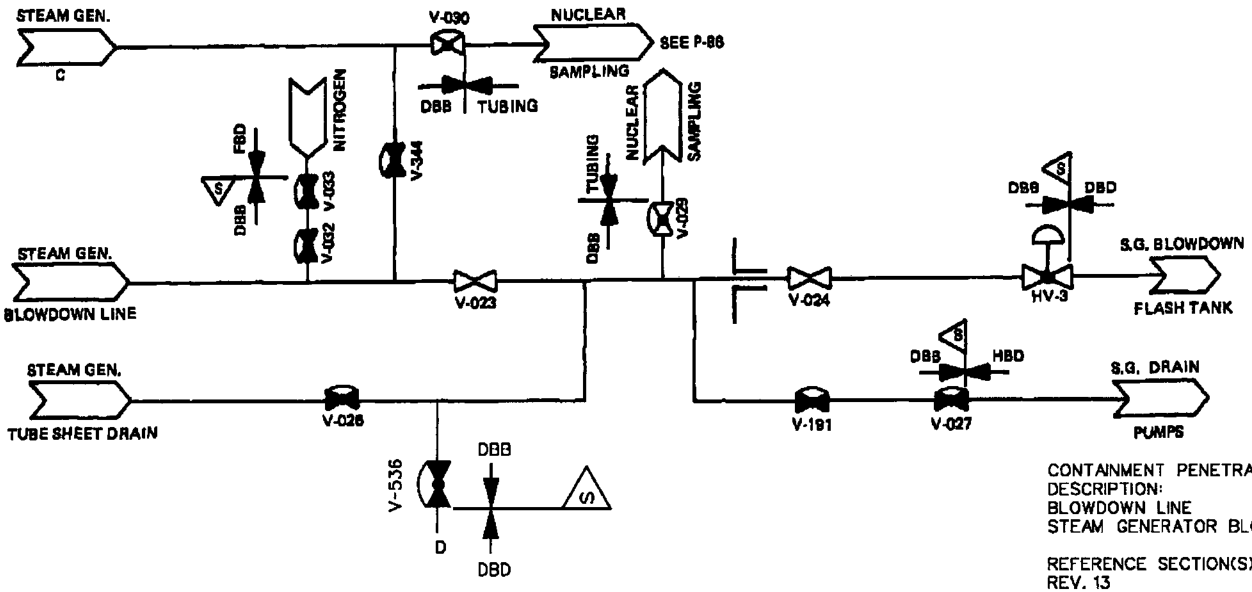
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 6.8 FT

APPLICABLE GDC NO. NONE

GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED. THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.



CONTAINMENT PENETRATION NO. P-12
DESCRIPTION:
BLOWDOWN LINE
STEAM GENERATOR BLOWDOWN SYSTEM

REFERENCE SECTION(S) 10.4.8
REV. 13

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
ENHV-07	12/12	OUTSIDE	OUT	GATE	MOTOR	4	CIS-A	REM/MAN	30	CLOSED	CLOSED	AS IS	CLOSED	OPEN	A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

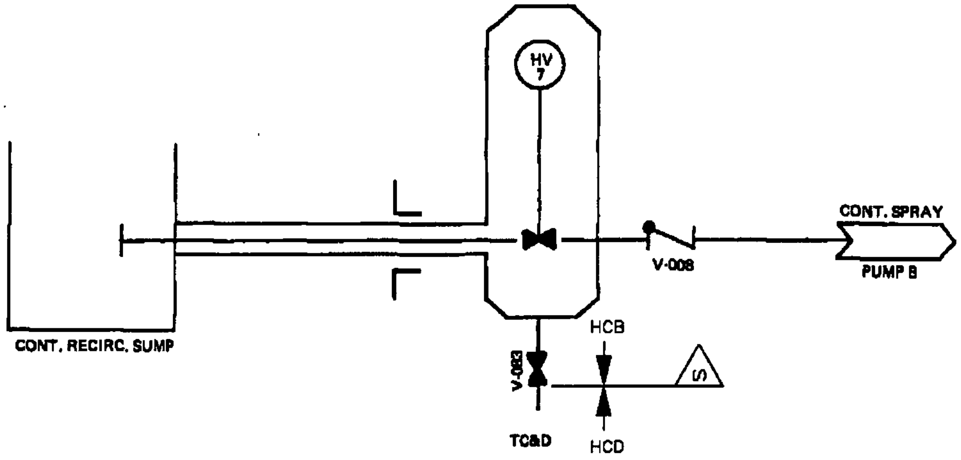
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE CONTAINMENT SPRAY SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A SINGLE REMOTE-MANUAL ISOLATION IS PROVIDED, LOCATED WITHIN A WATERTIGHT COMPARTMENT OUTSIDE THE CONTAINMENT, FOR GREATER SYSTEM RELIABILITY. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS CLOSED OUTSIDE THE CONTAINMENT AND IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT.

LOCAL TESTING OF THE VALVE OR THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT IS NOT REQUIRED SINCE THE SYSTEM IS OPERATED AND INSPECTED DURING NORMAL PLANT OPERATION TO ASSURE THAT THE INTEGRITY IS BEING MAINTAINED.



CONTAINMENT PENETRATION NO. P-13
DESCRIPTION:
RECIRCULATION LINE
CONTAINMENT SPRAY SYSTEM

REFERENCE SECTION(S) 6.2.2
REV. 13

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EJHV-8811B	14/14	OUTSIDE	OUT	GATE	MOTOR	4	REM/MAN	SIS&RWST-LO	N/A	CLOSED	CLOSED	AS IS	CLOSED	OPEN	A
EJV-224	¾ / ¾	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EJV-225	¾ / ¾	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

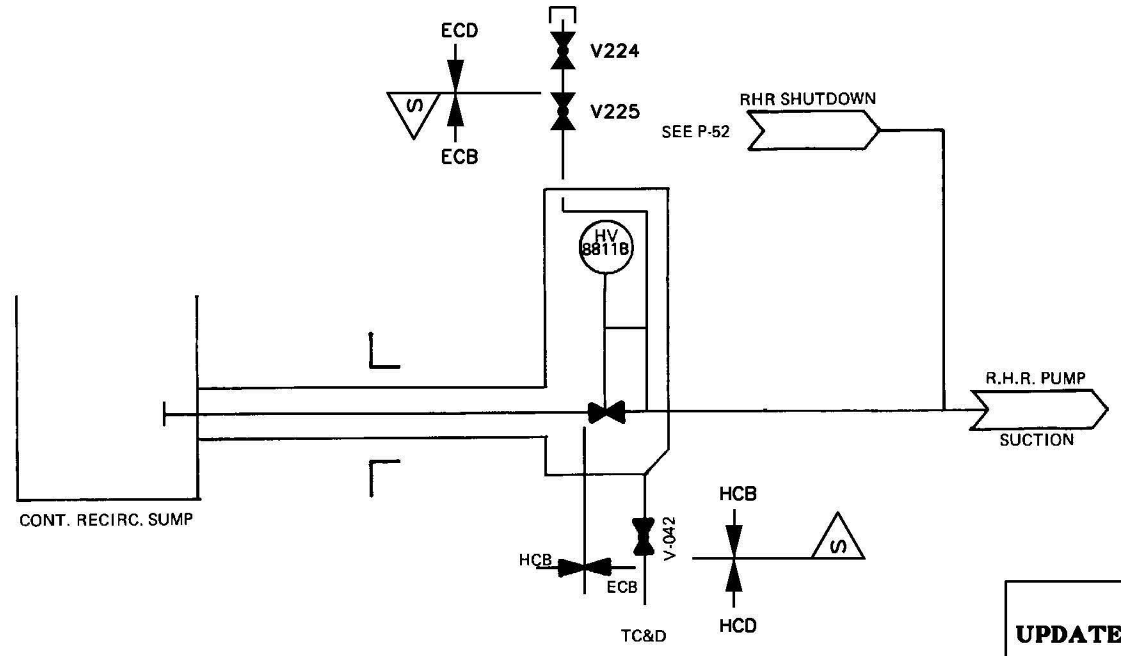
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE RHR SYSTEM. RHR IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A SINGLE REMOTE-MANUAL ISOLATION IS PROVIDED, LOCATED WITHIN A WATERTIGHT COMPARTMENT OUTSIDE THE CONTAINMENT, FOR GREATER SYSTEM RELIABILITY. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS CLOSED OUTSIDE THE CONTAINMENT AND IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT.

LOCAL TESTING OF THE RHR VALVE OR THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT IS NOT REQUIRED SINCE THE SYSTEM IS OPERATED AND INSPECTED DURING NORMAL PLANT OPERATION TO ASSURE THAT THE INTEGRITY IS BEING MAINTAINED.



CONTAINMENT PENETRATION NO. P-14
DESCRIPTION:
RECIRCULATION LINE
RESIDUAL HEAT REMOVAL SYSTEM

REFERENCE SECTION(S) 5.4.7 & 6.3

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FIGURE 6.2.4-1

CONTAINMENT PENETRATIONS

VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EJHV-8811A	14/14	OUTSIDE	OUT	GATE	MOTOR	1	REM/MAN	SIS AND RWST-LO	N/A	CLOSED	CLOSED	AS IS	CLOSED	OPEN	A
EJV-220	¾ / ¾	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EJV-222	¾ / ¾	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

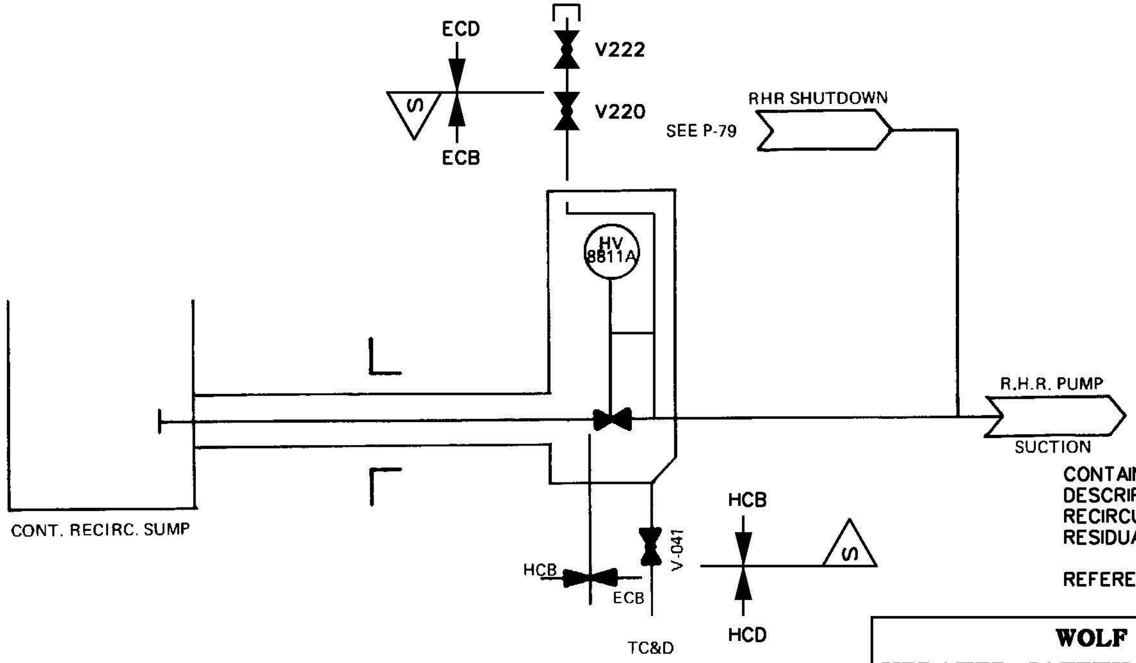
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE RHR SYSTEM. RHR IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A SINGLE REMOTE-MANUAL ISOLATION IS PROVIDED, LOCATED WITHIN A WATERTIGHT COMPARTMENT OUTSIDE THE CONTAINMENT, FOR GREATER SYSTEM RELIABILITY. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS CLOSED OUTSIDE THE CONTAINMENT AND IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT.

LOCAL TESTING OF THE RHR VALVE OR THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT IS NOT REQUIRED SINCE THE SYSTEM IS OPERATED AND INSPECTED DURING NORMAL PLANT OPERATION TO ASSURE THAT THE INTEGRITY IS BEING MAINTAINED.



CONTAINMENT PENETRATION NO. P-15
DESCRIPTION:
RECIRCULATION LINE
RESIDUAL HEAT REMOVAL SYSTEM

REFERENCE SECTION(S) 5.4.7 & 6.3

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FIGURE 6.2.4-1

CONTAINMENT PENETRATIONS

VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
ENHV-01	12/12	OUTSIDE	OUT	GATE	MOTOR	1	CIS-A	REM/MAN	30	CLOSED	CLOSED	AS IS	CLOSED	OPEN	A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

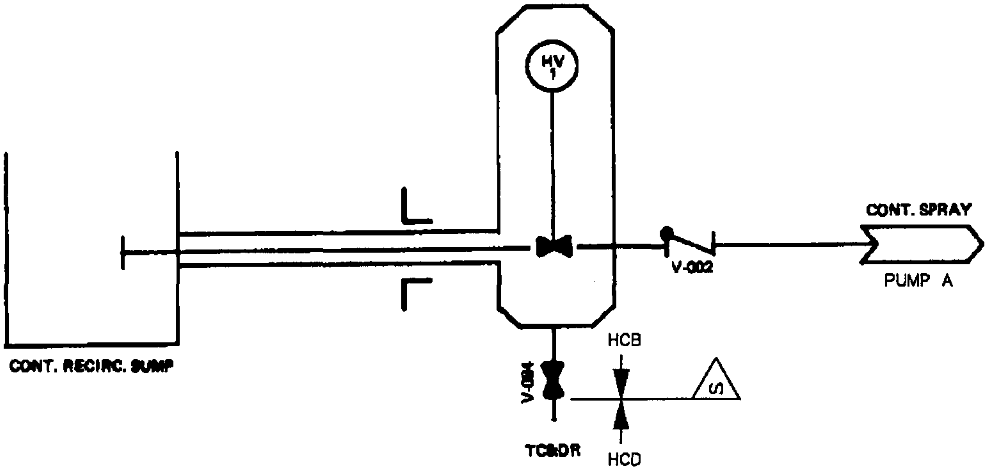
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE CONTAINMENT SPRAY SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A SINGLE REMOTE-MANUAL ISOLATION IS PROVIDED, LOCATED WITHIN A WATERTIGHT COMPARTMENT OUTSIDE THE CONTAINMENT, FOR GREATER SYSTEM RELIABILITY. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS CLOSED OUTSIDE THE CONTAINMENT AND IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT.

LOCAL TESTING OF THE VALVE OR THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT IS NOT REQUIRED SINCE THE SYSTEM IS OPERATED AND INSPECTED DURING NORMAL PLANT OPERATION TO ASSURE THAT THE INTEGRITY IS BEING MAINTAINED.



CONTAINMENT PENETRATION NO. P-16
DESCRIPTION:
RECIRCULATION LINE
CONTAINMENT SPRAY SYSYTEM

REFERENCE SECTION(S) 6.2.2
REV. 13

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EJHCV-8825	¾/¾	INSIDE	IN	GLOBE	AIR	1	CIS-A	NONE	10	CLOSED	CLOSED	CLOSED	CLOSED	N/A	A
EJHV-8840	10/10	OUTSIDE	IN	GATE	MOTOR	4	NONE	REM/MAN	N/A	CLOSED	CLOSED	AS IS	CLOSED	OPEN	A
EJV-056	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EJV-124	1/1	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EJV-122	¾	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EJV-118,120	1/1	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EJV-175,6,7,8	¾/¾	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED		N/A
EJV-218	¾/¾	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EJV-219	¾/¾	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EJ-8841A	6/6	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	OPEN	A
EJ-8841B	6/6	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	OPEN	A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

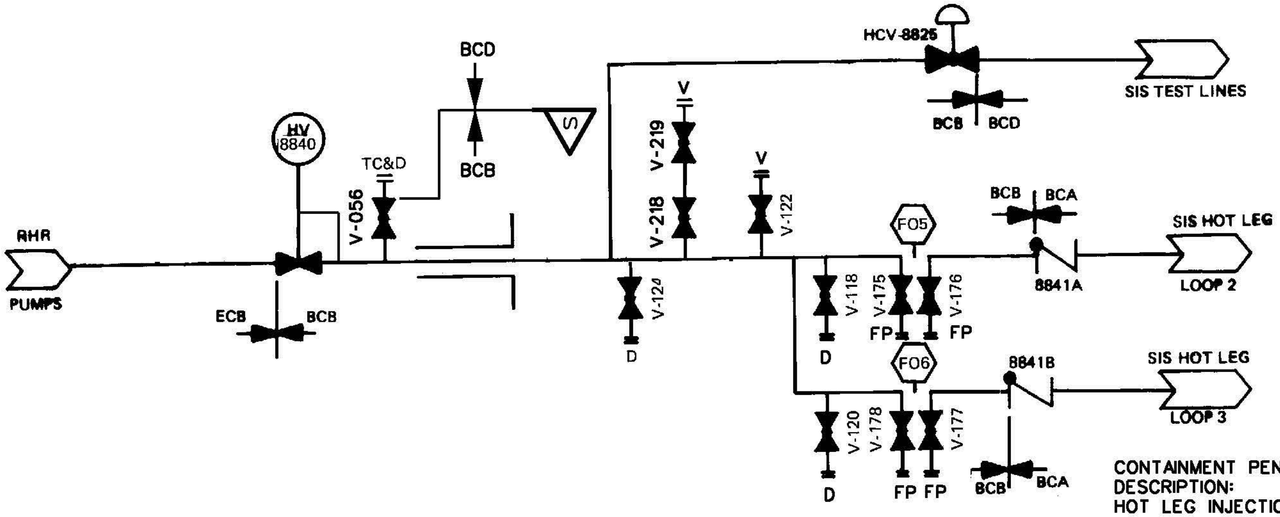
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE RESIDUAL HEAT REMOVAL SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A CHECK VALVE IS PROVIDED FOR EACH BRANCH LINE INSIDE THE CONTAINMENT, AND A REMOTE-MANUAL ISOLATION VALVE IS PROVIDED OUTSIDE THE CONTAINMENT. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS CLOSED OUTSIDE THE CONTAINMENT AND IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT. LEAKAGE DETECTION FROM THIS LINE OUTSIDE THE CONTAINMENT IS PROVIDED, AS DESCRIBED IN SECTION 9.3.3.

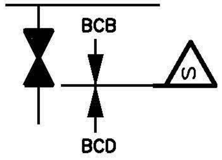
LOCAL TESTING OF THE VALVES OR THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT IS NOT REQUIRED SINCE THE SYSTEM IS OPERATED AND INSPECTED DURING NORMAL PLANT OPERATION TO ASSURE THAT THE INTEGRITY IS BEING MAINTAINED.



CONTAINMENT PENETRATION NO. P-21
DESCRIPTION:
HOT LEG INJECTION
RESIDUAL HEAT REMOVAL SYSTEM

REFERENCE SECTION(S) 5.4.7/6.3

NOTE: ALL VENTS, DRAINS AND FLOW POINTS AS INDICATED BELOW.



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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
BBHV-8351B	2/2	OUTSIDE	IN	GLOBE	MOTOR	4	NONE	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	C
BBV-354	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
BBV-246	¾/¾	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
BBV148	2/2	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	OPEN	OPEN	N/A	OPEN	CLOSED	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 11.7ft.

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

THIS PENETRATION PIPING HAS A HIGH PRESSURE WATER INFLOW WHICH PRECLUDES THE NEED FOR AUTOMATIC ISOLATION OF THIS PENETRATION. THE CVCS CHARGING PUMPS SUPPLY REACTOR COOLANT PUMP SEAL INJECTION WATER, AND THERE IS A POTENTIAL FOR DAMAGE TO THE REACTOR COOLANT PUMP IF UNDESIRED ISOLATION SHOULD OCCUR.

THE ISOLATION CAN BE AFFECTED BY REMOTE-MANUAL CLOSURE OF THE MOTOR-OPERATED VALVE BY THE OPERATOR AFTER THE CHARGING PUMPS COMPLETE THEIR SAFETY FUNCTION.

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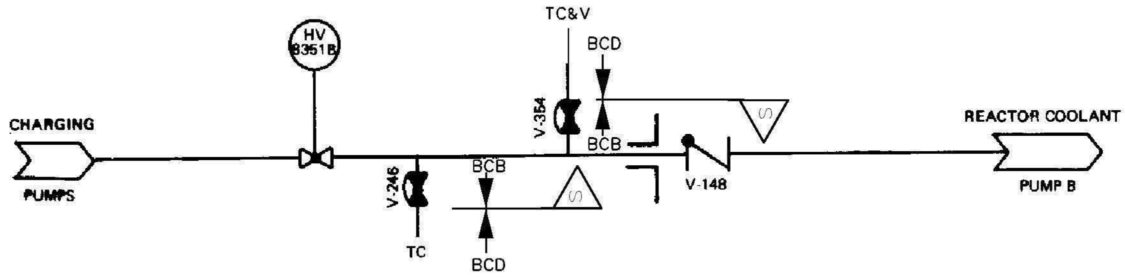

CONTAINMENT PENETRATION NO. P-22
DESCRIPTION:
RCP SEAL WATER SUPPLY
REACTOR COOLANT SYSTEM

REFERENCE SECTION(S) 5.0
REV. 23

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
BGHV-8160	3/3	INSIDE	OUT	GLOBE	AIR	1	CIS-A	NONE	10	OPEN	OPEN	CLOSED	CLOSED	N/A	C
BGV-363	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	NONE	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
BGHV-8152	3/3	OUTSIDE	OUT	GLOBE	AIR	4	CIS-A	NONE	10	OPEN	OPEN	CLOSED	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

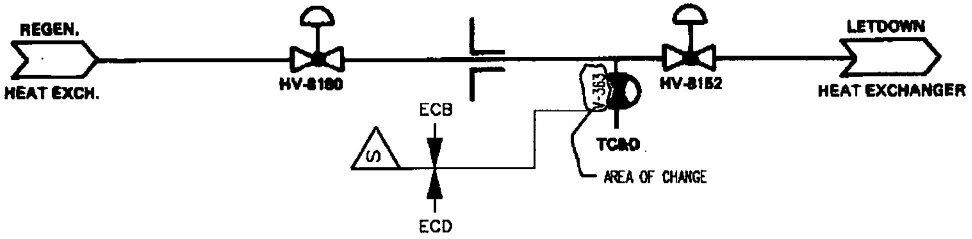
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 11.6ft

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-23
DESCRIPTION:
NORMAL LETDOWN
CHEMICAL & VOLUME CONTROL SYSTEM

REFERENCE SECTION(S) 9.3.4
REV. 15

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
BGHV-8112	2/2	INSIDE	OUT	GLOBE	MOTOR	1	CIS-A	NONE	10	OPEN	OPEN	AS IS	CLOSED	N/A	C
BGV-135	3/4/3/4	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	C
BGHV-8100	2/2	OUTSIDE	OUT	GLOBE	MOTOR	4	CIS-A	NONE	10	OPEN	OPEN	AS IS	CLOSED	N/A	C
BGV-457	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

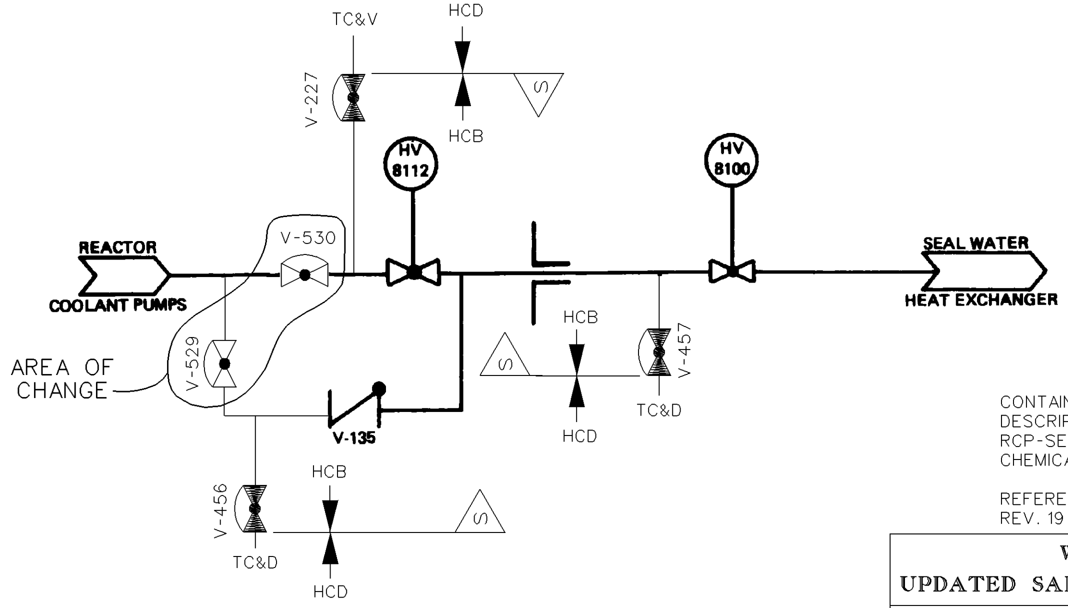
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 12.6ft

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-24
DESCRIPTION:
RCP-SEAL WATER RETURN
CHEMICAL & VOLUME CONTROL SYSTEM

REFERENCE SECTION(S) 9.3.4
REV. 19

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
BLHV-8047	3/3	OUTSIDE	IN	DIAPHRAGM	AIR	4	CIS-A	NONE	10	OPEN	OPEN	CLOSED	CLOSED	N/A	C
BLV-054	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
BL-8046	3/3	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	OPEN	OPEN	N/A	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

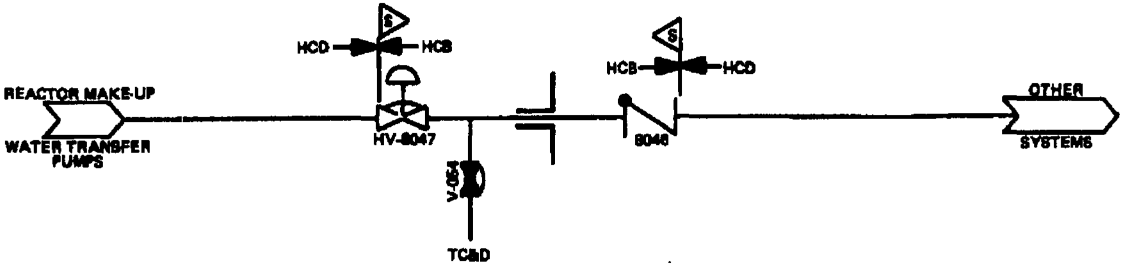
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 12.2ft

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-25
DESCRIPTION:
REACTOR MAKEUP WATER
REACTOR MAKEUP WATER SYSTEM

REFERENCE SECTION(S) 9.2.7
REV. 11

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
HBHV-7176	3/3	INSIDE	OUT	DIAPHRAGM	AIR	1	CIS-A	NONE	10	OPEN	OPEN	CLOSED	CLOSED	N/A	C
HBHV-7136	3/3	OUTSIDE	OUT	DIAPHRAGM	AIR	4	CIS-A	NONE	10	OPEN	OPEN	CLOSED	CLOSED	N/A	C
HBV-419	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

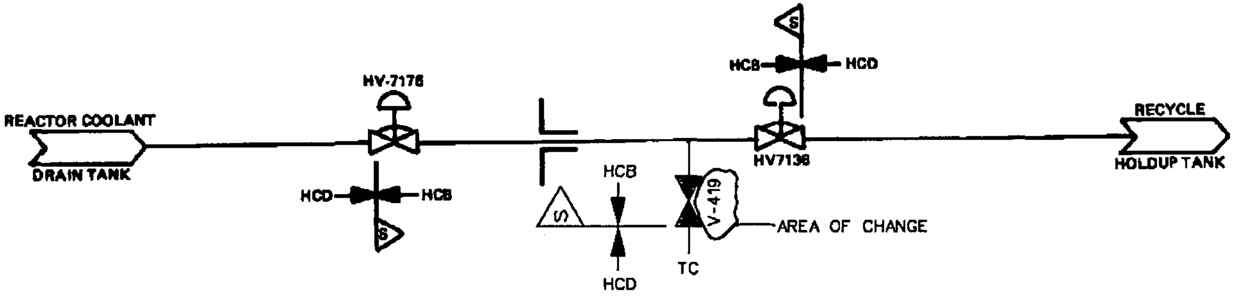
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 11.9ft

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-26
DESCRIPTION:
REACTOR COOLANT DRAIN TANK
DISCHARGE
LIQUID RADWASTE SYSTEM
REFERENCE SECTION(S) 11.2
REV. 15

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EJHV-8809B	10/10	OUTSIDE	IN	GATE	MOTOR	4	NONE	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	A
EJV-058	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EJHCV-8890B	¾/¾	INSIDE	IN	GLOBE	AIR	4	CIS-A	NONE	13	CLOSED	CLOSED	CLOSED	CLOSED	N/A	A
EJV-086	1/1	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EJV-088,090	¾/¾	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EP-8818C	6/6	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	OPEN	N/A	OPEN	CLOSED	A
EJV-179, EJV-180	¾/¾	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EP-8818D	6/6	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	OPEN	N/A	OPEN	CLOSED	A
EJV-166	¾/¾	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

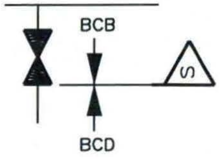
APPLICABLE GDC NO. 55

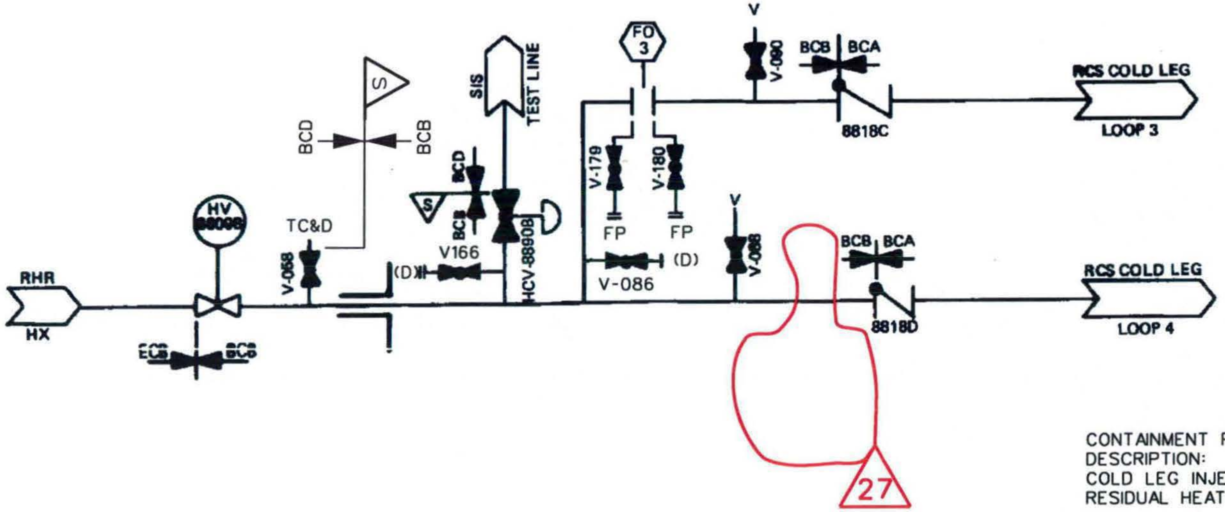
GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE RESIDUAL HEAT REMOVAL SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A CHECK VALVE IS PROVIDED FOR EACH BRANCH LINE INSIDE THE CONTAINMENT, AND A REMOTE-MANUAL ISOLATION VALVE IS PROVIDED OUTSIDE THE CONTAINMENT. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS CLOSED OUTSIDE THE CONTAINMENT AND IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT.

LOCAL TESTING OF THE VALVE OR THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT IS NOT REQUIRED SINCE THE SYSTEM IS OPERATED AND INSPECTED DURING NORMAL PLANT OPERATION TO ASSURE THAT THE INTEGRITY IS BEING MAINTAINED.

NOTE: ALL VENTS, DRAINS AND FLOW POINTS AS INDICATED BELOW.





CONTAINMENT PENETRATION NO. P-27
DESCRIPTION:
COLD LEG INJECTION
RESIDUAL HEAT REMOVAL SYSTEM

REFERENCE SECTION(S) 5.4.7 & 6.3
REV. 27

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EFHV-32	14/14	OUTSIDE	IN	BUTTERFLY	MOTOR	4	SIS	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	C
EFHV-34	14/14	INSIDE	IN	BUTTERFLY	MOTOR	4	SIS	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	C
EFV-278	1/1	INSIDE	N/A	GATE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

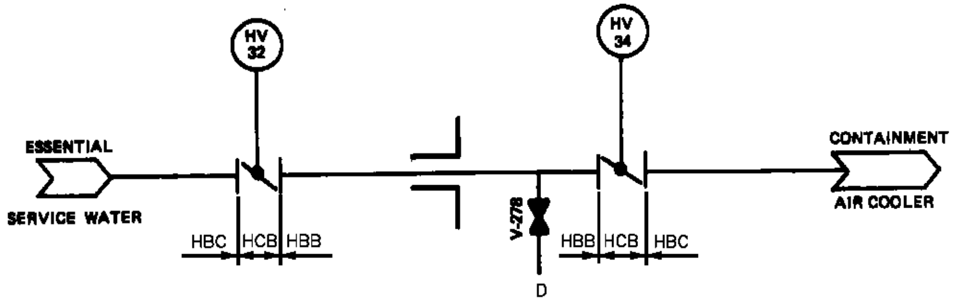
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 17.2ft

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE ESSENTIAL SERVICE WATER SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A REMOTE-MANUAL POWER-OPERATED VALVE IS LOCATED INSIDE, AND A REMOTE-MANUAL POWER-OPERATED VALVE IS LOCATED OUTSIDE THE CONTAINMENT.

THESE VALVES ARE POWERED FROM THE SAME POWER SOURCE FOR GREATER SYSTEM RELIABILITY. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS A CLOSED SYSTEM INSIDE THE CONTAINMENT, WHICH IS DESIGNED AND CONSTRUCTED IN ACCORDANCE WITH ASME SECTION III, CLASS 3 REQUIREMENTS. THE ESSENTIAL SERVICE WATER LINES ARE NOT VENTED OR DRAINED DURING A TYPE A TEST SINCE THE AIR COOLERS MAY BE REQUIRED TO COOL THE CONTAINMENT. A TYPE C TEST IS PERFORMED.



CONTAINMENT PENETRATION NO. P-28
DESCRIPTION:
ESW TO CONTAINMENT AIR COOLER
ESSENTIAL SERVICE WATER SYSTEM

REFERENCE SECTION(S) 6.2.2
REV. 13

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EFHV-46	14/14	INSIDE	OUT	BUTTERFLY	MOTOR	4	SIS	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	C
EFV-279	1/1	INSIDE	N/A	GATE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EFHV-50	14/14	OUTSIDE	OUT	BUTTERFLY	MOTOR	4	SIS	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

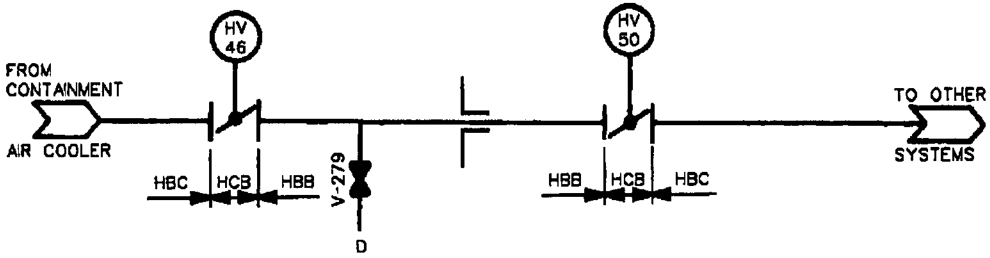
APPLICABLE GDC NO. 56

GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE ESSENTIAL SERVICE WATER SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A REMOTE-MANUAL POWER-OPERATED VALVE IS LOCATED INSIDE AND A REMOTE-MANUAL POWER-OPERATED VALVE IS LOCATED OUTSIDE THE CONTAINMENT.

THESE VALVES ARE POWERED FROM THE SAME POWER SOURCE FOR GREATER SYSTEM RELIABILITY. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS A CLOSED SYSTEM INSIDE THE CONTAINMENT, WHICH IS DESIGNED AND CONSTRUCTED IN ACCORDANCE WITH ASME SECTION III, CLASS 3 REQUIREMENTS.

THE ESSENTIAL SERVICE WATER LINES ARE NOT VENTED OR DRAINED DURING A TYPE A TEST SINCE THE AIR COOLERS MAY BE REQUIRED TO COOL THE CONTAINMENT. A TYPE C TEST IS PERFORMED.



CONTAINMENT PENETRATION NO. P-29
DESCRIPTION:
ESW FROM CONTAINMENT AIR COOLERS
ESSENTIAL SERVICE WATER SYSTEM

REFERENCE SECTION(S) 6.2.2
REV. 13

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
KAFV-29	1½/2	OUTSIDE	IN	GLOBE	AIR	1	CIS-A	REM/MAN	5	OPEN	OPEN	CLOSED	CLOSED	OPEN	C
KAV-218	1½/1½	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	C
KAV-204	1½/1½	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	OPEN	OPEN	N/A	CLOSED	OPEN	C

AREA OF CHANGE

ASSOCIATED WITH A SAFETY FEATURES SYS. YES☐ NO☒

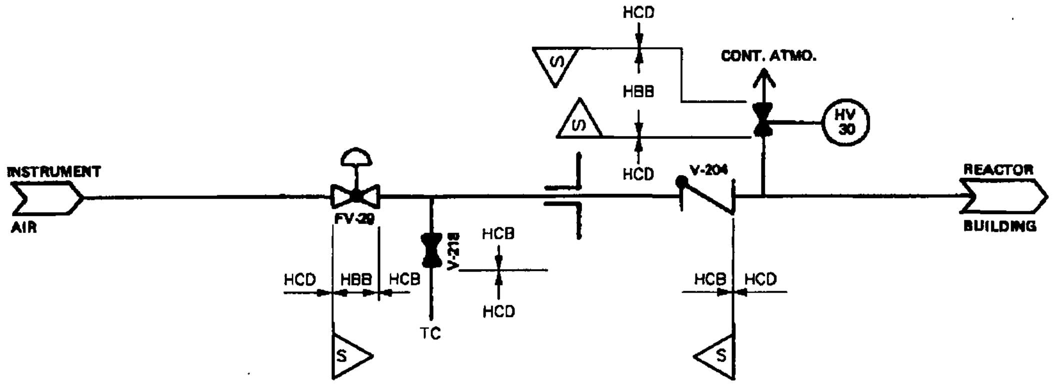
FLUID CONTAINED: AIR

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 7.9ft

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-30
DESCRIPTION:
INST. AIR AND H_2 CONTROL MAKEUP AIR
COMPRESSED AIR SYSTEM

REFERENCE SECTION(S) 9.3.1
REV. 15

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
LFFV-95	6/6	INSIDE	OUT	GATE	MOTOR	1	CIS-A	NONE	30	OPEN	OPEN	AS IS	CLOSED	N/A	C
LFFV-96	6/6	OUTSIDE	OUT	GLOBE	AIR	4	CIS-A	NONE	4	SEE NOTES	SEE NOTES	CLOSED	CLOSED	N/A	C
LFV-093	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

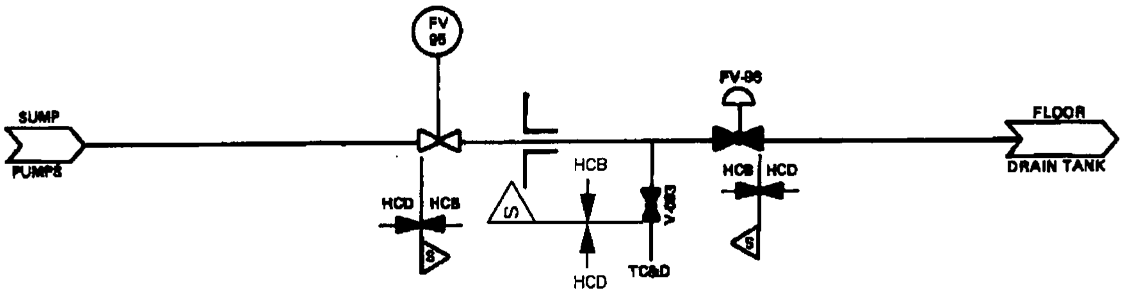
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 18.3ft

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

VALVE FV-96 OPENS ONLY WHEN ONE OF THE CONTAINMENT SUMP PUMPS ARE OPERATING, THE CONTROL GRADE SIGNAL TO OPEN THE VALVE IS NEGATED WHEN A PROTECTION GRADE CIS-A SIGNAL IS IS RECEIVED



CONTAINMENT PENETRATION NO. P-32
DESCRIPTION:
CONTAINMENT SUMP PUMP DISCHARGE
FLOOR AND EQUIPMENT DRAINAGE SYSTEM

REFERENCE SECTION(S) 9.3.3
REV. 13

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
GPV-010	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
FLANGES	6/6	BOTH	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	B

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

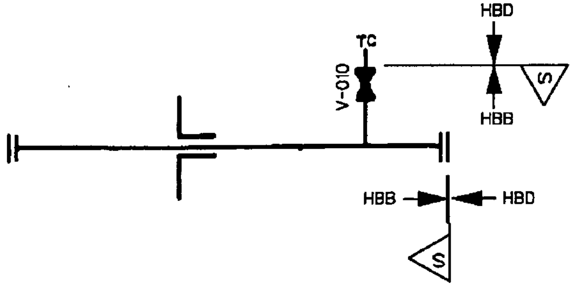
FLUID CONTAINED: AIR

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

FLANGES ARE REMOVED ONLY DURING PERFORMANCE OF TYPE A TEST



CONTAINMENT PENETRATION NO. P-34
DESCRIPTION:
CONTAINMENT PRESSURIZATION LINE
ILRT PRESSURIZATION SYSTEM

REFERENCE SECTION(S) 6.2.6
REV. 13

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
BBHV-8351C	2/2	OUTSIDE	IN	GLOBE	MOTOR	4	NONE	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	C
BBV-356	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
BBV-247	¾/ ¾	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
BBV-178	2/2	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	OPEN	OPEN	N/A	OPEN	CLOSED	C

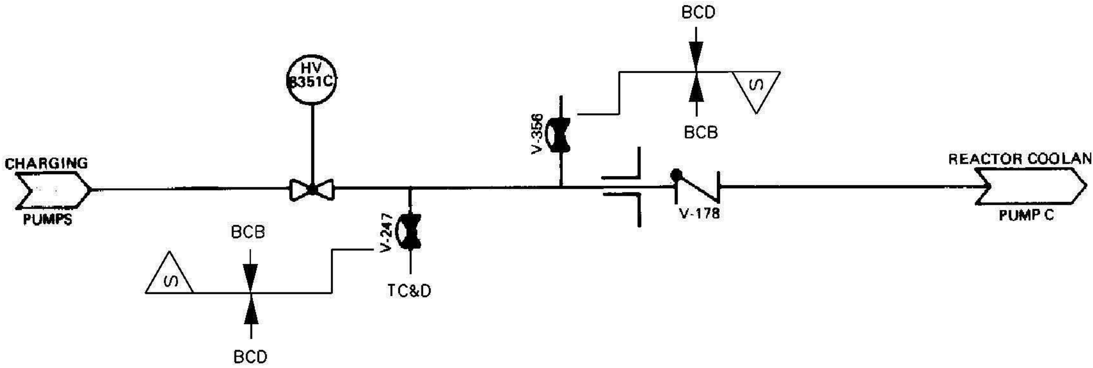
ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒
FLUID CONTAINED: WATER
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 17.5
APPLICABLE GDC NO. 55

GENERAL COMMENTS:

THIS PENETRATION PIPING HAS A HIGH PRESSURE WATER INFLOW WHICH PRECLUDES THE NEED FOR AUTOMATIC ISOLATION OF THIS PENETRATION. THE CVCS CHARGING PUMPS SUPPLY REACTOR COOLANT PUMP SEAL INJECTION WATER, AND THERE IS A POTENTIAL FOR DAMAGE TO THE REACTOR COOLANT PUMP IF UNDESIRED ISOLATION SHOULD OCCUR.

THE ISOLATION CAN BE AFFECTED BY REMOTE-MANUAL CLOSURE OF THE MOTOR-OPERATED VALVE BY THE OPERATOR AFTER THE CHARGING PUMPS COMPLETE THEIR SAFETY FUNCTION.

23



CONTAINMENT PENETRATION NO. P-39
DESCRIPTION:
RCP - SEAL WATER SUPPLY
REACTOR COOLANT SYSTEM

REFERENCE SECTION(S) 5.0
REV. 23

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
BBHV-8351D	2/2	OUTSIDE	IN	GLOBE	MOTOR	4	NONE	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	C
BBV-358	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
BBV-248	¾/ ¾	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
BBV-208	2/2	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	OPEN	OPEN	N/A	OPEN	CLOSED	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 17.5ft

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

THIS PENETRATION PIPING HAS A HIGH PRESSURE WATER INFLOW WHICH PRECLUDES THE NEED FOR AUTOMATIC ISOLATION OF THIS PENETRATION. THE CVCS CHARGING PUMPS SUPPLY REACTOR COOLANT PUMP SEAL INJECTION WATER, AND THERE IS A POTENTIAL FOR DAMAGE TO THE REACTOR COOLANT PUMP IF UNDESIRED ISOLATION SHOULD OCCUR.

THE ISOLATION CAN BE AFFECTED BY REMOTE-MANUAL CLOSURE OF THE MOTOR-OPERATED VALVE BY THE OPERATOR AFTER THE CHARGING PUMPS COMPLETE THEIR SAFETY FUNCTION.

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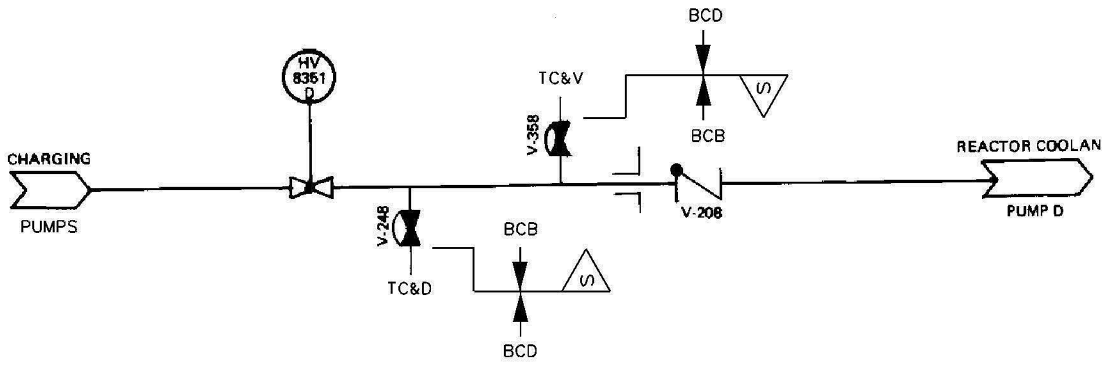

CONTAINMENT PENETRATION NO. P-40
DESCRIPTION:
RCP - SEAL WATER SUPPLY
REACTOR COOLANT SYSTEM

REFERENCE SECTION(S) 5.0
REV. 23

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
BBHV-8351A	2/2	OUTSIDE	IN	GLOBE	MOTOR	4	NONE	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	C
BBV-352	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
BBV-245	¾/ ¾	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
BBV-118	2/2	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	OPEN	OPEN	N/A	OPEN	CLOSED	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 20.0ft

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

THIS PENETRATION PIPING HAS A HIGH PRESSURE WATER INFLOW WHICH PRECLUDES THE NEED FOR AUTOMATIC ISOLATION OF THIS PENETRATION. THE CVCS CHARGING PUMPS SUPPLY REACTOR COOLANT PUMP SEAL INJECTION WATER, AND THERE IS A POTENTIAL FOR DAMAGE TO THE REACTOR COOLANT PUMP IF UNDESIRED ISOLATION SHOULD OCCUR.

THE ISOLATION CAN BE AFFECTED BY REMOTE-MANUAL CLOSURE OF THE MOTOR-OPERATED VALVE BY THE OPERATOR AFTER THE CHARGING PUMPS COMPLETE THEIR SAFETY FUNCTION.

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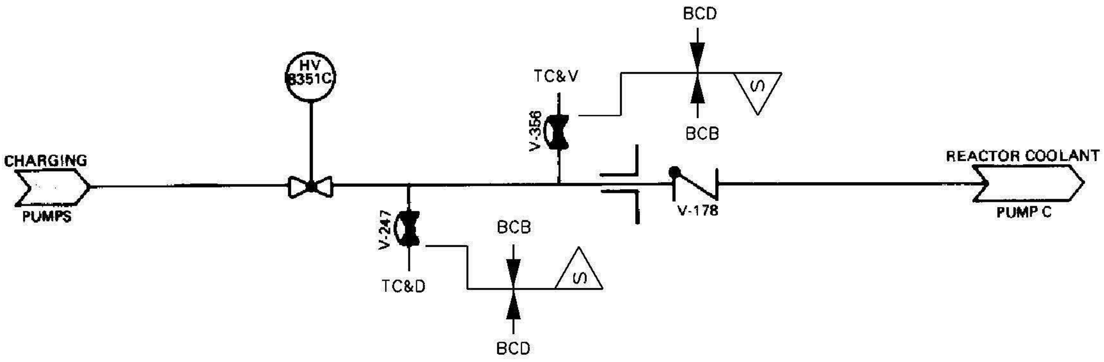

CONTAINMENT PENETRATION NO. P-41
DESCRIPTION:
RCP - SEAL WATER SUPPLY
REACTOR COOLANT SYSTEM

REFERENCE SECTION(S) 5.0
REV. 23

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
HDV-016	2/2	OUTSIDE	IN	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	C
HDV-023	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	N/A	N/A	CLOSED	N/A	N/A
HDV-017	2/2	INSIDE	IN	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

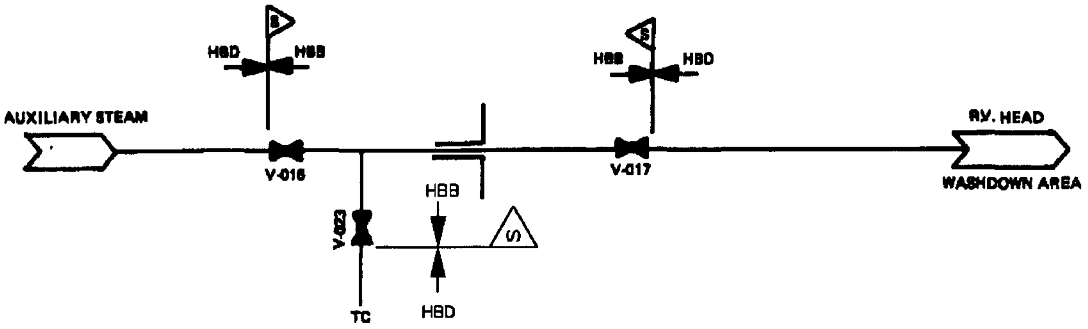
FLUID CONTAINED: STEAM

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 14.9ft

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-43
DESCRIPTION:
DECONTAMINATION STEAM
DECONTAMINATION SYSTEM

REFERENCE SECTION(S) 12.3
REV. 13

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
HBHV-7126	¾/ ¾	INSIDE	OUT	DIAPHRAGM	AIR	1	CIS-A	NONE	10	OPEN	OPEN	CLOSED	CLOSED	N/A	C
HBHV-7150	¾/ ¾	OUTSIDE	OUT	DIAPHRAGM	AIR	4	CIS-A	NONE	10	OPEN	OPEN	CLOSED	CLOSED	N/A	C
HBV-420	¾/ ¾	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

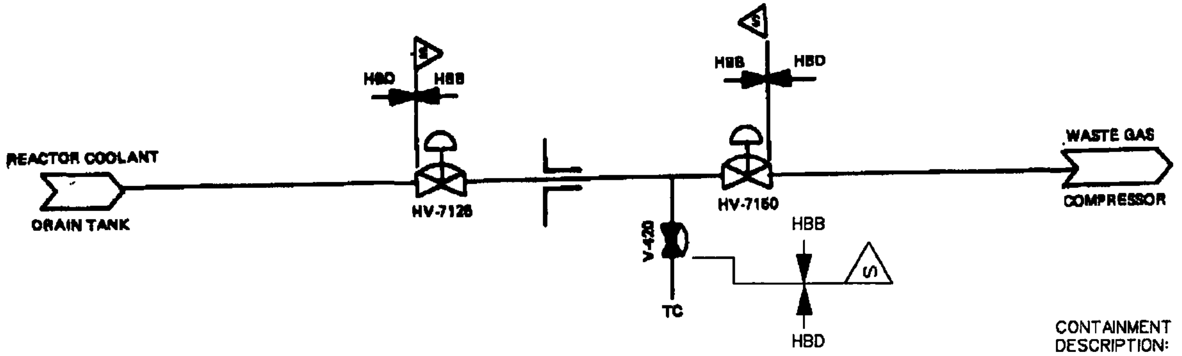
FLUID CONTAINED: GAS

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 12.3ft

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-44
DESCRIPTION:
R.C.D. TANK VENT LINE
LIQUID RADWASTE SYSTEM

REFERENCE SECTION(S) 11.2
REV. 13

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EPV-046	1/1	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	C
EPV-043	¾/¾	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EPHV-8880	1/1	OUTSIDE	IN	GLOBE	AIR	4	CIS-A	NONE	10	CLOSED	CLOSED	CLOSED	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

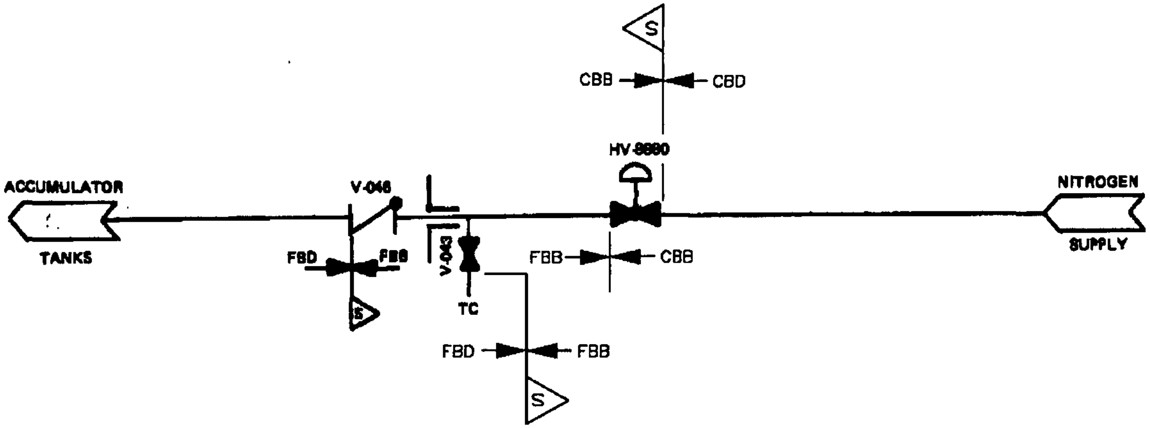
FLUID CONTAINED: GAS

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 13.0ft

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-45
DESCRIPTION:
NITROGEN SUPPLY LINE
ACCUMULATOR SAFETY INJECTION SYSTEM

REFERENCE SECTION(S) 6.3
REV. 13

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EMHV-8802B	4/4	OUTSIDE	IN	GATE	MOTOR	4	NONE	REM/MAN	N/A	CLOSED	CLOSED	AS IS	CLOSED	OPEN	A
EMHV-8824	¾/ ¾	INSIDE	OUT	GLOBE	AIR	1	CIS-A	NONE	10	CLOSED	CLOSED	CLOSED	CLOSED	N/A	A
EMV-003	2/2	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	OPEN	A
EMV-004	2/2	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	OPEN	A
EMV-060,061, 063, 064 EMV-217, 169	¾/ ¾	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EMV-170, 172	1/1	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EMV-059	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

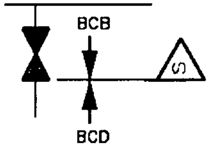
APPLICABLE GDC NO. 55

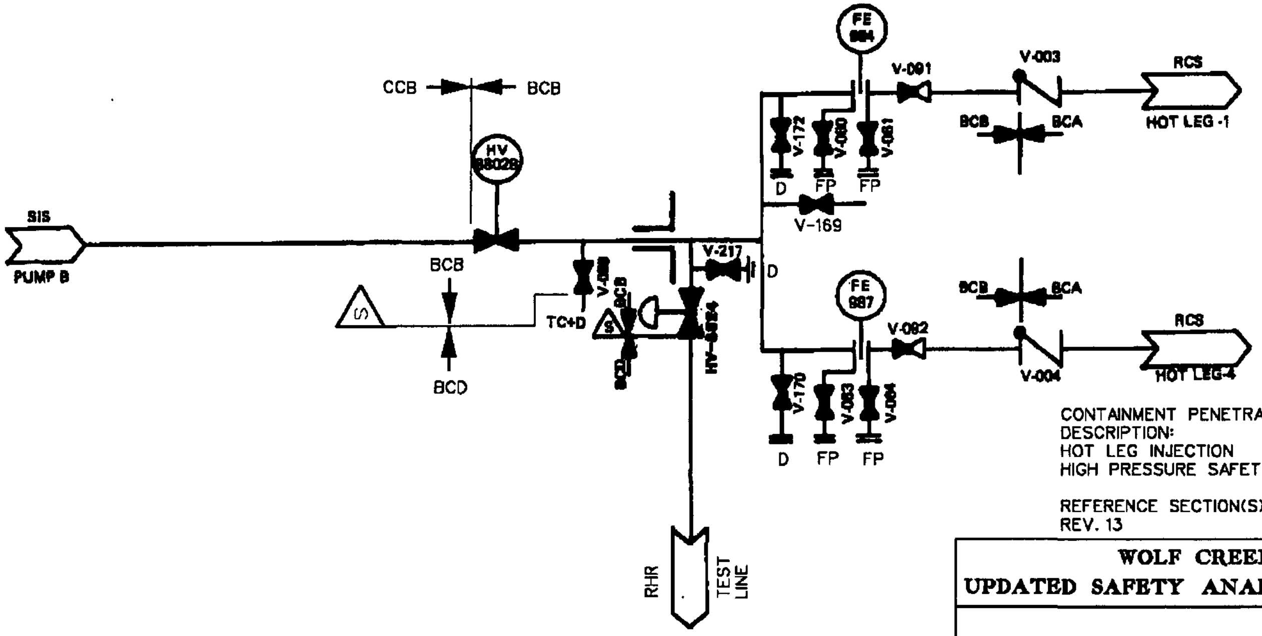
GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE HIGH PRESSURE COOLANT INJECTION SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A CHECK VALVE IS PROVIDED FOR EACH BRANCH LINE INSIDE THE CONTAINMENT, AND A REMOTE-MANUAL ISOLATION VALVE IS PROVIDED OUTSIDE THE CONTAINMENT. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS CLOSED OUTSIDE THE CONTAINMENT AND IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT. LEAKAGE DETECTION FROM THIS LINE OUTSIDE THE CONTAINMENT IS PROVIDED, AS DESCRIBED IN SECTION 6.3.3.

LOCAL TESTING OF THE VALVES OR THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT IS NOT REQUIRED SINCE THE SYSTEM IS OPERATED AND INSPECTED DURING NORMAL PLANT OPERATION TO ASSURE THAT THE INTEGRITY IS BEING MAINTAINED.

NOTE: ALL VENTS, DRAINS AND FLOW POINTS AS INDICATED BELOW.





CONTAINMENT PENETRATION NO. P-48
DESCRIPTION:
HOT LEG INJECTION
HIGH PRESSURE SAFETY INJECTION SYSTEM

REFERENCE SECTION(S) 6.3
REV. 13

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UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EMHV-8835	4/4	OUTSIDE	IN	GATE	MOTOR	4	NONE	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	A
EMHV-8823	3/4-3/4	INSIDE	OUT	GLOBE	AIR	1	CIS-A	NONE	10	CLOSED	CLOSED	CLOSED	CLOSED	N/A	A
EPV-020	2/2	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	OPEN	CLOSED	A
EPV-010	2/2	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	OPEN	CLOSED	A
EPV-040	2/2	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	OPEN	CLOSED	A
EPV-030	2/2	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	OPEN	CLOSED	A
EMV-067	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EMV-068 thru EMV-075	3/4-3/4	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EMV-218 EMV162 thru 168	1/1	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

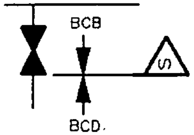
APPLICABLE GDC NO. 55

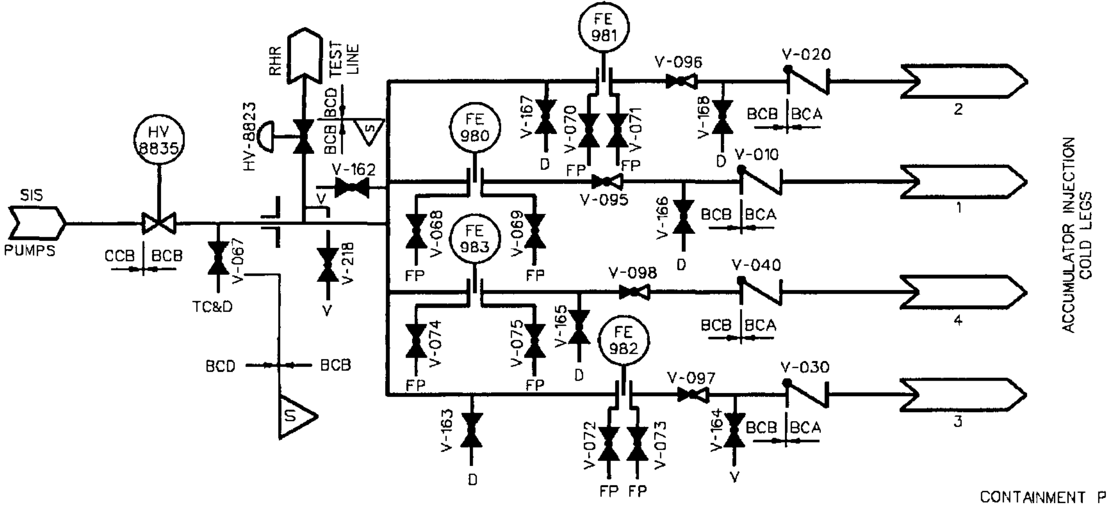
GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE HIGH PRESSURE COOLANT INJECTION SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A CHECK VALVE IS PROVIDED FOR EACH BRANCH LINE INSIDE THE CONTAINMENT AND A REMOTE-MANUAL ISOLATION VALVE IS PROVIDED OUTSIDE THE CONTAINMENT. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS CLOSED OUTSIDE THE CONTAINMENT AND IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT. LEAKAGE DETECTION FROM THIS LINE OUTSIDE THE CONTAINMENT IS PROVIDED, AS DESCRIBED IN SECTION 9.3.3.

LOCAL TESTING OF THE VALVES OR THE CLOSED SYSTEM OUTSIDE THE CONTAINOMENT IS NOT REQUIRED SINCE THE SYSTEM IS OPERATED AND INSPECTED DURING NORMAL PLANT OPERATION TO ASSURE THAT THE INTEGRITY IS BEING MAINTAINED.

NOTE: ALL VENTS, DRAINS AND FLOW POINTS AS INDICATED BELOW.





CONTAINMENT PENETRATION NO. P-49
DESCRIPTION:
COLD LEG INJECTION
HIGH PRESSURE COOLANT
INJECTION SYSTEM
REFERENCE SECTION (S) 6.3
REV. 14

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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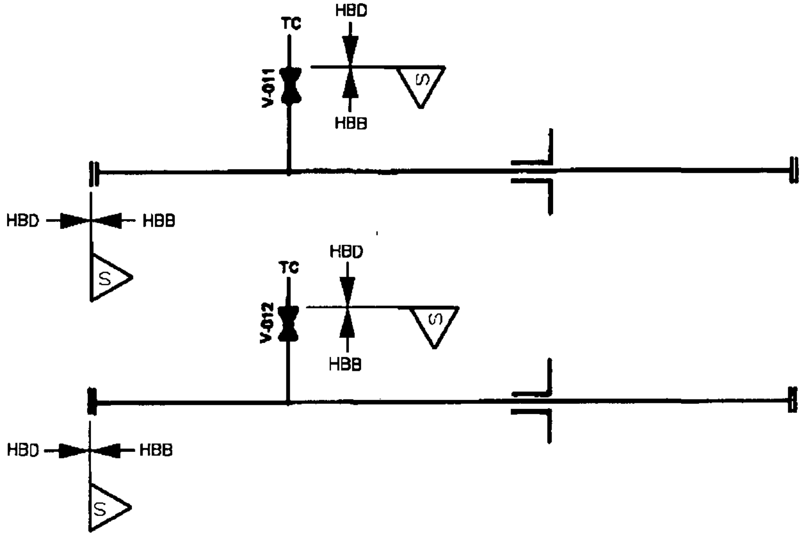
VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
GPV-011	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
GPV-012	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
FLANGES	1/1	BOTH	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	B

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒
FLUID CONTAINED: AIR
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A
APPLICABLE GDC NO. 56

GENERAL COMMENTS:

FLANGES ARE REMOVED ONLY DURING PERFORMANCE OF TYPE A TEST



CONTAINMENT PENETRATION NO. P-51
DESCRIPTION:
PRESSURE SENSING LINES
ILRT PRESSURIZATION SYSTEM

REFERENCE SECTION(S) 6.2.6
REV. 13

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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AREA OF CHANGE

VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EJHV-8701B	12/12	INSIDE	OUT	GATE	MOTOR	1	REM/MAN	NONE	N/A	CLOSED	OPEN	AS IS	CLOSED	N/A	A
EJ-8708B	3/3	INSIDE	N/A	RELIEF	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES☒ NO☐

FLUID CONTAINED: WATER

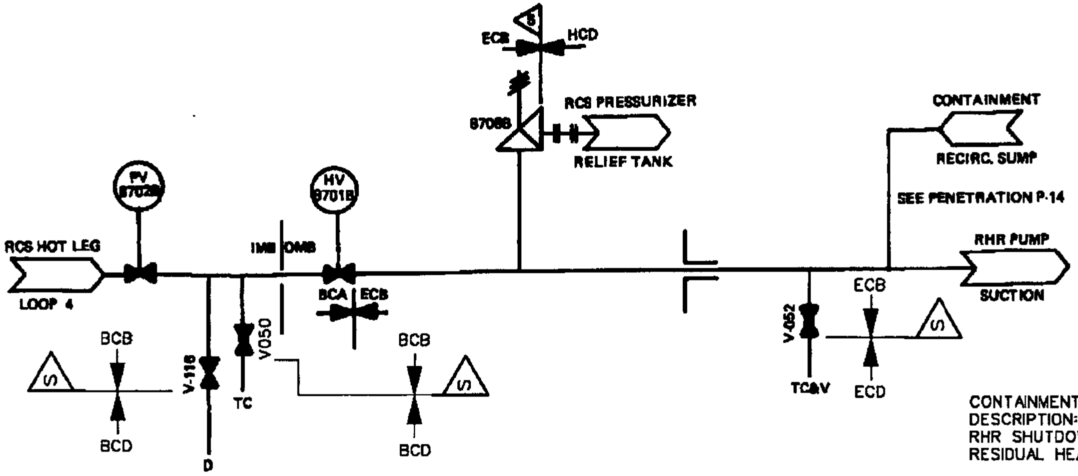
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

THE RESIDUAL HEAT REMOVAL SYSTEM SUCTION LINE FROM THE REACTOR COOLANT SYSTEM CONTAINS TWO NORMALLY CLOSED, POWER-OPERATED REMOTE MANUAL VALVES IN SERIES INSIDE THE CONTAINMENT. THE VALVES ARE ALSO INTERLOCKED TO PREVENT THEM FROM BEING INADVERTENTLY OPENED. CONTAINMENT ISOLATION IS ASSURED BY SYSTEM ISOLATION VALVES CLOSEST TO THE CONTAINMENT AND THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT, WHICH IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT. LEAKAGE DETECTION FROM THIS LINE OUTSIDE THE CONTAINMENT IS PROVIDED, AS DESCRIBED IN SECTION 9.3.3.

LOCAL TESTING OF THE VALVE OR THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT IS NOT REQUIRED SINCE THE SYSTEM IS OPERATED AND INSPECTED DURING NORMAL PLANT OPERATION TO ASSURE THAT THE INTEGRITY IS BEING MAINTAINED.



CONTAINMENT PENETRATION NO. P-52
DESCRIPTION:
RHR SHUTDOWN LINES
RESIDUAL HEAT REMOVAL SYSTEM

REFERENCE SECTION(S) 5.4.7 & 6.3
REV. 15

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
ECV-084	6/6	INSIDE	IN	GATE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	OPEN	N/A	CLOSED	N/A	C
ECV-085	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
ECV-083	6/6	OUTSIDE	IN	GATE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	OPEN	N/A	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

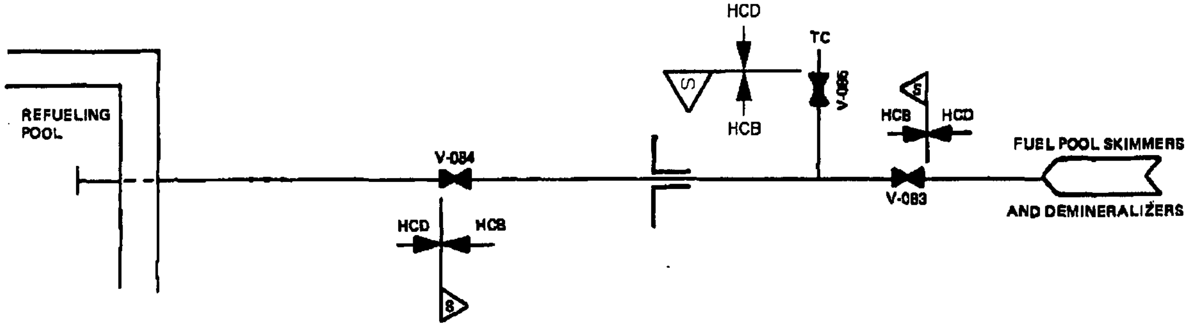
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 6.1 FT

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-53
DESCRIPTION:
CLEANUP RETURN
FUEL POOL COOLING
AND CLEANUP SYSTEM
REFERENCE SECTION(S) 9.1.3
REV. 13

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
ECV-087	6/6	INSIDE	OUT	GATE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	OPEN	N/A	CLOSED	N/A	C
ECV-086	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
ECV-088	6/6	OUTSIDE	OUT	GATE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	OPEN	N/A	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

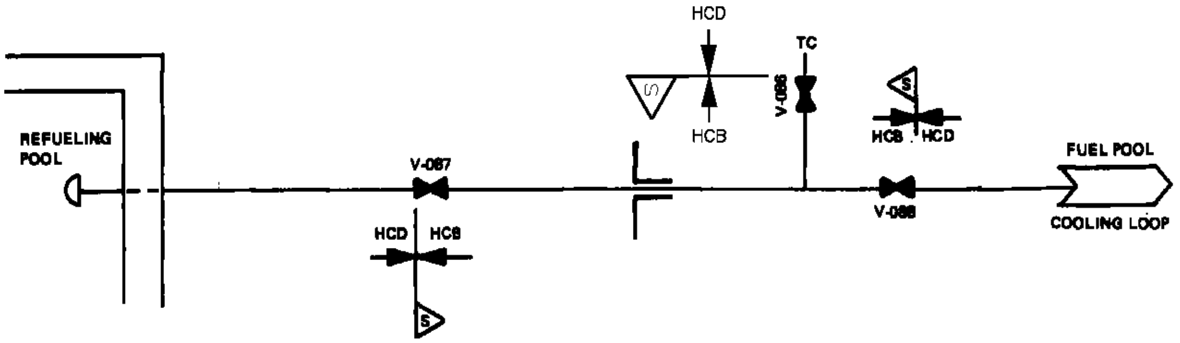
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 6.1 FT

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-54
DESCRIPTION:
REFUELING POOL CLEANUP LINE
FUEL POOL COOLING & CLEANUP SYSTEM

REFERENCE SECTION(S) 9.1.3
REV. 13

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UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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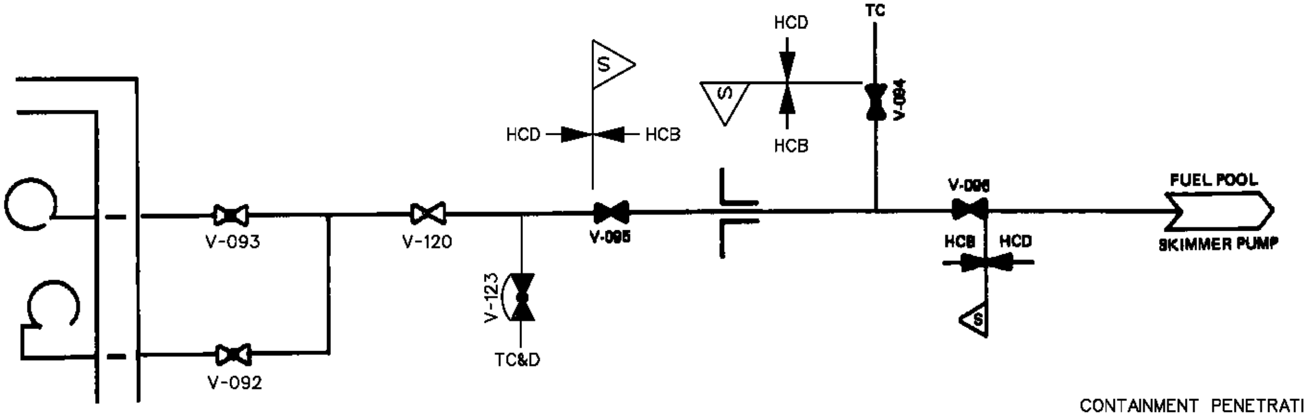
VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
ECV-095	3/3	INSIDE	OUT	GATE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	OPEN	N/A	CLOSED	N/A	C
ECV-094	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
ECV-096	3/3	OUTSIDE	OUT	GATE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	OPEN	N/A	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒
FLUID CONTAINED: WATER
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 6.1 FT
APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-55
DESCRIPTION:
REFUELING POOL SKIMMER LINES
FUEL POOL COOLING & CLEANUP SYSTEM

REFERENCE SECTION(S) 9.1.3
REV. 13

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
GSHV-9	1/1	INSIDE	IN	GATE	SOLENOID	4	CIS-A	REM/MAN	5	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	A,C
GSHV-8	1/1	OUTSIDE	IN	GATE	SOLENOID	4	CIS-A	REM/MAN	5	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	A,C
GSV-032	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

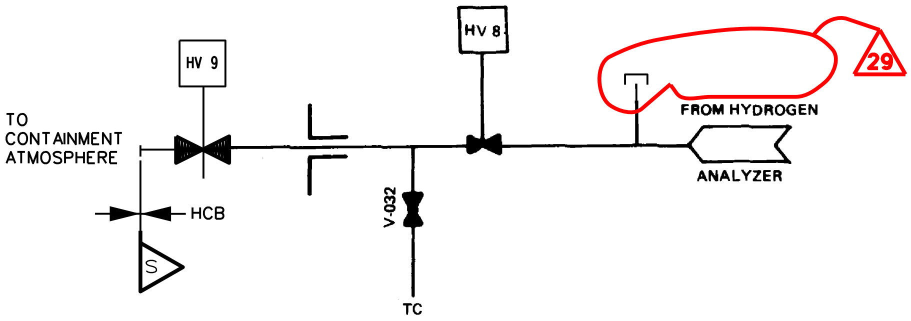
FLUID CONTAINED: CONT. ATM

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE CONTAINMENT HYDROGEN CONTROL SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA.



THE HYDROGEN ANALYZER IS A CLOSED SYSTEM OUTSIDE THE CONTAINMENT WHICH IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT.

TO ASSURE LEAKTIGHT INTEGRITY, THE VALVES ARE SUBJECTED TO TYPE C TESTING, AND THE SAMPLE LINES ARE OPENED DURING THE TYPE A TESTING.

CONTAINMENT PENETRATION NO. P-56
DESCRIPTION:
H_2 SAMPLE RETURN
HYDROGEN CONTROL SYSTEM
CONTAINMENT
REFERENCE SECTION(S) 6.2.5

REV. 29

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
GSHV-38	1/1	OUTSIDE	IN	GATE	SOLENOID	1	CIS-A	REM/MAN	5	OPEN	OPEN	CLOSED	CLOSED	OPEN	C
GSHV-39	1/1	INSIDE	IN	GATE	SOLENOID	4	CIS-A	REM/MAN	5	OPEN	OPEN	CLOSED	CLOSED	OPEN	C
GSV-058	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

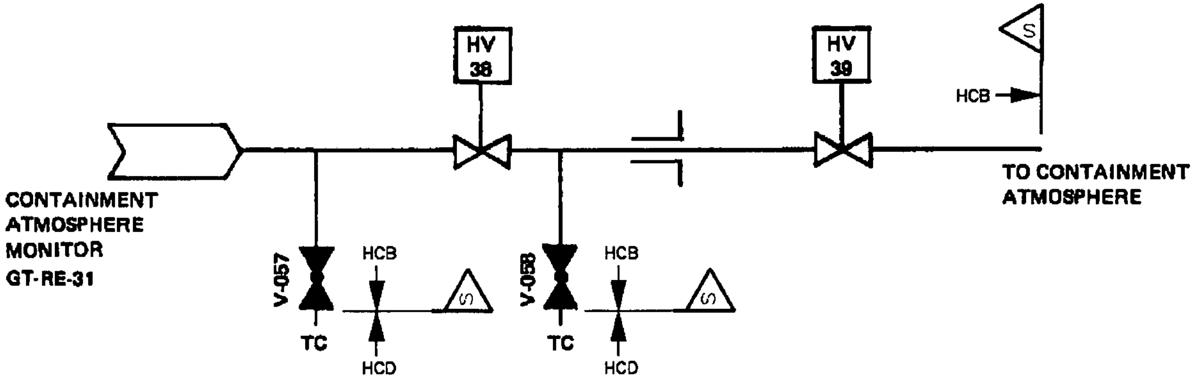
FLUID CONTAINED: CONT. ATM

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 7.1

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-56
DESCRIPTION:
SAMPLE RETURN
CONTAINMENT ATMOSPHERE MONITOR

REFERENCE SECTION(S) 9.4.6
REV. 13

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
SJHV-131	1/1	OUTSIDE	IN	GLOBE	SOLENOID	1	CIS-A	REM/MAN	5	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	C
SJHV-132	1/1	OUTSIDE	IN	GLOBE	SOLENOID	4	CIS-A	REM/MAN	5	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	C
SJV-111	1/1	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	OPEN	C
SJV-114	1/1	OUTSIDE	OUT	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

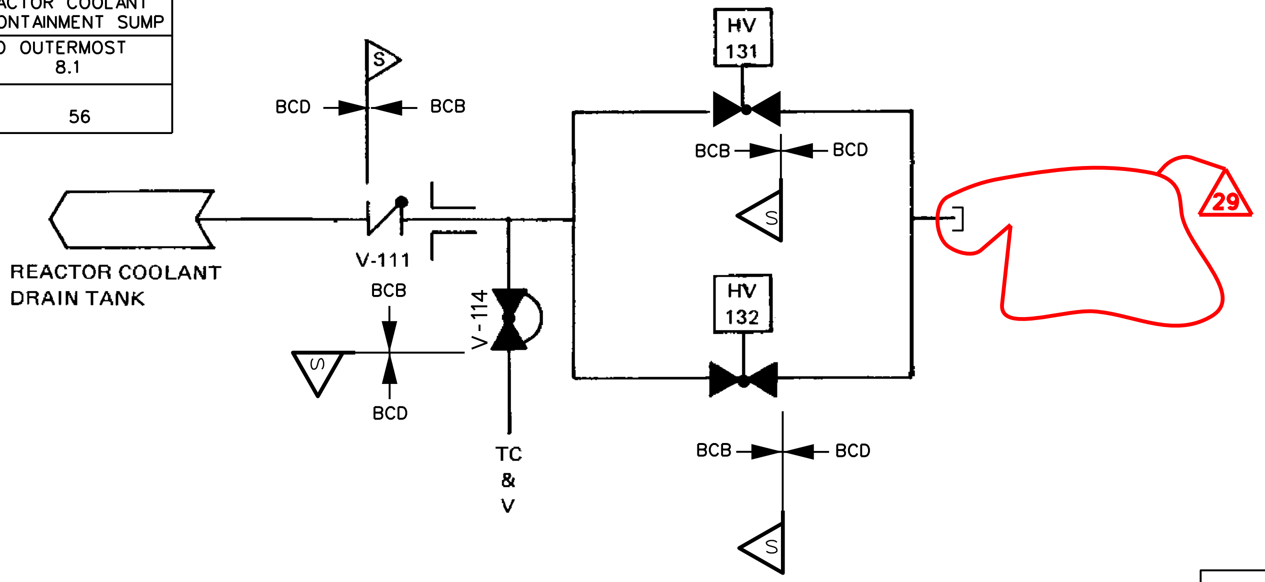
FLUID CONTAINED: REACTOR COOLANT & CONTAINMENT SUMP

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 8.1

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-57
DESCRIPTION:
SAMPLE RETURN
POST ACCIDENT SAMPLING SYSTEM

REFERENCE SECTION(S) 18.2.3

REV. 29

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EMV-006	1/1	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	C
EMV-182	¾/¾	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EMV-123	¾/¾	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EMHV-8888	1/1	OUTSIDE	IN	GLOBE	AIR	4	CIS-A	NONE	5	CLOSED	CLOSED	CLOSED	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

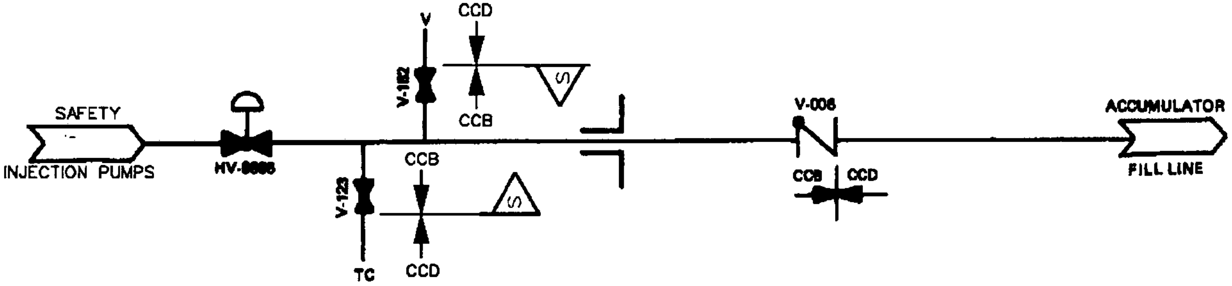
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 7.6 FT

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-58
DESCRIPTION:
ACCUMULATOR FILL LINE
HIGH PRESSURE COOLANT INJECTION
SYSTEM
REFERENCE SECTION(S) 6.3
REV. 13

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

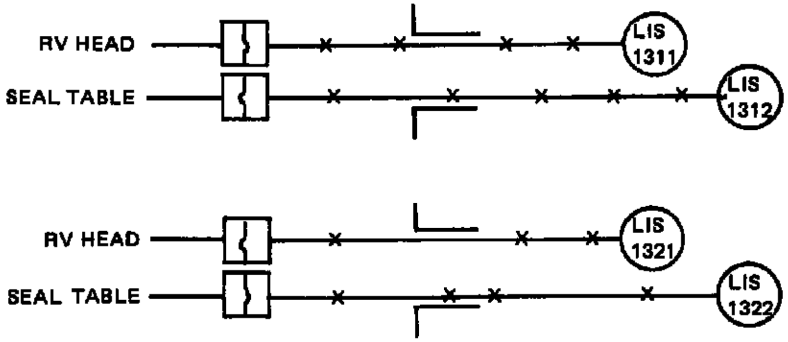
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

HYDRAULIC SENSORS PROVIDE ISOLATION OF RCS FROM THE CAPILLARY TUBING. THE CAPILLARY TUBING AND THE LIS'S SERVE AS THE SECOND BOUNDARY. THIS ARRANGEMENT IS SIMILAR TO THAT PROVIDED FOR THE CONTAINMENT PRESSURE TRANSMITTERS SHOWN ON SHEET 72 OF 74.



CONTAINMENT PENETRATION NO. P-59, 91
DESCRIPTION:
RVLIS SAMPLE LINE
REACTOR COOLANT SYSTEM

REFERENCE SECTION(S) 18.2.13.2
REV. 11

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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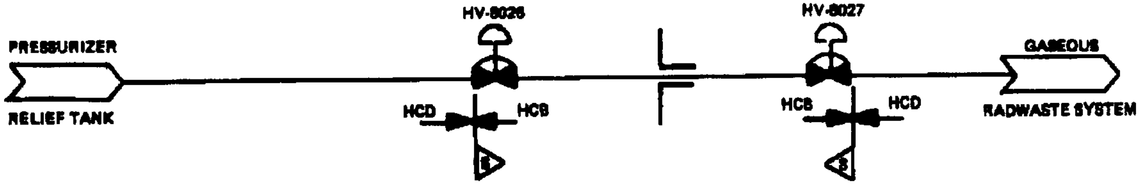
VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
BBHV-8026	1/1	INSIDE	BOTH	DIAPHRAGM	AIR	1	CIS-A	NONE	10	CLOSED	OPEN	CLOSED	CLOSED	N/A	C
BBHV-8027	1/1	OUTSIDE	BOTH	DIAPHRAGM	AIR	4	CIS-A	NONE	10	CLOSED	OPEN	CLOSED	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒
FLUID CONTAINED: GAS
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 12.3ft
APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-62
DESCRIPTION:
PRESSURIZER PURGE & VENT LINE
REACTOR COOLANT SYSTEM

REFERENCE SECTION(S) 5.0
REV. 11

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
KAV-118	4/4	OUTSIDE	IN	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	C
KAV-163	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
KAV-039	4/4	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

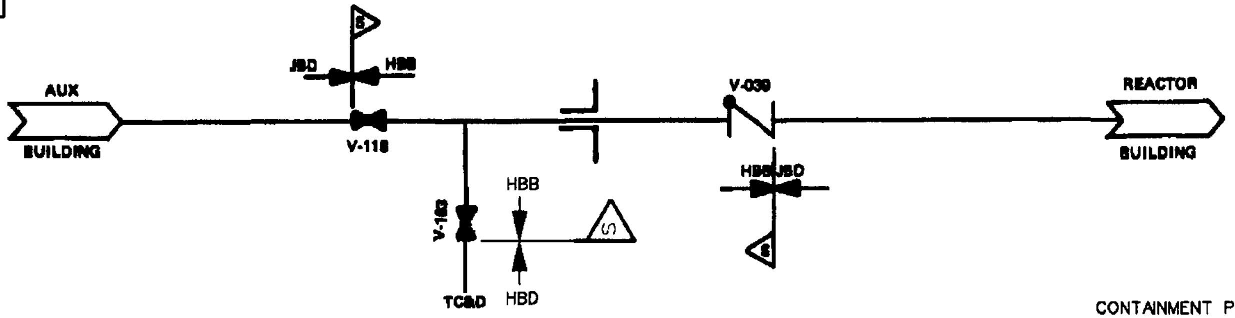
FLUID CONTAINED: AIR

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 8.6ft

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-63
DESCRIPTION:
SERVICE AIR
COMPRESSED AIR SYSTEM

REFERENCE SECTION(S) 9.3.1
REV. 13

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
SJHV-128	1/1	INSIDE	OUT	GLOBE	SOLENOID	1	CIS-A	REM/MAN	5	CLSOED	CLOSED	CLOSED	CLOSED	OPEN	C
SJHV-129	1/1	OUTSIDE	OUT	GLOBE	SOLENOID	4	CIS-A	REM/MAN	5	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	C
SJHV-130	1/1	OUTSIDE	OUT	GLOBE	SOLENOID	1	CIS-A	REM/MAN	5	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	C
SJV-106	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

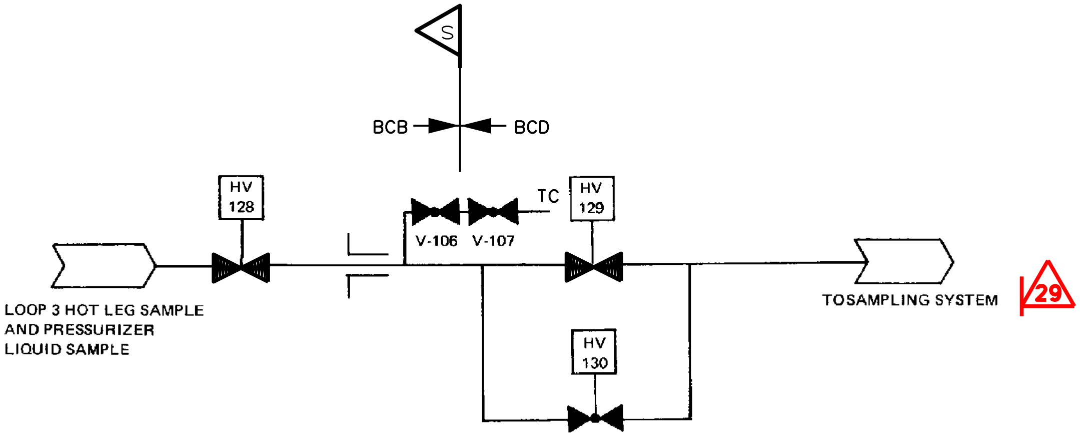
FLUID CONTAINED: REACTOR COOLANT

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 8.6

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-64
DESCRIPTION:
RC LOOP AND PRESSURIZER LIQUID SAMPLE 29

REFERENCE SECTION(S) 18.2.3/9.3.2

REV. 29

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
GSHV-20	6/6	INSIDE	OUT	BUTTERFLY	MOTOR	1	CIS-A	REM/MAN	5	CLOSED	CLOSED	AS IS	CLOSED	OPEN	C
GSHV-21	6/6	OUTSIDE	OUT	BUTTERFLY	MOTOR	4	CIS-A	REM/MAN	5	CLOSED	CLOSED	AS IS	CLOSED	OPEN	C
GSV-041	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

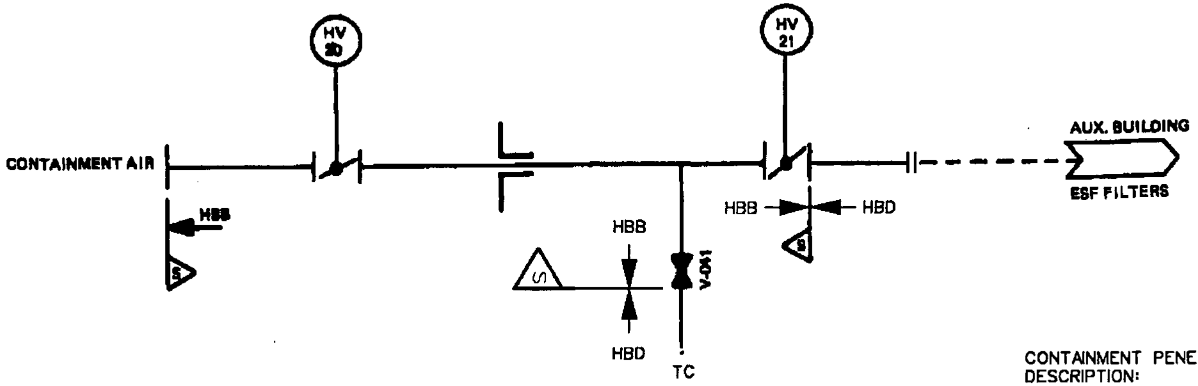
FLUID CONTAINED: CONT. AIR

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 5.5ft

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. 65
DESCRIPTION:
CONT. H_2 PURGE
CONTAINMENT HYDROGEN CONTROL SYSTEM

REFERENCE SECTION(S) 6.2.5
REV. 13

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
ENHV-12	10/10	OUTSIDE	IN	GATE	MOTOR	4	CSAS	REM/MAN	N/A	CLOSED	CLOSED	AS IS	OPEN	CLOSED	A
ENV-080	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
ENV-017	10/10	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	OPEN	CLOSED	A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

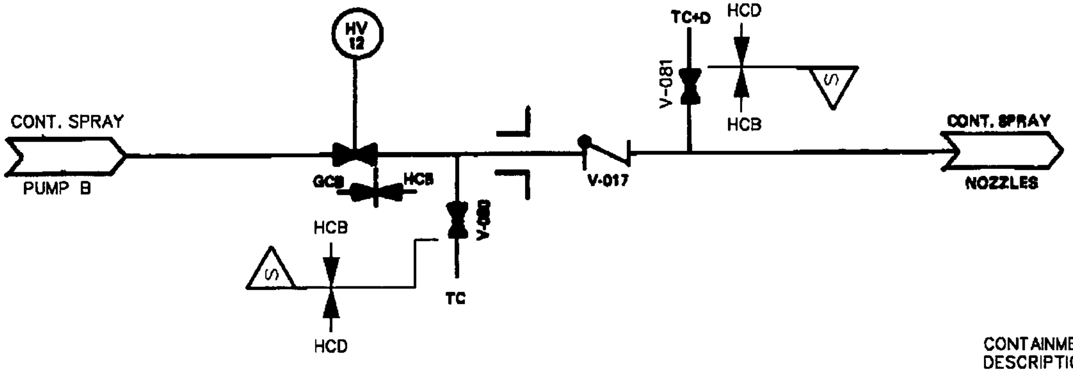
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE CONTAINMENT SPRAY SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A CHECK VALVE IS PROVIDED INSIDE THE CONTAINMENT, AND A REMOTE-MANUAL ISOLATION VALVE IS PROVIDED OUTSIDE THE CONTAINMENT. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS CLOSED OUTSIDE THE CONTAINMENT AND IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT. LEAKAGE DETECTION FROM THIS LINE OUTSIDE THE CONTAINMENT IS PROVIDED, AS DESCRIBED IN SECTION 9.3.3.

LOCAL TESTING OF THE VALVES OR THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT IS NOT REQUIRED SINCE THE SYSTEM IS OPERATED AND INSPECTED DURING NORMAL PLANT OPERATION TO ASSURE THAT THE INTEGRITY IS BEING MAINTAINED.



CONTAINMENT PENETRATION NO. P-66
DESCRIPTION:
CONTAINMENT SPRAY
CONTAINMENT SPRAY SYSTEM

REFERENCE SECTION(S) 6.2.2
REV. 13

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
KCHV-253	4/4	OUTSIDE	IN	GATE	MOTOR	1	CIS-A	NONE	30	CLOSED	CLOSED	AS IS	CLOSED	N/A	C
KCV-478	4/4	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	C
KCV-431	1	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

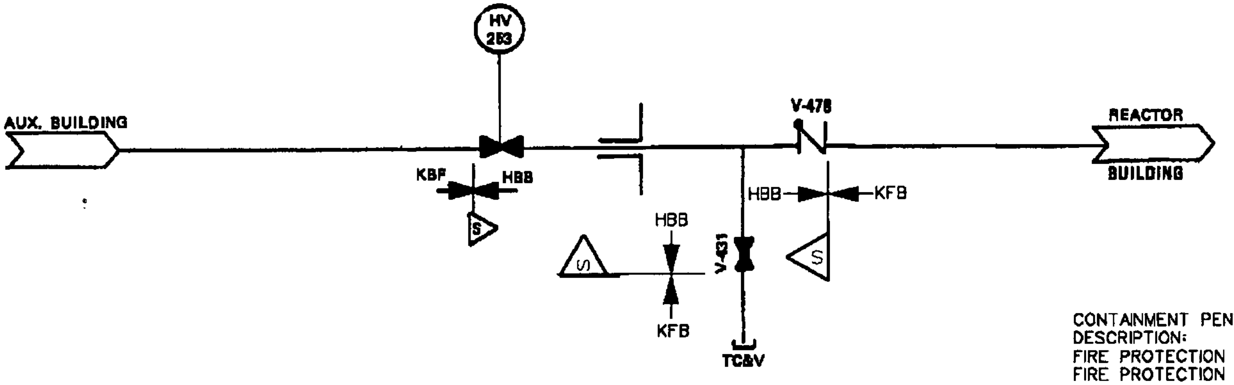
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 15.4

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-67
DESCRIPTION:
FIRE PROTECTION
FIRE PROTECTION SYSTEM

REFERENCE SECTION(S) 9.5.1
REV. 13

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
SJHV-12	1/1	INSIDE	OUT	GATE	SOLENOID	4	CIS-A	NONE	5	CLOSED	CLOSED	CLOSED	CLOSED	N/A	C
SJHV-13	1/1	OUTSIDE	OUT	GATE	SOLENOID	1	CIS-A	NONE	5	CLOSED	CLOSED	CLOSED	CLOSED	N/A	C
SJV-071	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

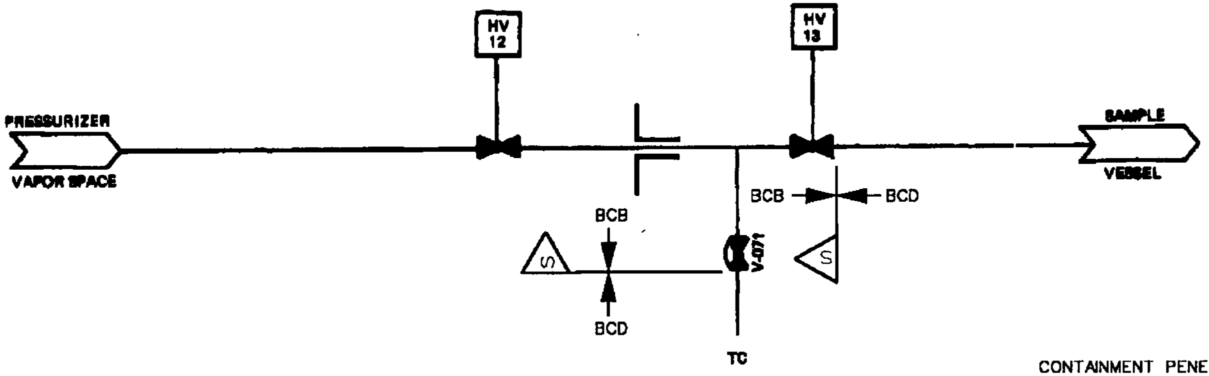
FLUID CONTAINED: STEAM

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 7.7ft

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-69
DESCRIPTION:
PRESSURIZER VAPOR SAMPLE LINE
NUCLEAR SAMPLING SYSTEM

REFERENCE SECTION(S) 9.3.2
REV. 13

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EFHV-31	14/14	OUTSIDE	IN	BUTTERFLY	MOTOR	1	SIS	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	C
EFV-276	1/1	INSIDE	N/A	GATE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EFHV-33	14/14	INSIDE	IN	BUTTERFLY	MOTOR	1	SIS	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

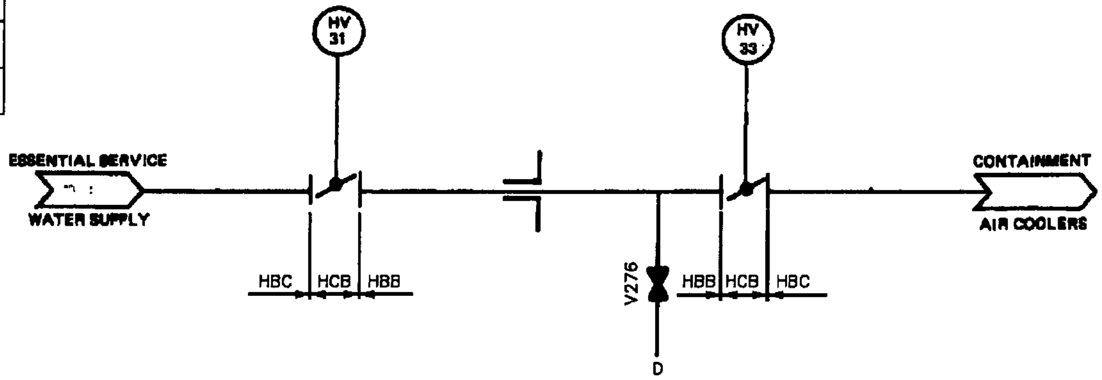
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 15.5 ft

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE ESSENTIAL SERVICE WATER SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A REMOTE-MANUAL POWER-OPERATED VALVE IS LOCATED INSIDE, AND A REMOTE-MANUAL POWER-OPERATED VALVE IS LOCATED OUTSIDE THE CONTAINMENT.

THESE VALVES ARE POWERED FROM THE SAME POWER SOURCE FOR GREATER SYSTEM RELIABILITY. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS A CLOSED SYSTEM INSIDE THE CONTAINMENT, WHICH IS DESIGNED AND CONSTRUCTED IN ACCORDANCE WITH ASME SECTION III, CLASS 3 REQUIREMENTS. THE ESSENTIAL SERVICE WATER LINES ARE NOT VENTED OR DRAINED DURING A TYPE A TEST SINCE THE AIR COOLERS MAY BE REQUIRED TO COOL THE CONTAINMENT. A TYPE C TEST IS PERFORMED.



CONTAINMENT PENETRATION NO. P-71
DESCRIPTION:
ESW TO CONTAINMENT AIR COOLER
ESSENTIAL SERVICE WATER SYSTEM

REFERENCE SECTION(S) 6.2.2
REV. 13

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EFHV-45	14/14	INSIDE	OUT	BUTTERFLY	MOTOR	1	SIS	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	C
EFV-277	1/1	INSIDE	N/A	GATE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EFHV-49	14/14	OUTSIDE	OUT	BUTTERFLY	MOTOR	1	SIS	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

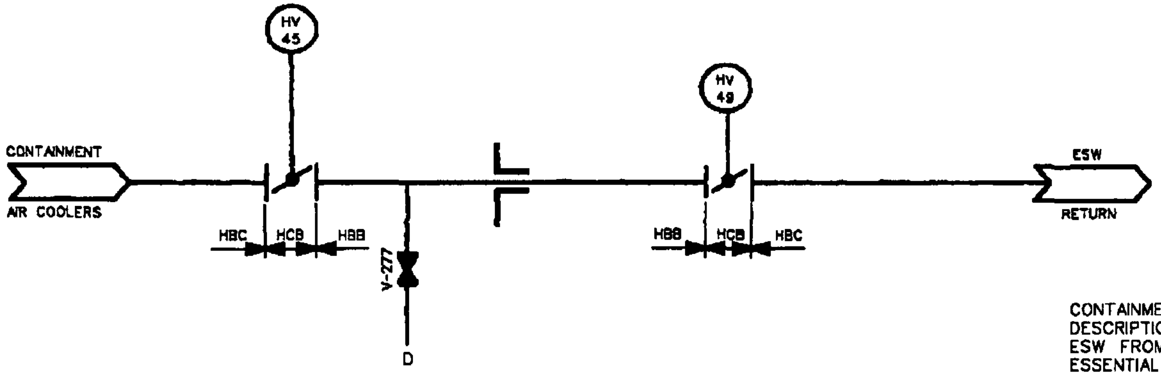
APPLICABLE GDC NO. 56

GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE ESSENTIAL SERVICE WATER SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A REMOTE-MANUAL POWER-OPERATED VALVE IS LOCATED INSIDE AND A REMOTE-MANUAL POWER-OPERATED VALVE IS LOCATED OUTSIDE THE CONTAINMENT.

THESE VALVES ARE POWERED FROM THE SAME POWER SOURCE FOR GREATER SYSTEM RELIABILITY. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS A CLOSED SYSTEM INSIDE THE CONTAINMENT, WHICH IS DESIGNED AND CONSTRUCTED IN ACCORDANCE WITH ASME SECTION III, CLASS 3 REQUIREMENTS.

THE ESSENTIAL SERVICE WATER LINES ARE NOT VENTED OR DRAINED DURING A TYPE A TEST SINCE THE AIR COOLERS MAY BE REQUIRED TO COOL THE CONTAINMENT. A TYPE C TEST IS PERFORMED.



CONTAINMENT PENETRATION NO. P-73
DESCRIPTION:
ESW FROM CONTAINMENT AIR COOLER
ESSENTIAL SERVICE WATER SYSTEM

REFERENCE SECTION(S) 6.2.2
REV. 13

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EGHV-58	12/12	OUTSIDE	IN	GATE	MOTOR	1	CIS-B	NONE	30	OPEN	OPEN	AS IS	CLOSED	N/A	C
EGV-090	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EGV-204	12/12	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	OPEN	OPEN	N/A	CLOSED	N/A	C
EGHV-127	12/12	OUTSIDE	IN	GATE	MOTOR	4	REM/MAN	NONE	N/A	CLOSED	CLOSED	AS IS	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

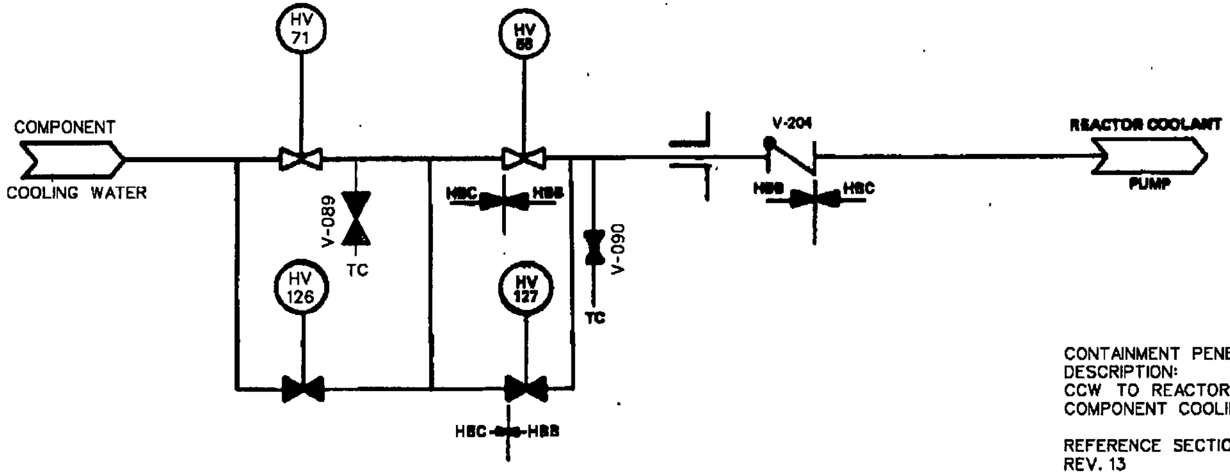
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 11.9 ft

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

ISOLATION SWITCH PROVIDED IN THE CONTROL ROOM FOR POWER LOCKOUT OF VALVE HV-127



CONTAINMENT PENETRATION NO. P-74
DESCRIPTION:
CCW TO REACTOR COOLANT PUMPS
COMPONENT COOLING WATER SYSTEM

REFERENCE SECTION(S) 9.2.2
REV. 13

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EGHV-60	12/12	INSIDE	OUT	GATE	MOTOR	4	CIS-B	NONE	30	OPEN	OPEN	AS IS	CLOSED	N/A	C
EG-V372	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EGHV-59	12/12	OUTSIDE	OUT	GATE	MOTOR	1	CIS-B	NONE	30	OPEN	OPEN	AS IS	CLOSED	N/A	C
EGHV-131	12/12	OUTSIDE	OUT	GATE	MOTOR	4	REM/MAN	NONE	N/A	CLOSED	CLOSED	AS IS	CLOSED	N/A	C
EGHV-130	12/12	INSIDE	OUT	GATE	MOTOR	1	REM/MAN	NONE	N/A	CLOSED	CLOSED	AS IS	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

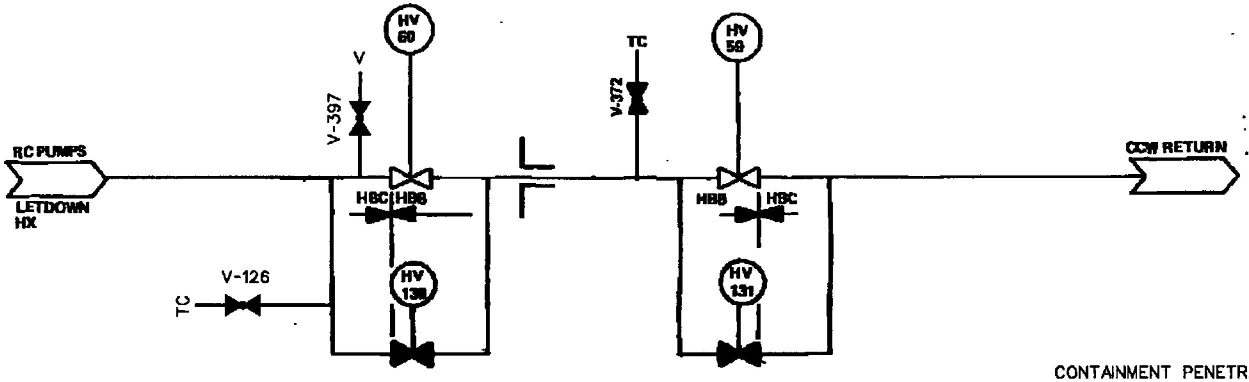
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 11.1 ft

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

ISOLATION SWITCH PROVIDED IN THE CONTROL ROOM FOR POWER LOCKOUT OF VALVES HV-130, 131



CONTAINMENT PENETRATION NO. P-75
DESCRIPTION:
CCW RETURN
COMPONENT COOLING WATER SYSTEM

REFERENCE SECTION(S) 9.2.2
REV. 13

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EGHV-62	4/4	INSIDE	OUT	GATE	MOTOR	4	CIS-B	NONE	30	OPEN	OPEN	AS IS	CLOSED	N/A	C
EGV-371	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EGHV-61	4/4	OUTSIDE	OUT	GATE	MOTOR	1	CIS-B	NONE	30	OPEN	OPEN	AS IS	CLOSED	N/A	C
EGHV-132	4/4	INSIDE	OUT	GATE	MOTOR	1	REM/MAN	NONE	N/A	CLOSED	CLOSED	AS IS	CLOSED	N/A	C
EGHV-133	4/4	OUTSIDE	OUT	GATE	MOTOR	4	REM/MAN	NONE	N/A	CLOSED	CLOSED	AS IS	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

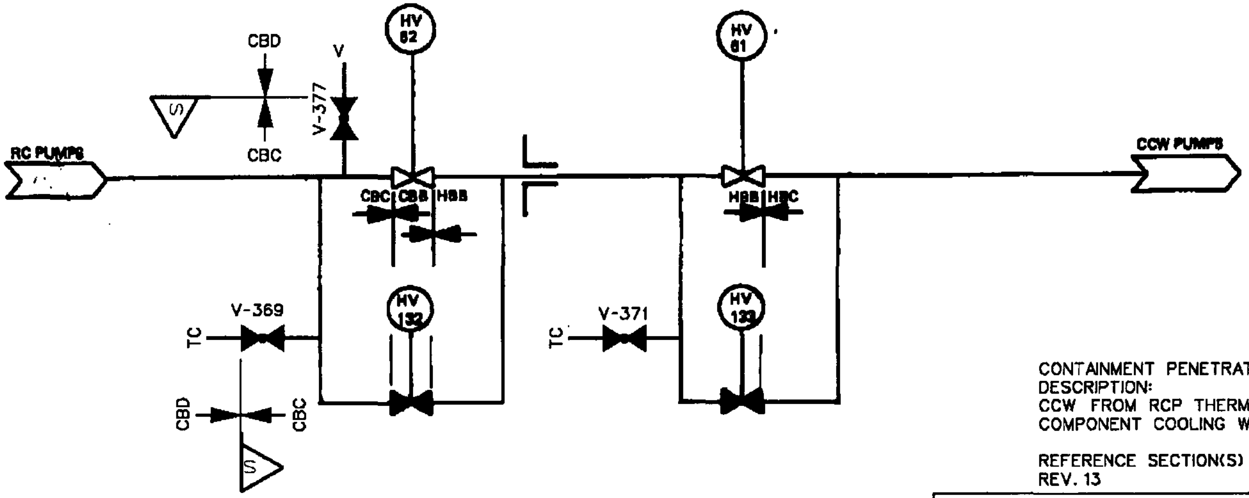
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 7.9 ft.

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

ISOLATION SWITCH PROVIDED IN THE CONTROL ROOM FOR POWER LOCKOUT OF VALVES HV122 AND HV133



CONTAINMENT PENETRATION NO. P-76
DESCRIPTION:
CCW FROM RCP THERMAL BARRIER
COMPONENT COOLING WATER SYSTEM

REFERENCE SECTION(S) 9.2.2
REV. 13

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
BMV-045	3/3	INSIDE	OUT	GATE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	C
BMV-302	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
BMV-046	3/3	OUTSIDE	OUT	GATE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

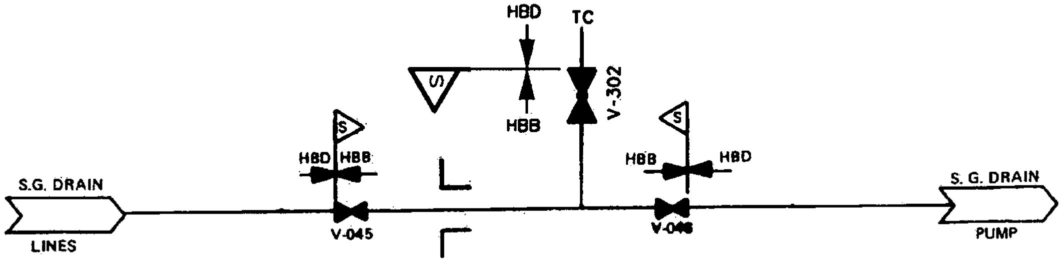
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 6.1 ft.

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-78
DESCRIPTION:
STEAM GENERATOR DRAIN LINE
STEAM GENERATOR BLOWDOWN SYSTEM

REFERENCE SECTION(S) 10.4.8

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EJHV-8701A	12/12	INSIDE	OUT	GATE	MOTOR	1	REM/MAN	NONE	N/A	CLOSED	OPEN	AS IS	CLOSED	N/A	A
EJ8708A	3/3	INSIDE	N/A	RELIEF	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EJV-154	¾/¾	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

AREA OF CHANGE

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

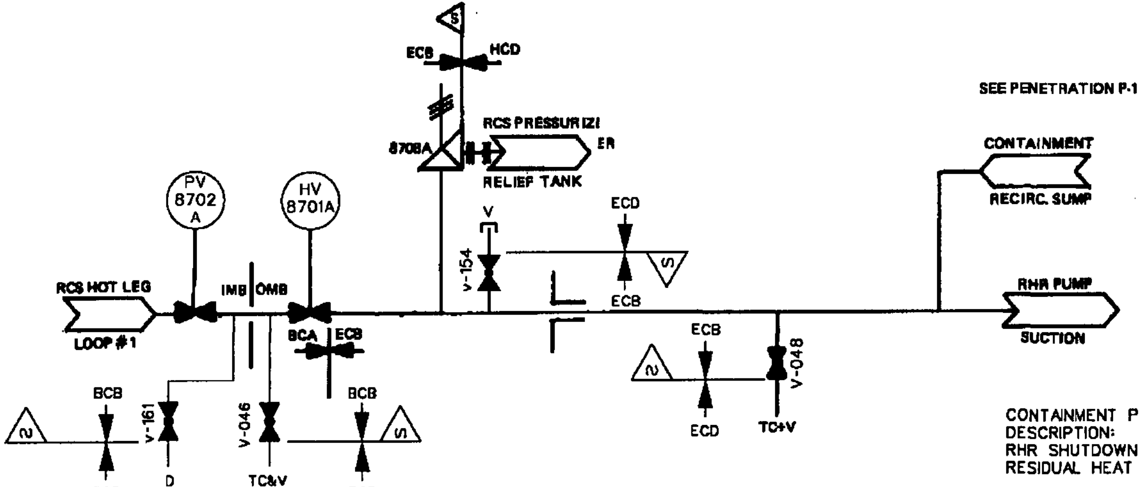
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

THE RESIDUAL HEAT REMOVAL SYSTEM SUCTION LINE FROM THE REACTOR COOLANT SYSTEM CONTAINS TWO NORMALLY CLOSED, POWER-OPERATED REMOTE MANUAL VALVES IN SERIES INSIDE THE CONTAINMENT. THE VALVES ARE ALSO INTERLOCKED TO PREVENT THEM FROM BEING INADVERTENTLY OPENED. CONTAINMENT ISOLATION IS ASSURED BY SYSTEM ISOLATION VALVES CLOSEST TO THE CONTAINMENT AND THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT, WHICH IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT. LEAKAGE DETECTION FROM THIS LINE OUTSIDE THE CONTAINMENT IS PROVIDED, AS DESCRIBED IN SECTION 6.2.2.

LOCAL TESTING OF THE VALVE OR THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT IS NOT REQUIRED SINCE THE SYSTEM IS OPERATED AND INSPECTED DURING NORMAL PLANT OPERATION TO ASSURE THAT THE INTEGRITY IS BEING MAINTAINED.



CONTAINMENT PENETRATION NO. P-79
DESCRIPTION:
RHR SHUTDOWN LINES
RESIDUAL HEAT REMOVAL SYSTEM

REFERENCE SECTION(S) 5.4.7 and 6.3
REV. 15

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
BGHV-8105	3/3	OUTSIDE	IN	GATE	MOTOR	4	SIS	NONE	10	OPEN	OPEN	AS IS	CLOSED	N/A	C
BGV-342	1/1	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
BG8381	3/3	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	OPEN	OPEN	N/A	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

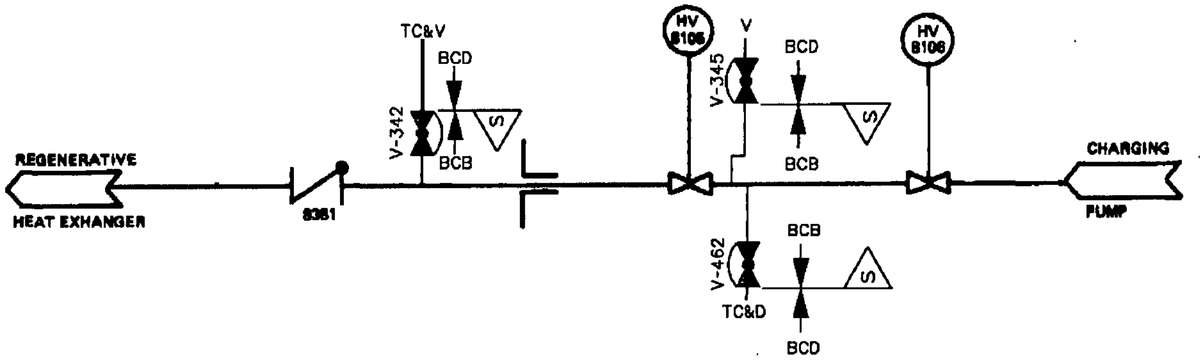
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 18.1 ft

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-80
DESCRIPTION:
CHARGING LINE
CHEMICAL AND VOLUME CONTROL SYSTEM

REFERENCE SECTION(S) 9.3.4
REV. 13

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EJHV-8809A	10/10	OUTSIDE	IN	GATE	MOTOR	1	NONE	REM/MAN	N/A	OPEN	OPEN	AS IS	OPEN	CLOSED	A
EJV-054	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EP8818A	6/6	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	OPEN	CLOSED	A
EP8818B	6/6	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	OPEN	CLOSED	A
EJHCV-8890A	¾/¾	INSIDE	OUT	GLOBE	AIR	1	CIS-A	NONE	13	CLOSED	CLOSED	CLOSED	CLOSED	N/A	A
EJV-134,V-136	¾/¾	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EJV-132	1/1	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EJV-173, EJV-174	¾/¾	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

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ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

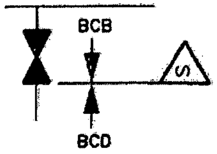
APPLICABLE GDC NO. 55

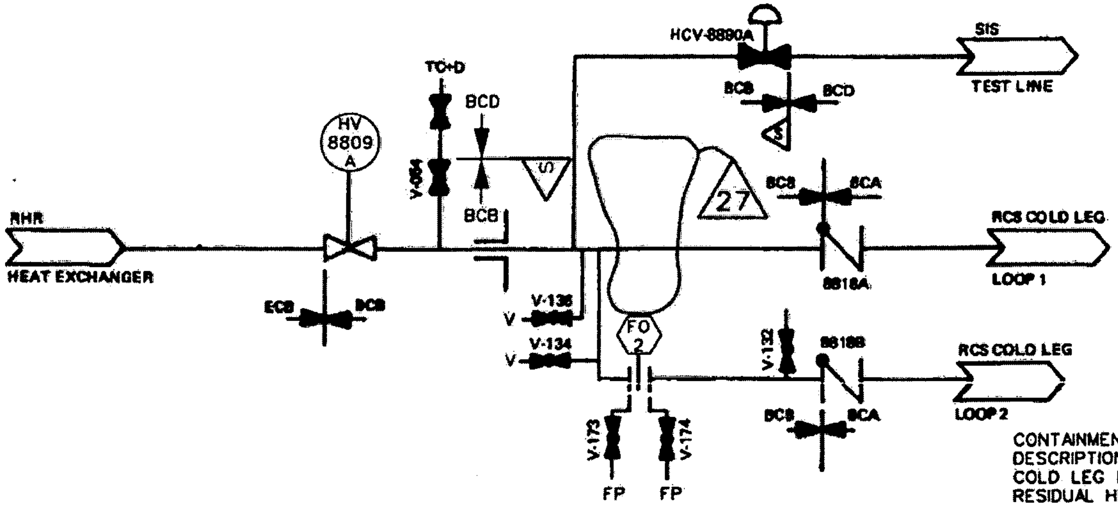
GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE HIGH PRESSURE COOLANT INJECTION SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A CHECK VALVE IS PROVIDED FOR EACH BRANCH LINE INSIDE THE CONTAINMENT, AND A REMOTE-MANUAL ISOLATION VALVE IS PROVIDED OUTSIDE THE CONTAINMENT. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS CLOSED OUTSIDE THE CONTAINMENT AND IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT. LEAKAGE DETECTION FROM THIS LINE OUTSIDE THE CONTAINMENT IS PROVIDED, AS DESCRIBED IN SECTION 5.2.5.

LOCAL TESTING OF THE VALVES OR THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT IS NOT REQUIRED SINCE THE SYSTEM IS OPERATED AND INSPECTED DURING NORMAL PLANT OPERATION TO ASSURE THAT THE INTEGRITY IS BEING MAINTAINED.

NOTE: ALL VENTS, DRAINS AND FLOW POINTS AS INDICATED BELOW.





CONTAINMENT PENETRATION NO. P-82
DESCRIPTION:
COLD LEG INJECTION
RESIDUAL HEAT REMOVAL SYSTEM

REFERENCE SECTION(S) 5.4.7 and 6.3
REV. 27

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UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT ✕
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

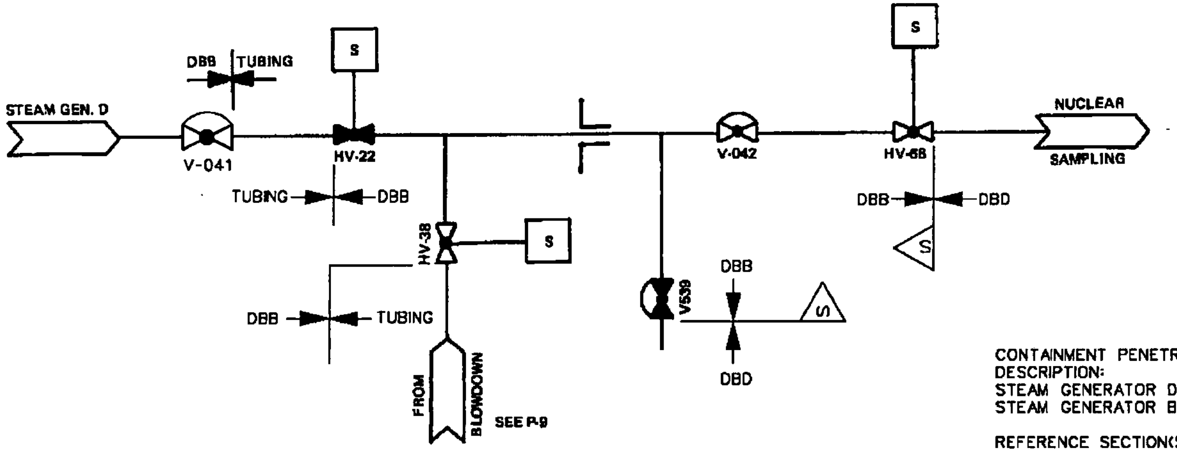
AREA OF CHANGE ✕ PENETRATION TESTED PER TYPE A APPENDEX J REQUIREMENTS.

ASSOCIATED WITH A SAFETY FEATURES SYS.	YES ☒ NO ☐
FLUID CONTAINED:	WATER
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE:	N/A
APPLICABLE GDC NO.	NONE

GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED, THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.



CONTAINMENT PENETRATION NO. P-83
DESCRIPTION:
STEAM GENERATOR D SAMPLE LINE
STEAM GENERATOR BLOWDOWN SYSTEM

REFERENCE SECTION(S) 10.4.8
REV. 15

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT ☒
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

AREA OF CHANGE ✕ PENETRATION TESTED PER TYPE A APPENDIX J REQUIREMENTS.

ASSOCIATED WITH A SAFETY FEATURES SYS. YES☒ NO☐

FLUID CONTAINED: WATER

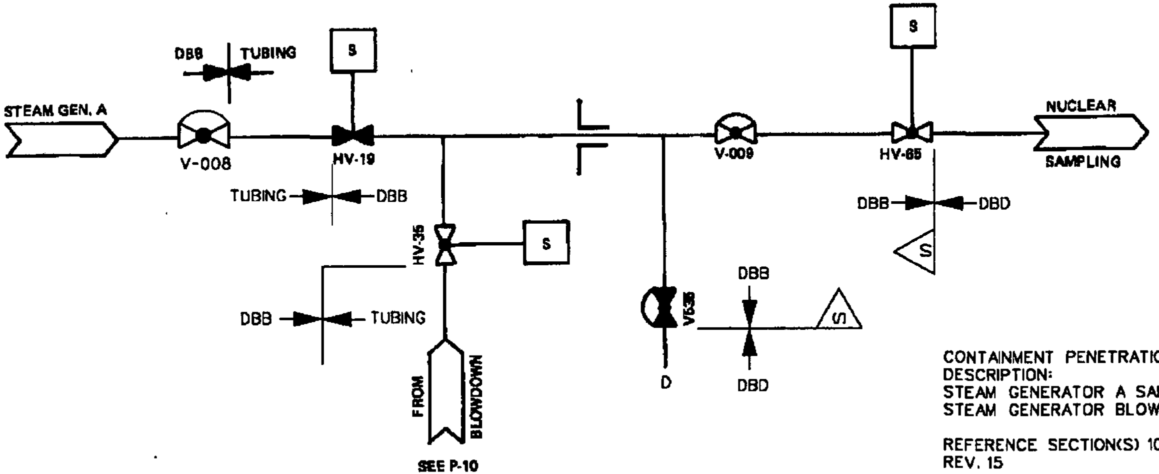
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. NONE

GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED. THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.



CONTAINMENT PENETRATION NO. P-84
DESCRIPTION:
STEAM GENERATOR A SAMPLE LINE
STEAM GENERATOR BLOWDOWN SYSTEM

REFERENCE SECTION(S) 10.4.8
REV. 15

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT ☒
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

AREA OF CHANGE

* PENETRATION TESTED PER TYPE A APPENDEX J REQUIREMENTS.

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

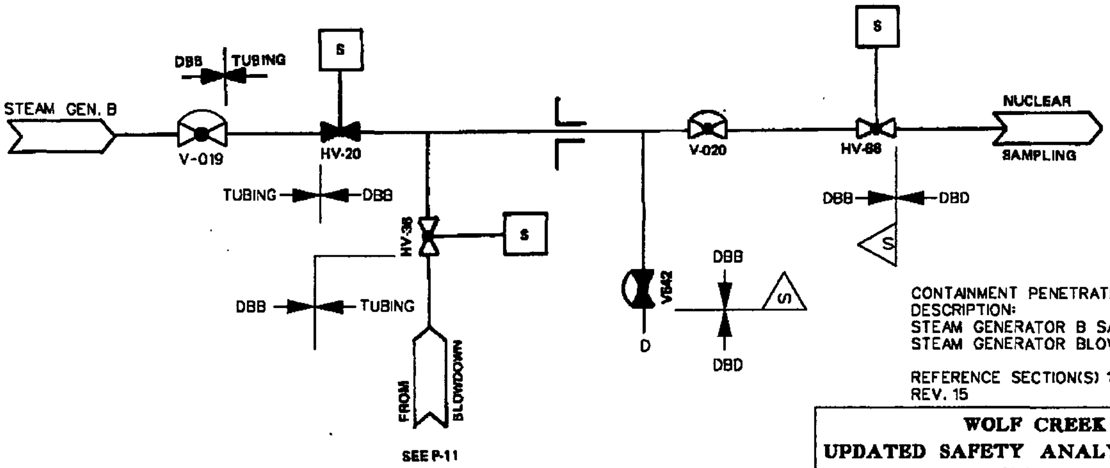
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. NONE

GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED. THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.



CONTAINMENT PENETRATION NO. P-85
DESCRIPTION:
STEAM GENERATOR B SAMPLE LINE
STEAM GENERATOR BLOWDOWN SYSTEM

REFERENCE SECTION(S) 10.4.8
REV. 15

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT ☒
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

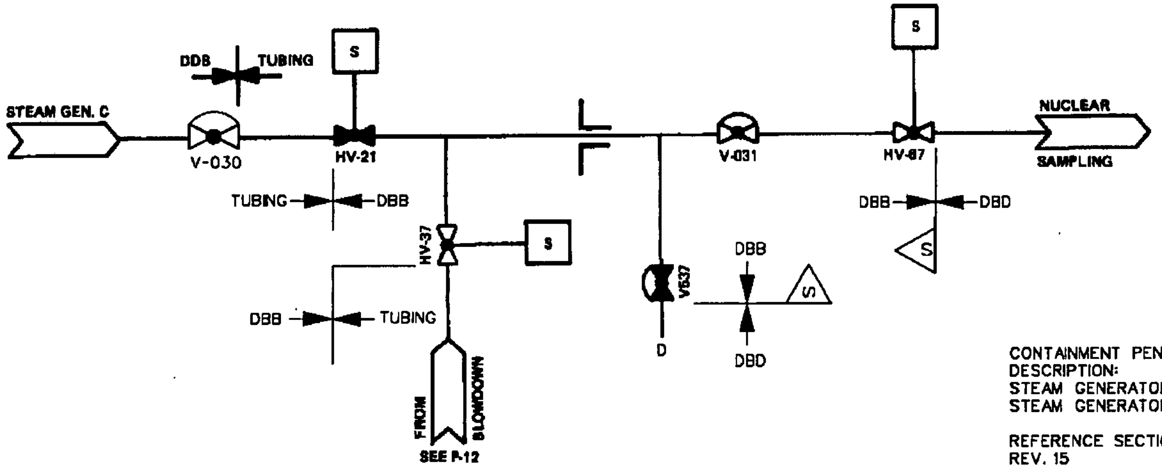
APPLICABLE GDC NO. NONE

AREA OF CHANGE ✕ PENETRATION TESTED PER TYPE A APPENDEX J REQUIREMENTS.

GENERAL COMMENTS:

THE CONTAINMENT PENETRATIONS ASSOCIATED WITH THE STEAM GENERATORS ARE NOT SUBJECT TO GDC-57, SINCE THE CONTAINMENT BARRIER INTEGRITY IS NOT BREACHED. THE BOUNDARY OR BARRIER AGAINST FISSION PRODUCT LEAKAGE TO THE ENVIRONMENT IS THE INSIDE OF THE STEAM GENERATOR TUBES AND THE OUTSIDE OF THE LINES EMANATING FROM THE STEAM GENERATOR SHELLS.

THIS PENETRATION IS INCLUDED FOR FIGURE COMPLETENESS. NONE OF THE VALVES SHOWN ARE CONSIDERED CONTAINMENT ISOLATION VALVES.



CONTAINMENT PENETRATION NO. P-86
DESCRIPTION:
STEAM GENERATOR C SAMPLE LINE
STEAM GENERATOR BLOWDOWN SYSTEM

REFERENCE SECTION(S) 10.4.8
REV. 15

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EMHV-8802A	4/4	OUTSIDE	IN	GATE	MOTOR	1	NONE	REM/MAN	N/A	CLOSED	CLOSED	AS IS	CLOSED	OPEN	A
EMHV-8881	¾/¾	INSIDE	OUT	GLOBE	AIR	1	CIS-A	NONE	10	CLOSED	CLOSED	CLOSED	CLOSED	N/A	A
EMV-001	2/2	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	OPEN	A
EMV-002	2/2	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	OPEN	A
EMV-052, V-053, V-055, V-056, V-184, V-185	¾/¾	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EMV-051	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N.A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EMV-186, V-187	1/1	INSIDE	N/A	GLOBE	MANUAL	N.A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

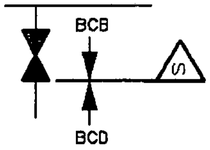
APPLICABLE GDC NO. 55

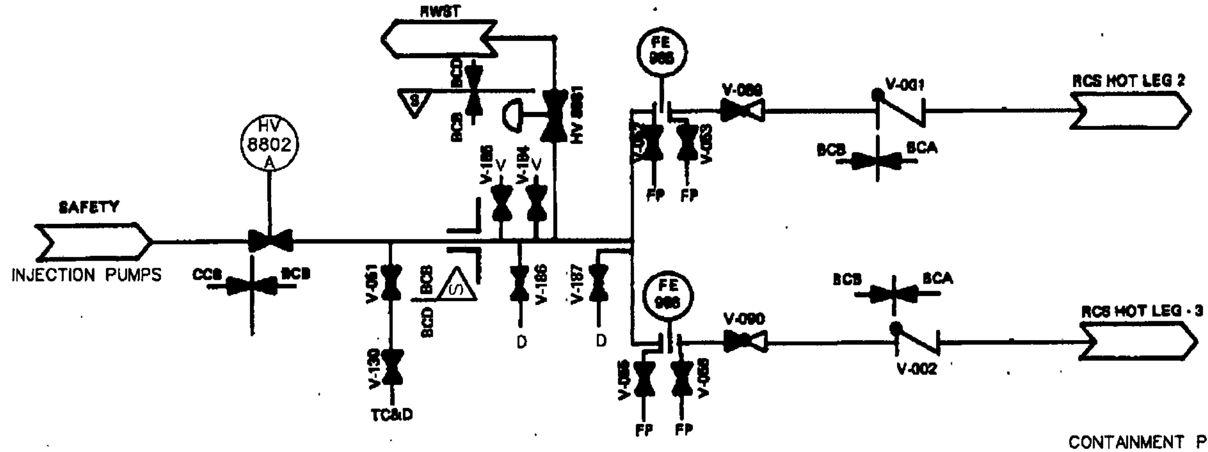
GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE HIGH PRESSURE COOLANT INJECTION SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A CHECK VALVE IS PROVIDED FOR EACH BRANCH LINE INSIDE THE CONTAINMENT, AND A REMOTE-MANUAL ISOLATION VALVE IS PROVIDED OUTSIDE THE CONTAINMENT. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS CLOSED OUTSIDE THE CONTAINMENT AND IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT. LEAKAGE DETECTION FROM THIS LINE OUTSIDE THE CONTAINMENT IS PROVIDED, AS DESCRIBED IN SECTION 9.3.3.

LOCAL TESTING OF THE VALVES OR THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT IS NOT REQUIRED SINCE THE SYSTEM IS OPERATED AND INSPECTED DURING NORMAL PLANT OPERATION TO ASSURE THAT THE INTEGRITY IS BEING MAINTAINED.

NOTE: ALL VENTS, DRAINS AND FLOW POINTS AS INDICATED BELOW.





CONTAINMENT PENETRATION NO. P-87
DESCRIPTION:
HOT LEG INJECTION
HIGH PRESSURE COOLANT INJECTION SYSTEM
REFERENCE SECTION(S) 6.3
REV. 13

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EMHV-8801A	4/4	OUTSIDE	IN	GATE	MOTOR	1	SIS	NONE	N/A	CLOSED	CLOSED	AS IS	OPEN	N/A	A
EMHV-8801B	4/4	OUTSIDE	IN	GATE	MOTOR	4	SIS	NONE	N/A	CLOSED	CLOSED	AS IS	OPEN	N/A	A
EMV-077	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EMHV-8843	¾/¾	INSIDE	IN	GLOBE	AIR	4	CIS-A	NONE	10	CLOSED	CLOSED	CLOSED	CLOSED	N/A	A
EMV-8815	3/3	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	OPEN	N/A	A
EMV-151	1/1	OUTSIDE	OUT	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

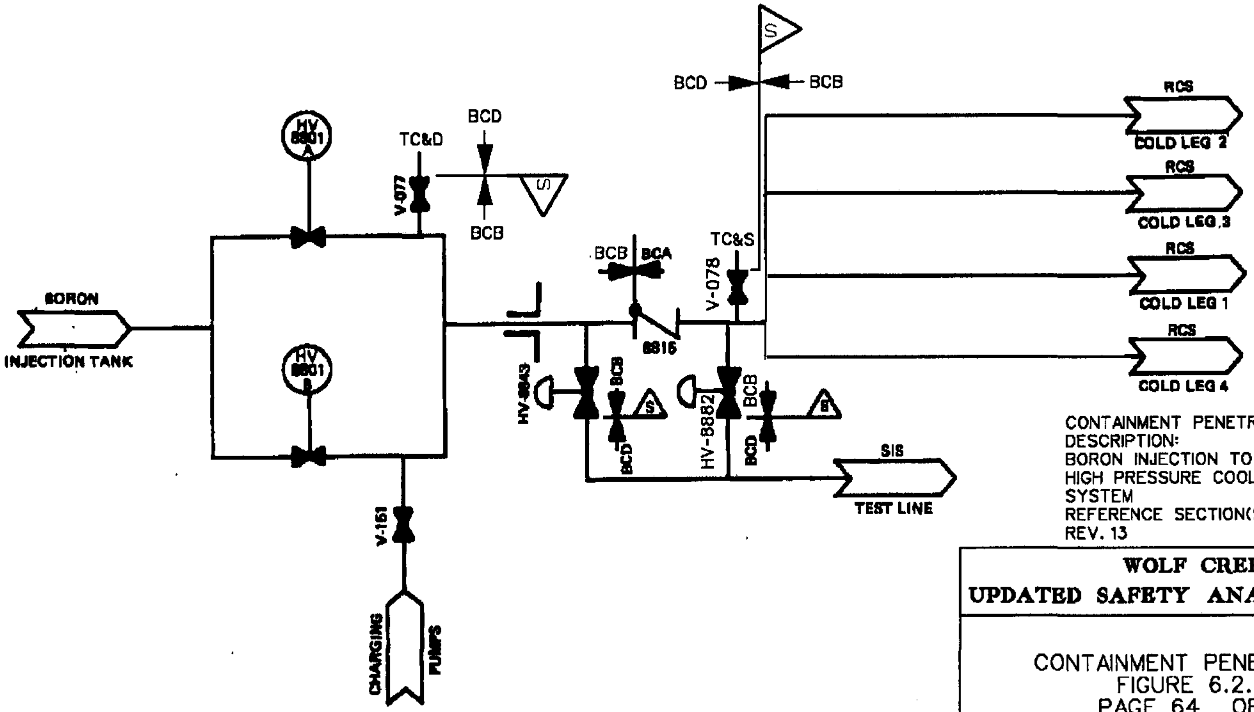
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE HIGH PRESSURE COOLANT INJECTION SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A CHECK VALVE IS PROVIDED FOR EACH BRANCH LINE INSIDE THE CONTAINMENT, AND A REMOTE-MANUAL ISOLATION VALVE IS PROVIDED FOR EACH BRANCH LINE OUTSIDE THE CONTAINMENT. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMODATED SINCE THE SYSTEM IS CLOSED OUTSIDE THE CONTAINMENT AND IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAIMENT. LEAKAGE DETECTION FROM THIS LINE OUTSIDE THE CONTAINMENT IS PROVIDED, AS DESCRIBED IN SECTION 9.3.3.

LOCAL TESTING OF THE VALVES OR THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT IS NOT REQUIRED SINCE THE SYSTEM IS OPERATED AND INSPECTED DURING NORMAL PLANT OPERATION TO ASSURE THAT THE INTEGRITY IS BEING MAINTAINED.



CONTAINMENT PENETRATION NO. P-88
DESCRIPTION:
BORON INJECTION TO COLD LEGS
HIGH PRESSURE COOLANT INJECTION SYSTEM
REFERENCE SECTION(S) 6.3
REV. 13

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
ENHV-06	10/10	OUTSIDE	IN	GATE	MOTOR	1	CSAS	REM/MAN	N/A	CLOSED	CLOSED	AS IS	OPEN	CLOSED	A
ENV-076	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
ENV-013	10/10	INSIDE	IN	CHECK	N/A	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	OPEN	CLOSED	A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: WATER

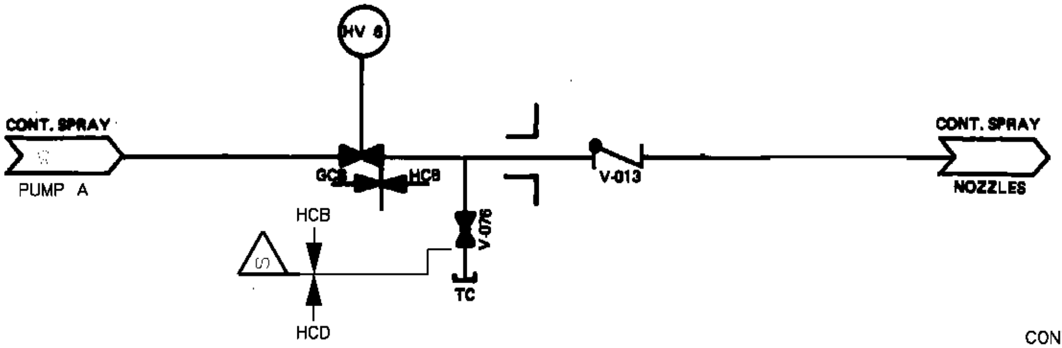
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

THIS PENETRATION IS ASSOCIATED WITH THE CONTAINMENT SPRAY SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA. A CHECK VALVE IS PROVIDED INSIDE THE CONTAINMENT, AND A REMOTE-MANUAL ISOLATION VALVE IS PROVIDED OUTSIDE THE CONTAINMENT. A SINGLE ACTIVE OR PASSIVE FAILURE CAN BE ACCOMMODATED SINCE THE SYSTEM IS CLOSED OUTSIDE THE CONTAINMENT AND IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT. LEAKAGE DETECTION FROM THIS LINE OUTSIDE THE CONTAINMENT IS PROVIDED, AS DESCRIBED IN SECTION 9.3.3.

LOCAL TESTING OF THE VALVES OR THE CLOSED SYSTEM OUTSIDE THE CONTAINMENT IS NOT REQUIRED SINCE THE SYSTEM IS OPERATED AND INSPECTED DURING NORMAL PLANT OPERATION TO ASSURE THAT THE INTEGRITY IS BEING MAINTAINED.



CONTAINMENT PENETRATION NO. P-89
DESCRIPTION:
CONTAINMENT SPRAY
CONTAINMENT SPRAY SYSTEM

REFERENCE SECTION(S) 6.2.2
REV. 13

WOLF CREEK
UPDATED SAFETY ANALYSIS REPORT

CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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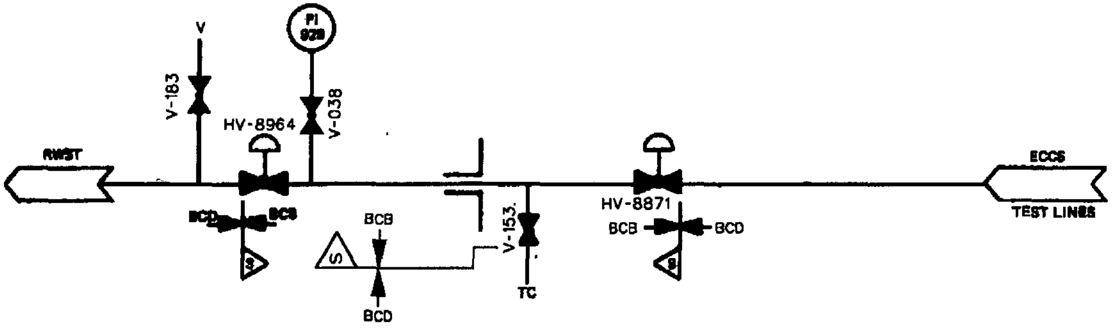
VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
EMHV-8964	¾/¾	OUTSIDE	OUT	GLOBE	AIR	1	CIS-A	NONE	10	CLOSED	CLOSED	CLOSED	CLOSED	N/A	C
EMV-153	¾/¾	INSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EMHV-8871	¾/¾	INSIDE	OUT	GLOBE	AIR	4	CIS-A	NONE	10	CLOSED	CLOSED	CLOSED	CLOSED	N/A	C
EMV-038	¾/¾	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
EMPI-929	¾	OUTSIDE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

AREA OF CHANGE

ASSOCIATED WITH A SAFETY FEATURES SYS.	YES ☐ NO ☒
FLUID CONTAINED:	WATER
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE:	16.7 ft
APPLICABLE GDC NO.	56

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-92
DESCRIPTION:
ECCS TEST LINE RETURN
HIGH PRESSURE COOLANT INJECTION
SYSTEM
REFERENCE SECTION(S) 6.3
REV. 15

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
SJHV-5	1/1	INSIDE	OUT	GLOBE	SOLENOID	4	CIS-A	NONE	5	OPEN	CLOSED	CLOSED	CLOSED	N/A	C
SJHV-6	1/1	OUTSIDE	OUT	GLOBE	SOLENOID	1	CIS-A	NONE	5	OPEN	CLOSED	CLOSED	CLOSED	N/A	C
SJV-069	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A
SJHV-127	1/1	OUTSIDE	OUT	GLOBE	SOLENOID	4	CIS-A	NONE	5	CLOSED	CLOSED	CLOSED	CLOSED	N/A	C

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

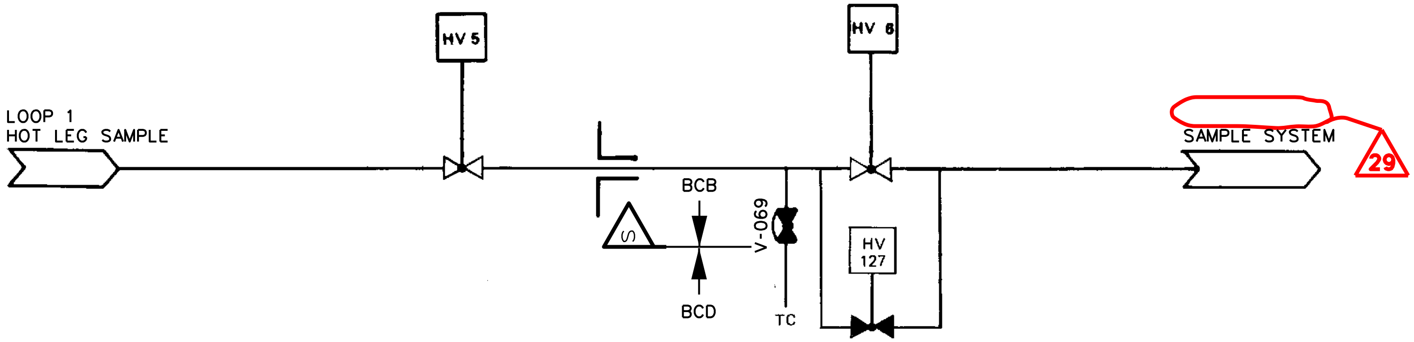
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 10.3 ft

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-93

DESCRIPTION:

RC LOOP LIQUID SAMPLES

29

REFERENCE SECTION(S) 9.3.2/18.2.3

REV. 29

WOLF CREEK

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CONTAINMENT PENETRATIONS

FIGURE 6.2.4-1

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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
SJHV-18	1/1	INSIDE	OUT	GATE	SOLENOID	4	CIS-A	NONE	5	CLOSED	CLOSED	CLOSED	CLOSED	N/A	C
SJHV-19	1/1	OUTSIDE	OUT	GATE	SOLENOID	1	CIS-A	NONE	5	CLOSED	CLOSED	CLOSED	CLOSED	N/A	C
SJV-066	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

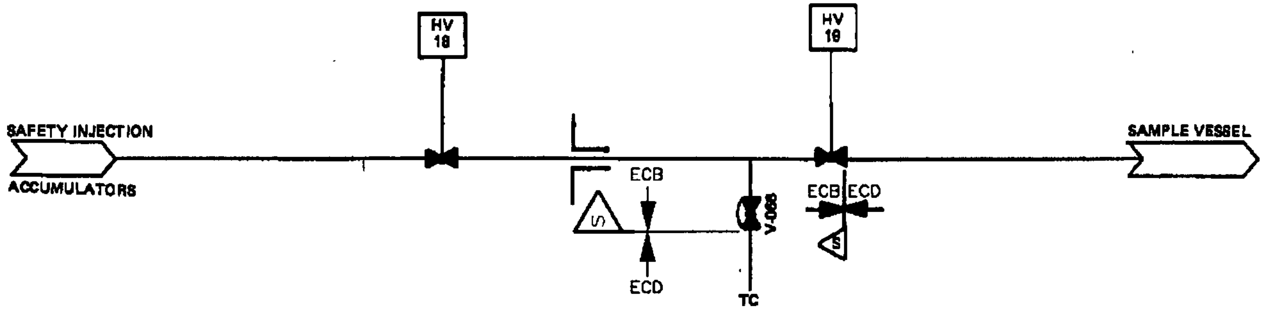
FLUID CONTAINED: WATER

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 10.3 ft

APPLICABLE GDC NO. 55

GENERAL COMMENTS:

NONE



CONTAINMENT PENETRATION NO. P-95
DESCRIPTION:
ACCUMULATOR SAMPLING
NUCLEAR SAMPLING SYSTEM

REFERENCE SECTION(S) 9.3.2
REV. 13

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
GSHV-18	1/1	INSIDE	IN	GATE	SOLENOID	1	CIS-A	REM/MAN	5	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	A,C
GSHV-17	1/1	OUTSIDE	IN	GATE	SOLENOID	1	CIS-A	REM/MAN	5	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	A,C
GSV-036	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: CONT. AIR

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 56

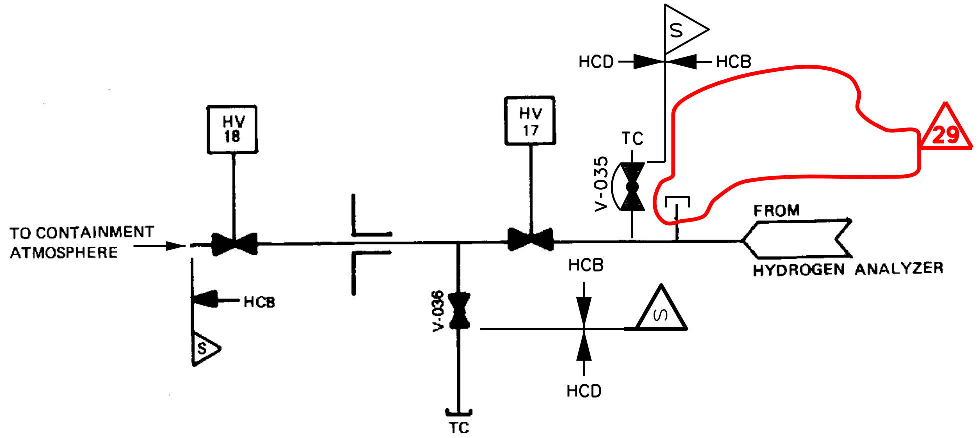
GENERAL COMMENTS:

29

THIS PENETRATION IS ASSOCIATED WITH THE CONTAINMENT HYDROGEN CONTROL SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA.

THE HYDROGEN ANALYZER IS A CLOSED SYSTEM OUTSIDE THE CONTAINMENT WHICH IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT.

TO ASSURE LEAKTIGHT INTEGRITY, THE VALVES ARE SUBJECTED TO TYPE C TESTING, AND THE SAMPLE LINES ARE OPENED DURING THE TYPE A TESTING.



CONTAINMENT PENETRATION NO. P-97
DESCRIPTION:
H_2 SAMPLE RETURN
HYDROGEN CONTROL SYSTEM

REFERENCE SECTION(S) 6.2.5

REV. 29

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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AREA OF CHANGE

VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
GSHV-33	1/1	OUTSIDE	IN	GATE	SOLENOID	4	CIS-A	REM/MAN	5	OPEN	OPEN	CLOSED	CLOSED	OPEN	A, C
GSHV-34	1/1	INSIDE	IN	GATE	SOLENOID	1	CIS-A	REM/MAN	5	OPEN	OPEN	CLOSED	CLOSED	OPEN	A, C
GSV-052	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

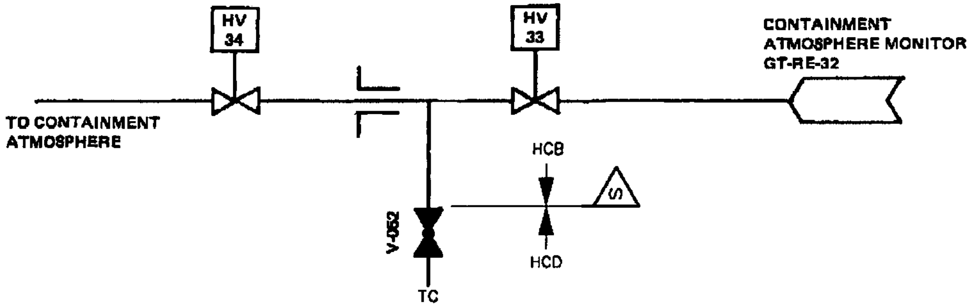
ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

FLUID CONTAINED: CONT. ATM

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 7.8 ft.

APPLICABLE GDC NO. 56

GENERAL COMMENTS: **NONE**



CONTAINMENT PENETRATION NO. P-97
DESCRIPTION:
SAMPLE RETURN
CONTAINMENT ATMOSPHERE MONITOR

REFERENCE SECTION(S) 9.4.6
REV. 15

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
KBV-001	2/2	INSIDE	IN	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	C
KBV-002	2/2	OUTSIDE	IN	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	C

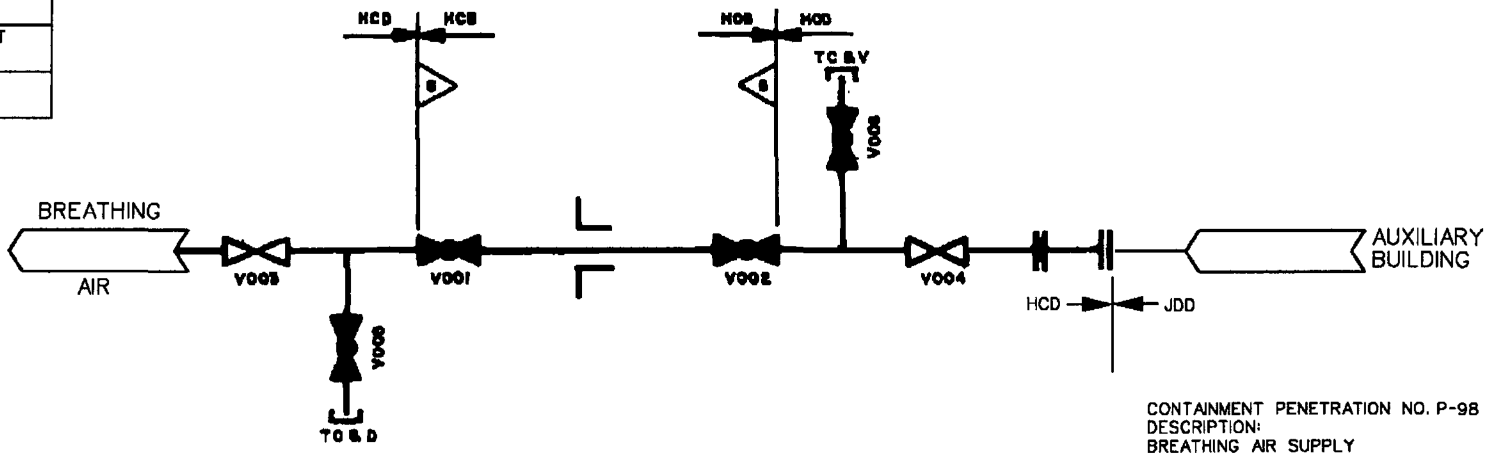
ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

FLUID CONTAINED: AIR

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 7.1 ft.

APPLICABLE GDC NO. 56

GENERAL COMMENTS:
NONE



CONTAINMENT PENETRATION NO. P-98
DESCRIPTION:
BREATHING AIR SUPPLY

REFERENCE SECTION(S) 9.5.10
REV. 13

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
GSHV-3	1/1	OUTSIDE	OUT	GATE	SOLENOID	4	CIS-A	REM/MAN	5	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	A,C
GSHV-4	1/1	INSIDE	OUT	GATE	SOLENOID	4	CIS-A	REM/MAN	5	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	A,C
GSHV-5	1/1	INSIDE	OUT	GATE	SOLENOID	4	CIS-A	REM/MAN	5	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	A,C
GSV-029	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: CONT. ATM

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 56

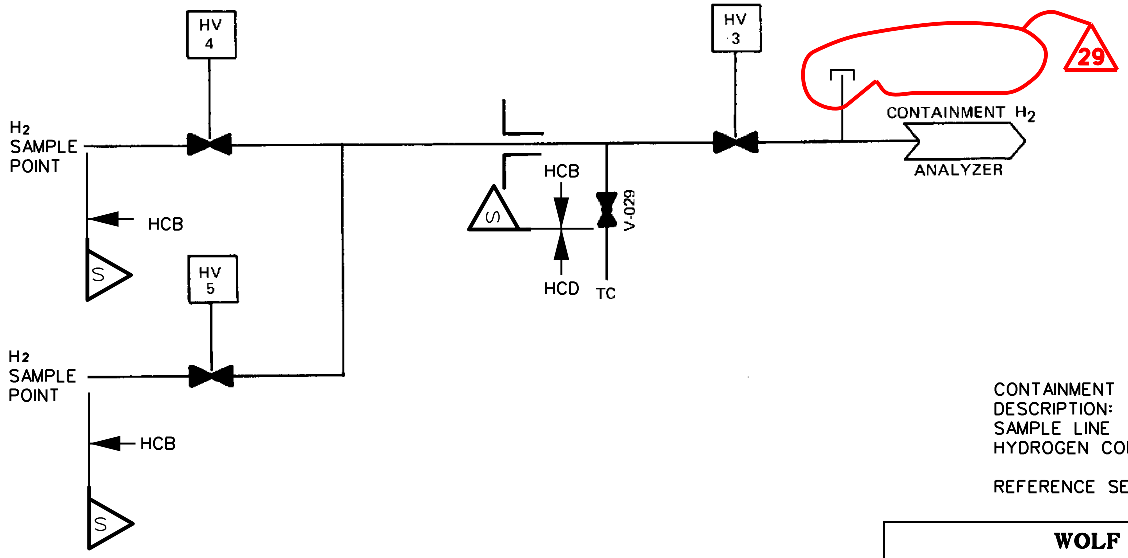
GENERAL COMMENTS:

29

THIS PENETRATION IS ASSOCIATED WITH THE CONTAINMENT HYDROGEN CONTROL SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA.

THE HYDROGEN ANALYZER IS A CLOSED SYSTEM OUTSIDE THE CONTAINMENT WHICH IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT.

TO ASSURE LEAKTIGHT INTEGRITY, THE VALVES ARE SUBJECTED TO TYPE C TESTING, AND THE SAMPLE LINES ARE OPENED DURING THE TYPE A TESTING.



CONTAINMENT PENETRATION NO. P-99
DESCRIPTION:
SAMPLE LINE
HYDROGEN CONTROL SYSTEM

REFERENCE SECTION(S) 6.2

REV. 29

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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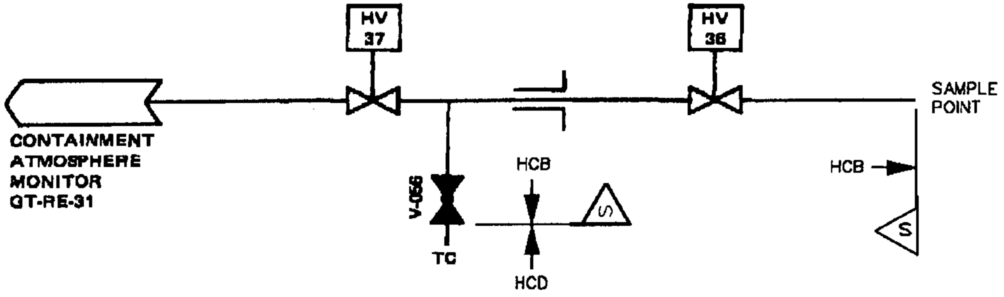
VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
GSHV-36	1/1	INSIDE	OUT	GATE	SOLENOID	4	CIS-A	REM/MAN	5	OPEN	OPEN	CLOSED	CLOSED	OPEN	C
GSHV-37	1/1	OUTSIDE	OUT	GATE	SOLENOID	1	CIS-A	REM/MAN	5	OPEN	OPEN	CLOSED	CLOSED	OPEN	C
GSV-056	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐
FLUID CONTAINED: CONT. AIR
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE:
APPLICABLE GDC NO. 56

GENERAL COMMENTS: NONE



CONTAINMENT PENETRATION NO. P-99
DESCRIPTION:
SAMPLE LINE
CONTAINMENT ATMOSPHERE MONITOR

REFERENCE SECTION(S) 9.4.6
REV. 13

WOLF CREEK
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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	APPENDIX J REQUIREMENT
GSHV-12	1/1	OUTSIDE	OUT	GATE	SOLENOID	1	CIS-A	REM/MAN	5	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	A,C
GSHV-13	1/1	INSIDE	OUT	GATE	SOLENOID	1	CIS-A	REM/MAN	5	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	A,C
GSHV-14	1/1	INSIDE	OUT	GATE	SOLENOID	1	CIS-A	REM/MAN	5	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	A,C
GSV-033	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: CONT. ATM.

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 56

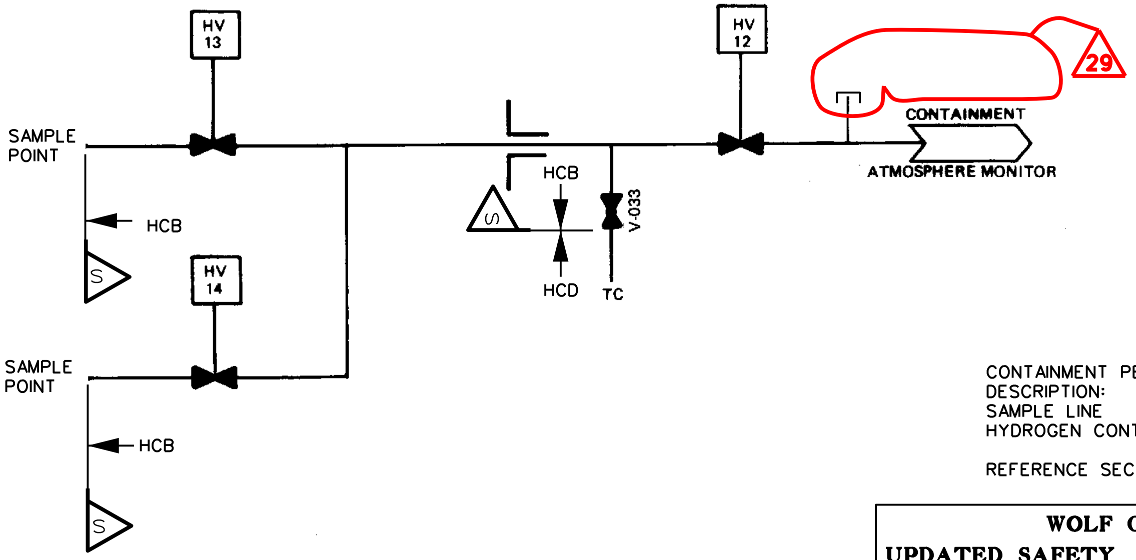
GENERAL COMMENTS:

29

THIS PENETRATION IS ASSOCIATED WITH THE CONTAINMENT HYDROGEN CONTROL SYSTEM, WHICH IS REQUIRED TO MITIGATE THE CONSEQUENCES OF A LOCA.

THE HYDROGEN ANALYZER IS A CLOSED SYSTEM OUTSIDE THE CONTAINMENT WHICH IS DESIGNED AND CONSTRUCTED COMMENSURATE WITH THE DESIGN AND CONSTRUCTION OF THE CONTAINMENT.

TO ASSURE LEAKTIGHT INTEGRITY, THE VALVES ARE SUBJECTED TO TYPE C TESTING, AND THE SAMPLE LINES ARE OPENED DURING THE TYPE A TESTING.



CONTAINMENT PENETRATION NO. P-101
DESCRIPTION:
SAMPLE LINE
HYDROGEN CONTROL SYSTEM

REFERENCE SECTION(S) 6.2.5

REV. 29

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
GSHV-31	1/1	INSIDE	OUT	GATE	SOLENOID	1	CIS-A	REM/MAN	5	OPEN	OPEN	CLOSED	CLOSED	OPEN	C
GSHV-32	1/1	OUTSIDE	OUT	GATE	SOLENOID	4	CIS-A	REM/MAN	5	OPEN	OPEN	CLOSED	CLOSED	OPEN	C
GSV-050	1/1	OUTSIDE	N/A	GLOBE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

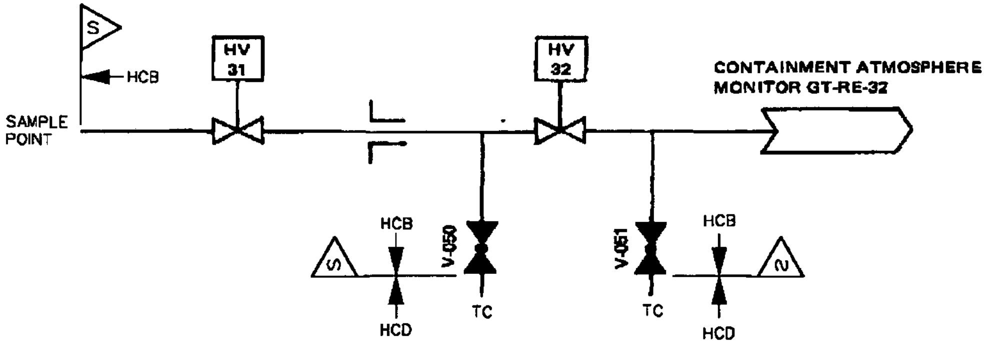
ASSOCIATED WITH A SAFETY FEATURES SYS. YES☐ NO☒

FLUID CONTAINED: CONT. ATM.

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: LATER

APPLICABLE GDC NO. 56

GENERAL COMMENTS: NONE



CONTAINMENT PENETRATION NO. P-101
DESCRIPTION:
SAMPLE LINE
CONTAINMENT ATMOSPHERE MONITOR

REFERENCE SECTION(S) 9.4.6
REV. 13

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
PRESSURE TRANSMITTER	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☒ NO ☐

FLUID CONTAINED: DOW CORNING D C 702 PURIFIED AND SUPPLIED BY WESTINGHOUSE

LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: N/A

APPLICABLE GDC NO. 56

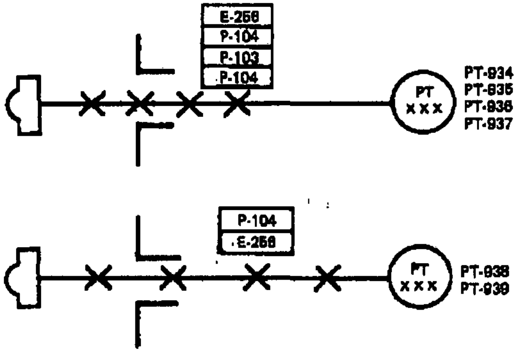
GENERAL COMMENTS:

PT-934, 935, 936 AND 937
THERE ARE FOUR INSTRUMENT LINES WHICH PENETRATE THE CONTAINMENT AND WHICH ARE REQUIRED TO REMAIN FUNCTIONAL FOLLOWING A LOCA OR STEAM BREAK. THESE LINES SENSE THE PRESSURE OF CONTAINMENT ATMOSPHERE ON THE INSIDE AND ARE CONNECTED TO PRESSURE TRANSMITTERS ON THE OUTSIDE. SIGNALS FROM THESE TRANSMITTERS CAN INITIATE SAFETY INJECTION AND CONTAINMENT ISOLATION ON HIGH CONTAINMENT PRESSURE. THEY ALSO, UPON HI-HI CONTAINMENT PRESSURE, PRODUCE THE ONLY SIGNAL TO INITIATE CONTAINMENT SPRAY. IN VIEW OF THIS FUNCTION, IT IS ESSENTIAL THAT THE LINE REMAIN OPEN AND NOT BE ISOLATED FOLLOWING AN ACCIDENT. BASED ON THIS REQUIREMENT, A SEALED SENSING LINE, AS DESCRIBED BELOW, IS USED.

PT-938 AND PT-939 ARE THE WIDE RANGE CONTAINMENT PRESSURE TRANSMITTERS REQUIRED BY NUREG-0737 AND REGULATORY GUIDE 1.97.

EACH OF THE FOUR CHANNELS HAS A SEPARATE PENETRATION, AND EACH PRESSURE TRANSMITTER IS LOCATED IMMEDIATELY ADJACENT TO THE OUTSIDE OF THE CONTAINMENT WALL. IT IS CONNECTED TO A SEALED BELLOWS, LOCATED IMMEDIATELY ADJACENT TO THE INSIDE CONTAINMENT WALL, BY MEANS OF A SEALED FLUID FILLED TUBE. THIS TUBING, ALONG WITH THE TRANSMITTER AND BELLOWS, IS CONSERVATIVELY DESIGNED AND SUBJECT TO STRICT QUALITY CONTROL AND TO REGULAR IN-SERVICE INSPECTIONS TO ASSURE ITS INTEGRITY. THIS ARRANGEMENT PROVIDES A DOUBLE BARRIER (ONE INSIDE AND ONE OUTSIDE) BETWEEN THE CONTAINMENT AND THE OUTSIDE ATMOSPHERS. SHOULD A LEAK OCCUR OUTSIDE THE CONTAINMENT, THE SEALED BELLOWS INSIDE THE CONTAINMENT, WHICH IS DESIGNED TO WITHSTAND FULL CONTAINMENT DESIGN PRESSURE, WILL PREVENT THE ESCAPE OF THE CONTAINMENT ATMOSPHERE. SHOULD A LEAK OCCUR INSIDE THE CONTAINMENT, THE DIAPHRAGM IN THE TRANSMITTER, WHICH IS DESIGNED TO WITHSTAND FULL CONTAINMENT DESIGN PRESSURE, WILL PREVENT ANY ESCAPE FROM THE CONTAINMENT. THIS ARRANGEMENT PROVIDES AUTOMATIC DOUBLE-BARRIER ISOLATION WITHOUT OPERATOR ACTION AND WITHOUT SACRIFICING ANY RELIABILITY. BOTH THE BELLOWS AND TUBING INSIDE THE CONTAINMENT ARE ENCLOSED BY PROTECTIVE SHIELDING. THIS SHIELDING (BOX, CHANNEL OR GUARD PIPE, ETC.) PREVENT MECHANICAL DAMAGE TO THE COMPONENTS FROM MISSILES, WATER JETS, DROPPED TOOLS, ETC.

BECAUSE OF THIS SEALED FLUID FILLED SYSTEM, A POSTULATED SEVERANCE OF THE LINE DURING EITHER NORMAL OPERATION OR ACCIDENT CONDITIONS WILL NOT RESULT IN ANY RELEASE FROM THE CONTAINMENT.



CONTAINMENT PENETRATION NO. P-103 & 104
DESCRIPTION: E-256

CONTAINMENT PRESSURE TRANSMITTERS

REFERENCE SECTION(S) 6.3, 9.4
REV. 11

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
GTHZ-9	36/36	OUTSIDE	OUT	BUTTERFLY	AIR/SPR	1	CPIS	NONE	10	CLOSED	OPEN	CLOSED	CLOSED	N/A	C
GTHZ-8	36/36	INSIDE	OUT	BUTTERFLY	AIR/SPR	4	CPIS	NONE	10	CLOSED	OPEN	CLOSED	CLOSED	N/A	C
GTHZ-12	18/18	OUTSIDE	OUT	BUTTERFLY	AIR/SPR	1	CPIS	NONE	3	NOTE 1	CLOSED	CLOSED	CLOSED	N/A	C
GTHZ-11	18/18	INSIDE	OUT	BUTTERFLY	AIR/SPR	4	CPIS	NONE	3	NOTE 1	CLOSED	CLOSED	CLOSED	N/A	C
GTV0223	1/1	OUTSIDE	N/A	GATE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

FLUID CONTAINED: CONT. ATM.

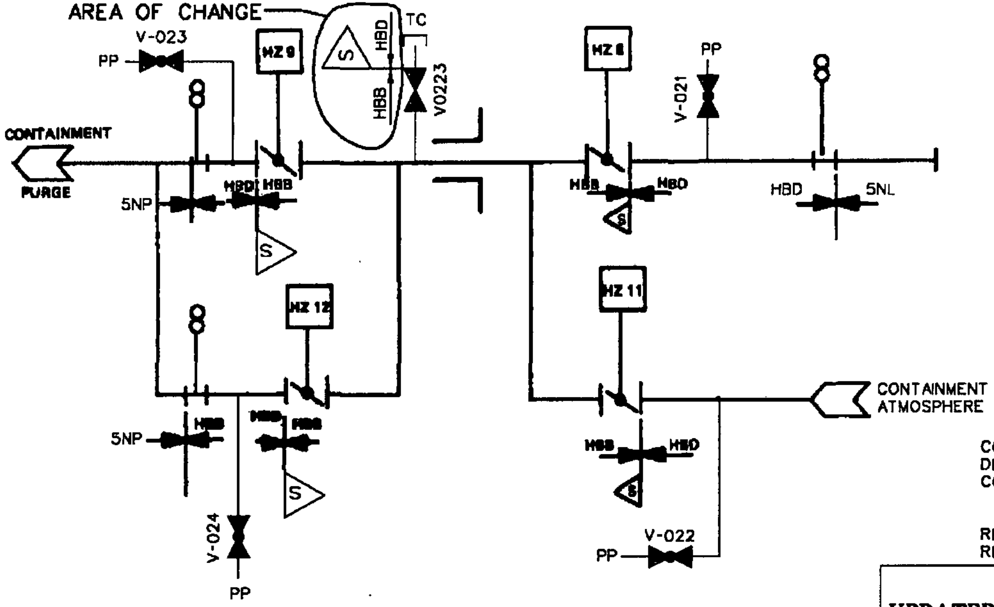
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 12.0 ft

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NOTE 1

THIS VALVE IS INTERMITTENTLY OPENED TO PROVIDE FOR CONTAINMENT MINI-PURGE DURING POWER OPERATION



CONTAINMENT PENETRATION NO. V-160
DESCRIPTION:
CONTAINMENT PURGE SYSTEM

REFERENCE SECTION(S) 9.4
REV. 15

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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VALVE NO.	LINE/ VALVE SIZE, IN.	INSIDE/ OUTSIDE CONT.	NORMAL FLOW DIRECTION	VALVE TYPE	VALVE OPERATOR	POWER SOURCE	PRIMARY ACTUATION SIGNAL	SECONDARY ACTUATION SIGNAL	MAXIMUM CLOSURE TIME (SEC.)	VALVE POSITION					APPENDIX J REQUIREMENT
										NORMAL	SHUTDOWN	FAIL	PRIMARY	SECONDARY	
GTHZ-7	36/36	INSIDE	IN	BUTTERFLY	AIR/SPR	1	CPIS	NONE	10	CLOSED	OPEN	CLOSED	CLOSED	N/A	C
GTHZ-5	18/18	INSIDE	IN	BUTTERFLY	AIR/SPR	1	CPIS	NONE	3	NOTE 1	CLOSED	CLOSED	CLOSED	N/A	C
GTHZ-4	18/18	OUTSIDE	IN	BUTTERFLY	AIR/SPR	4	CPIS	NONE	3	NOTE 1	CLOSED	CLOSED	CLOSED	N/A	C
GTHZ-6	36/36	OUTSIDE	IN	BUTTERFLY	AIR/SPR	4	CPIS	NONE	10	CLOSED	OPEN	CLOSED	CLOSED	N/A	C
GTV0222	1/1	OUTSIDE	N/A	GATE	MANUAL	N/A	N/A	N/A	N/A	CLOSED	CLOSED	N/A	CLOSED	N/A	N/A

ASSOCIATED WITH A SAFETY FEATURES SYS. YES ☐ NO ☒

FLUID CONTAINED: AIR.

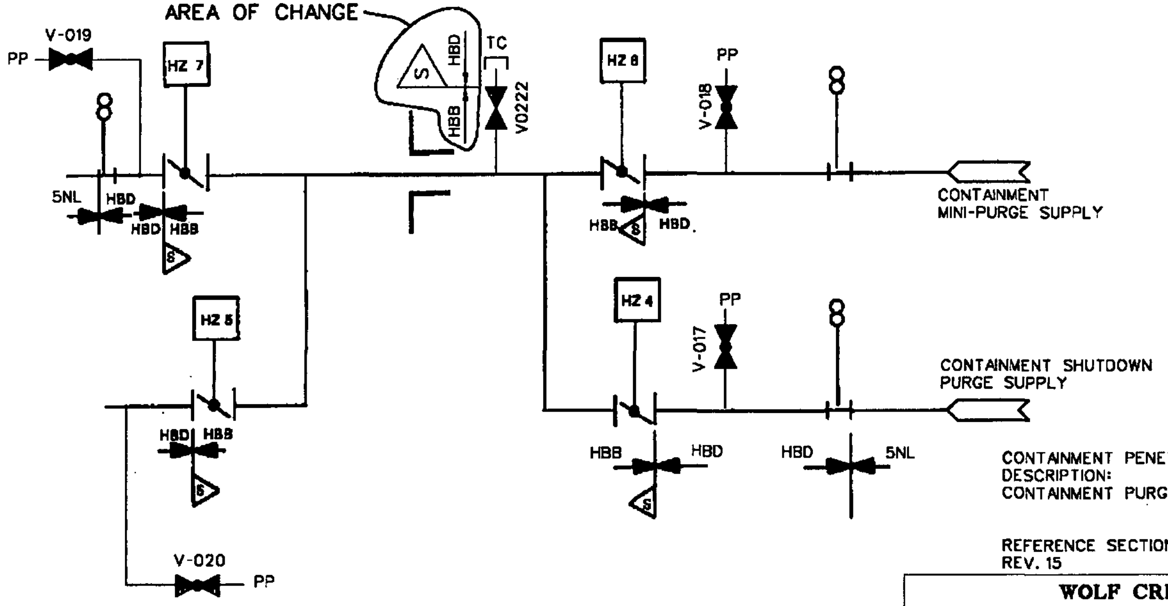
LENGTH OF PIPING TO OUTERMOST ISOLATION VALVE: 12.5 ft

APPLICABLE GDC NO. 56

GENERAL COMMENTS:

NOTE 1

THIS VALVE IS INTERMITTENTLY OPENED FOR PROVIDE FOR CONTAINMENT MINI-PURGE DURING POWER OPERATION



CONTAINMENT PENETRATION NO. V-161
DESCRIPTION:
CONTAINMENT PURGE SYSTEM

REFERENCE SECTION(S) 9.4
REV. 15

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CONTAINMENT PENETRATIONS
FIGURE 6.2.4-1
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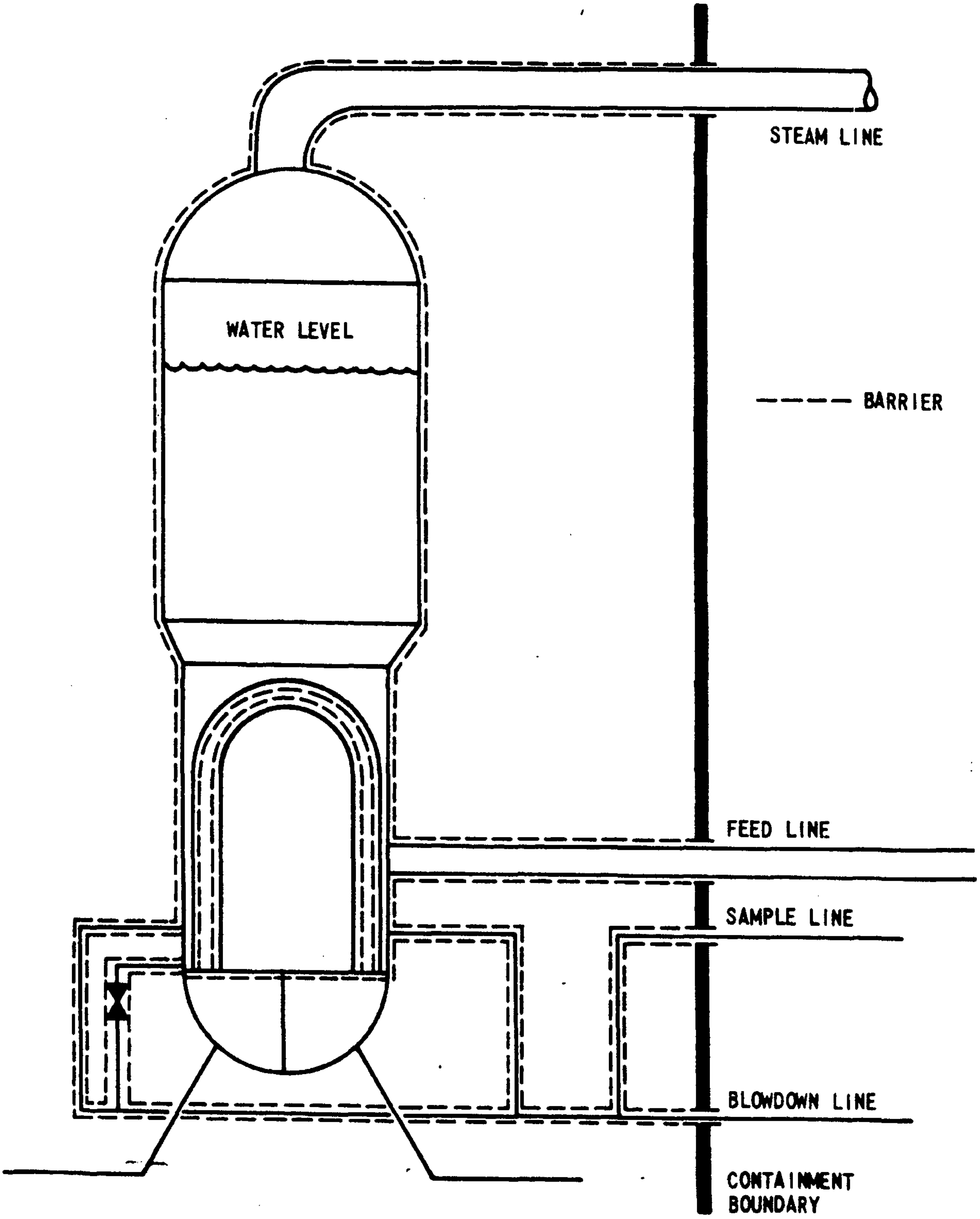

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FIGURE 6.2.4-2

STEAM GENERATOR AND ASSOCIATED SYSTEMS AS A BARRIER TO THE RELEASE OF RADIOACTIVITY POST LOCA

WOLF CREEK

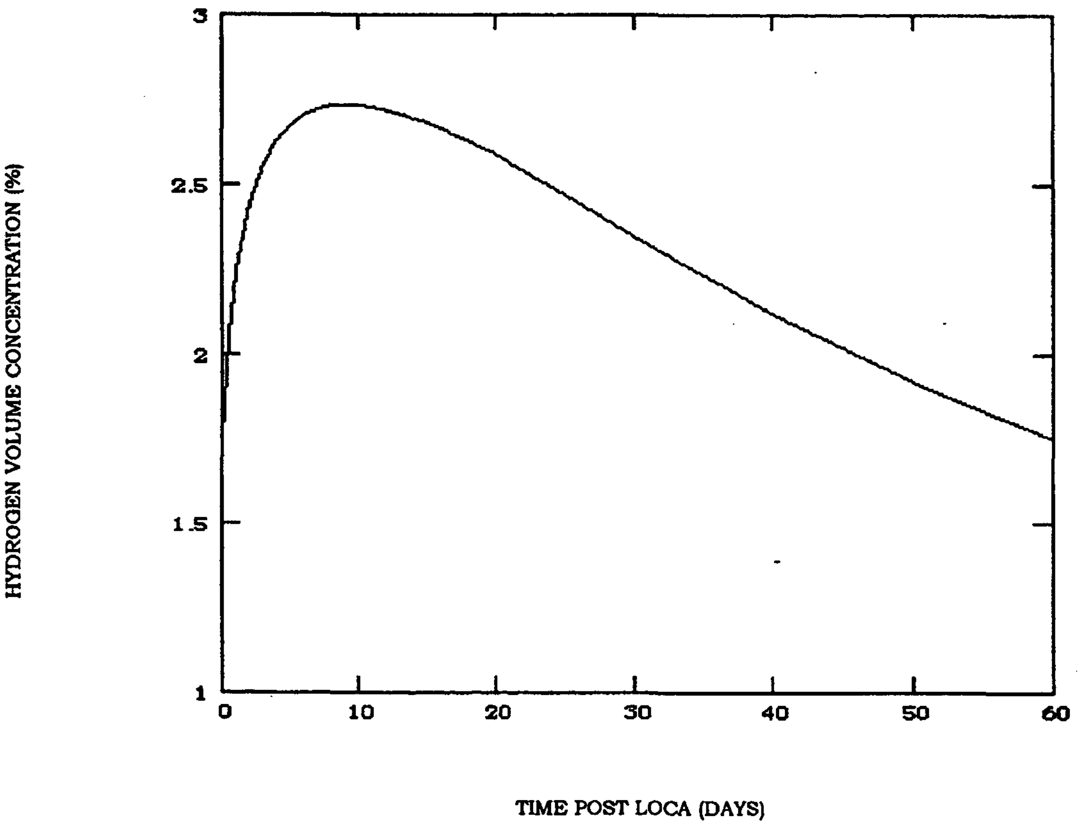

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Figure 6.2.5-2

HYDROGEN VOLUME CONCENTRATION IN CONTAINMENT WITH ONE RECOMBINER OPERATING AT ONE DAY

WOLF CREEK

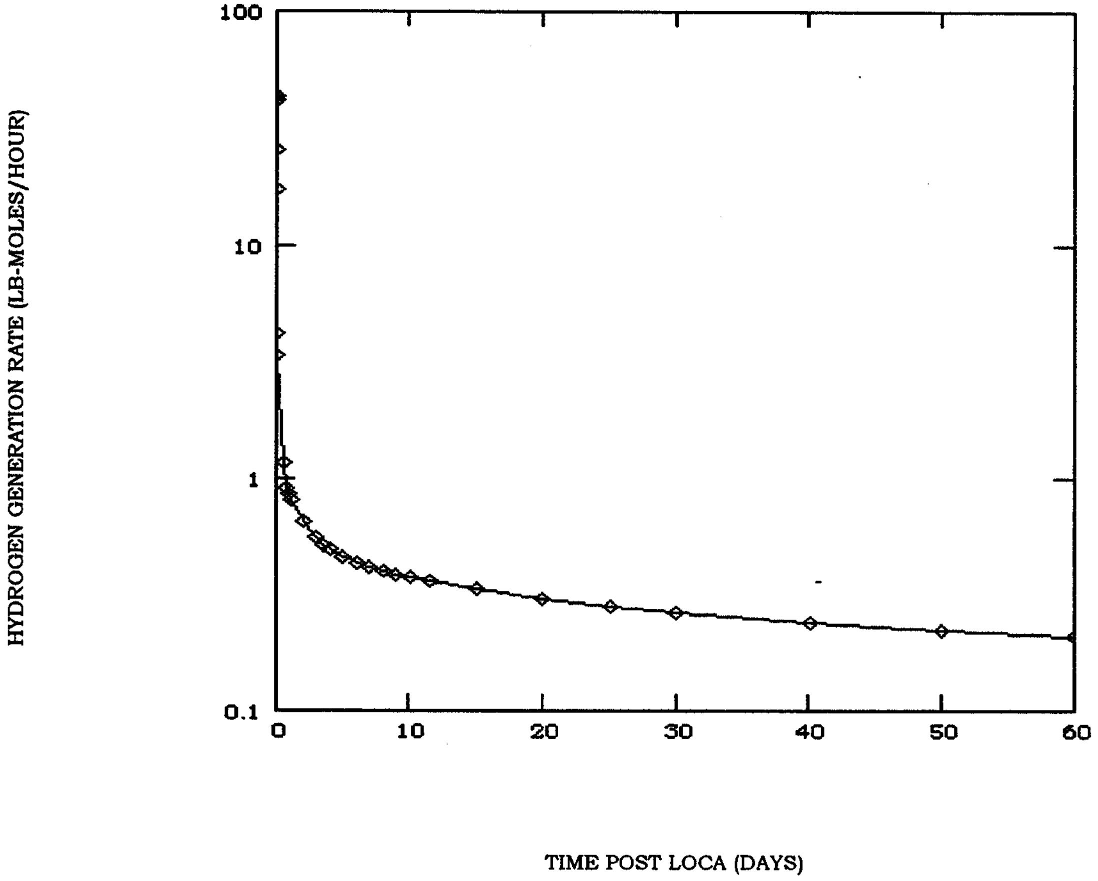

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Figure 6.2.5-3

HYDROGEN GENERATION
IN CONTAINMENT

WOLF CREEK

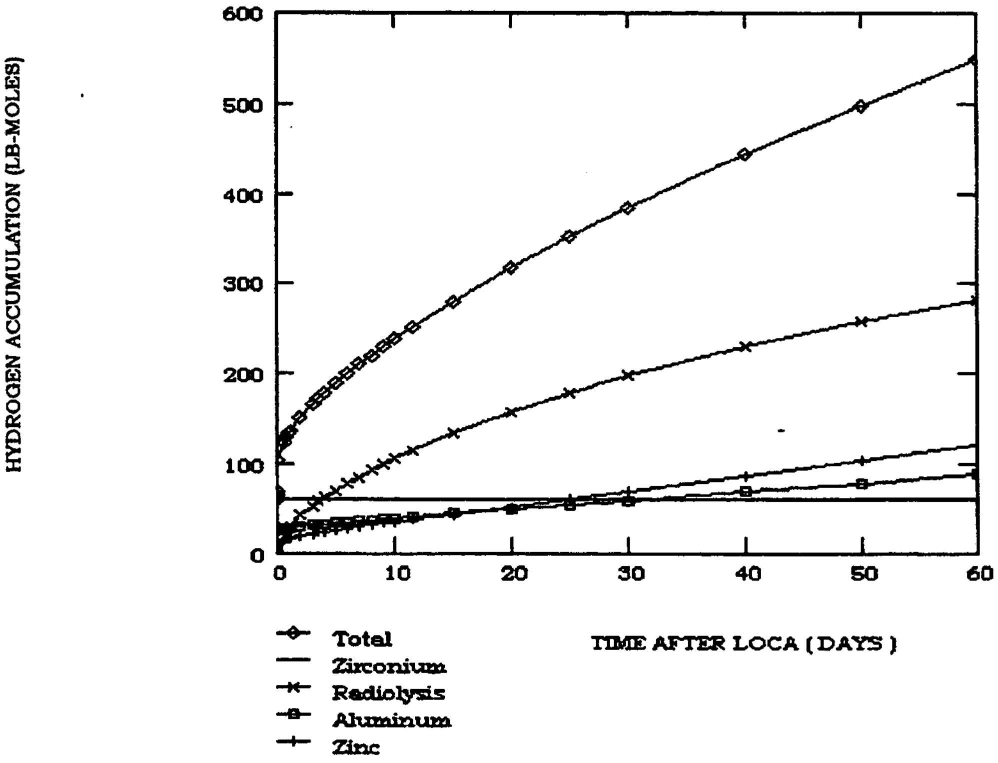

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Figure 6.2.5-4

HYDROGEN ACCUMULATION
IN CONTAINMENT

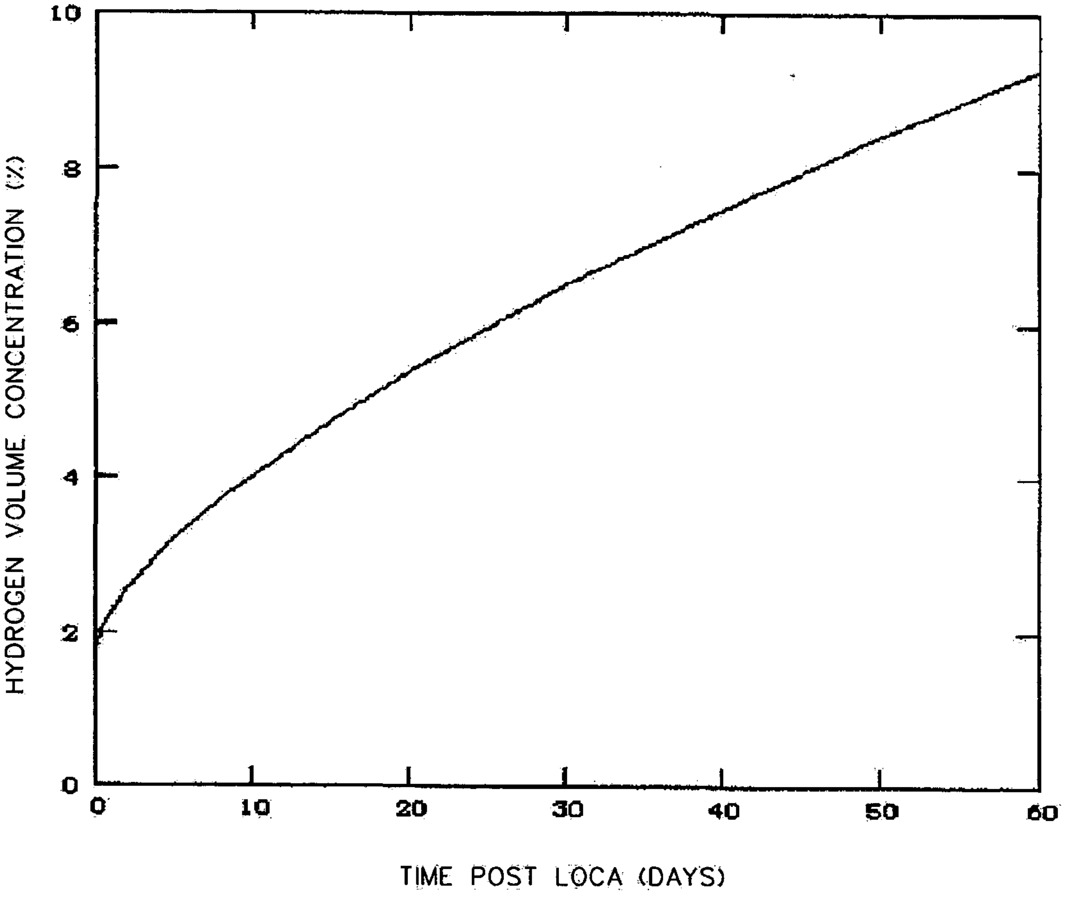

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Figure 6.2.5-5

HYDROGEN VOLUME CONCENTRATION IN CONTAINMENT ASSUMING NO PREVENTIVE ACTION TAKEN

WOLF CREEK

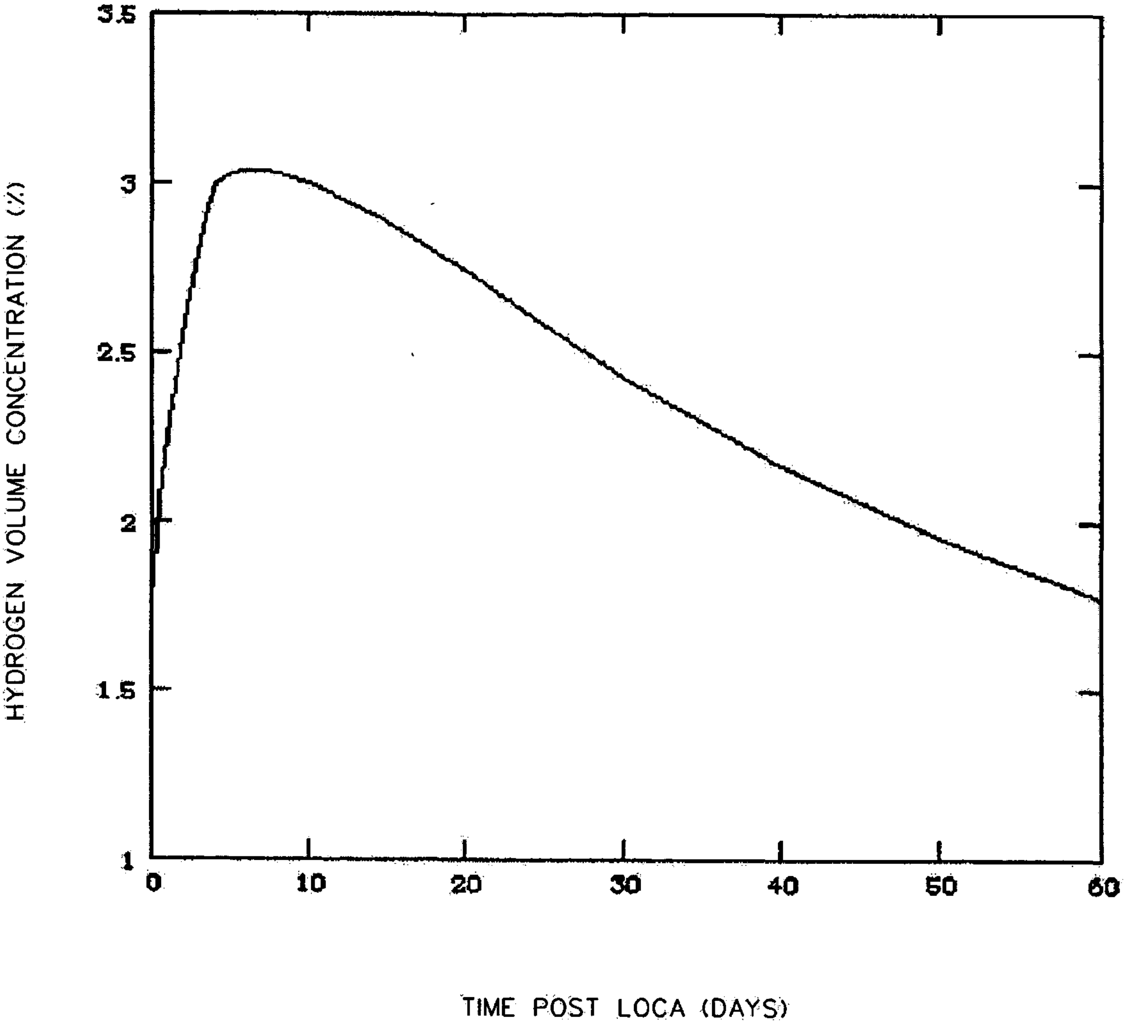

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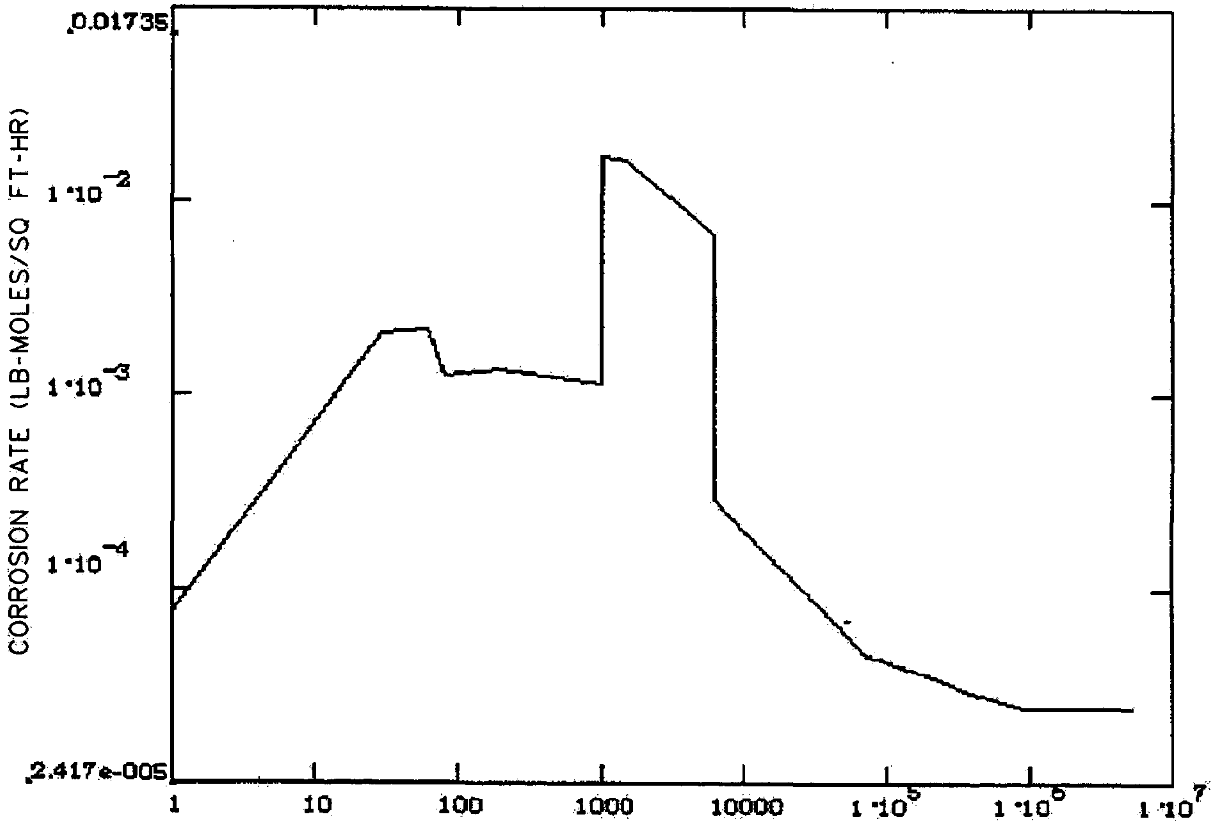
Figure 6.2.5-6

HYDROGEN VOLUME CONCENTRATION IN CONTAINMENT WITH PURGING AFTER 4 DAYS

WOLF CREEK



TIME POST LOCA (SECONDS)

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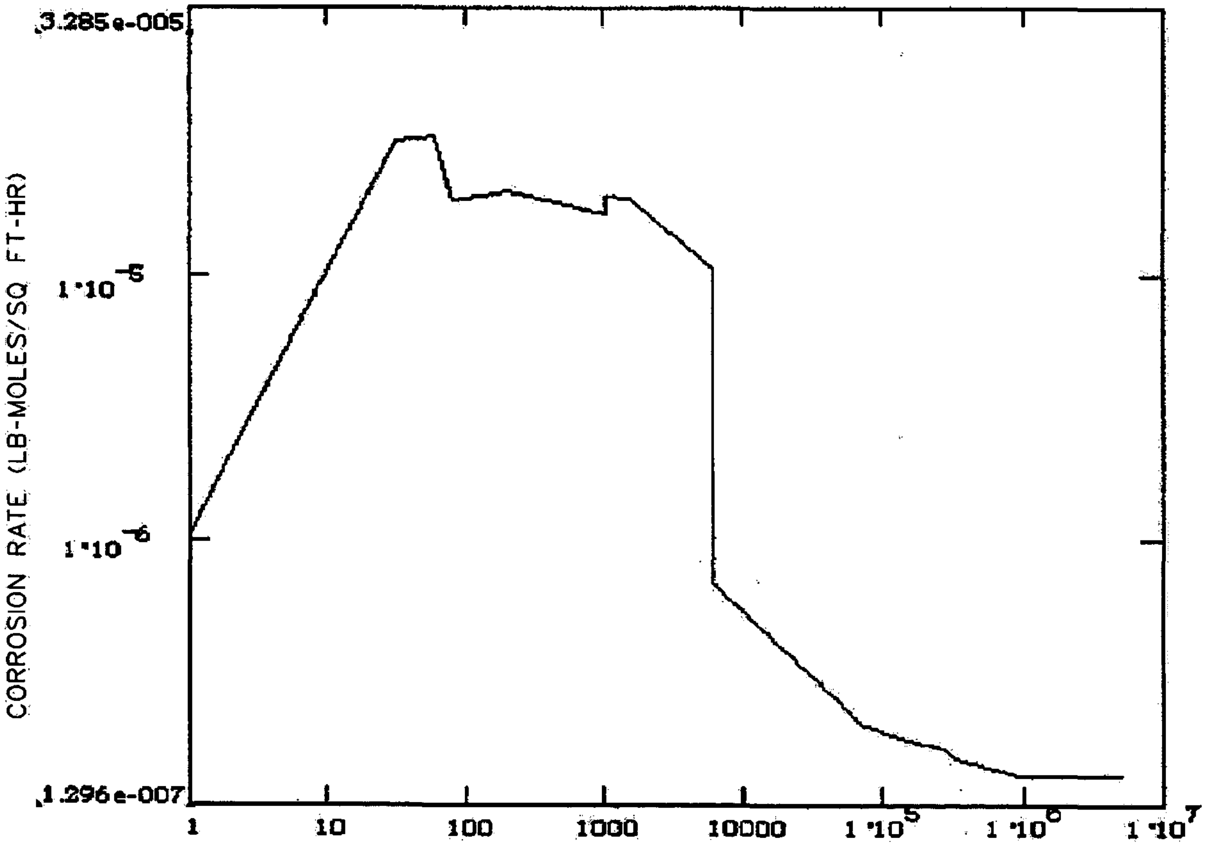
Figure 6.2.5-7

ALUMINUM CORROSION RATES USED IN THE HYDROGEN GENERATION CALCULATION

WOLF CREEK



TIME POST LOCA (SECONDS)

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Figure 6.2.5-8

ZINC CORROSION RATES USED IN THE HYDROGEN GENERATION CALCULATION

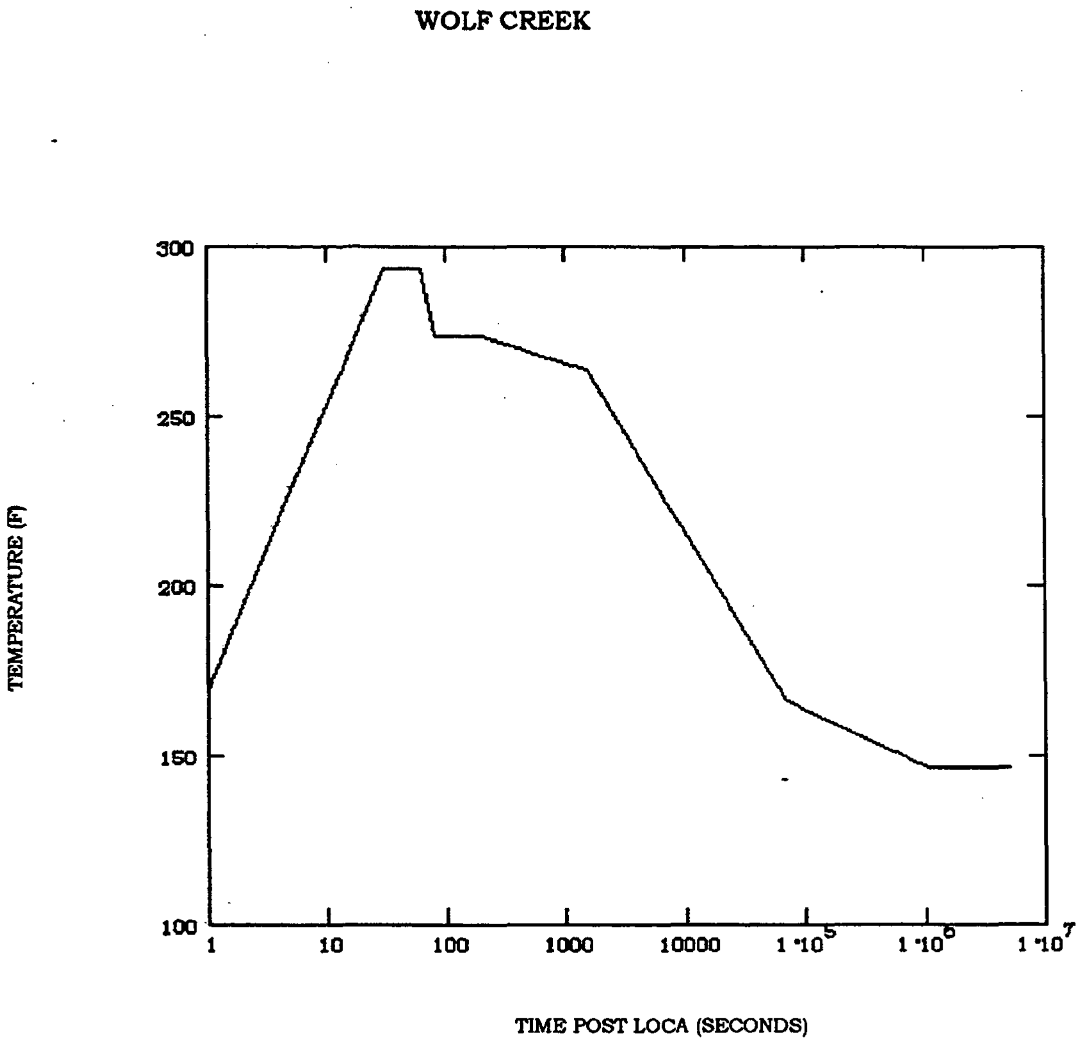

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Figure 6.2.5-9

TEMPERATURE PROFILE USED TO ADJUST CORROSION RATES FOR THE HYDROGEN GENERATION CALCULATION

6.3 EMERGENCY CORE COOLING SYSTEM

The emergency core cooling system (ECCS) is designed to cool the reactor core and provide shutdown capability following initiation of the following accident conditions:

a. Loss-of-coolant accident (LOCA), including a pipe break or a spurious relief or safety valve opening in the reactor coolant system (RCS) which would result in a discharge larger than that which could be made up by the normal makeup system.

b. Rupture of a control rod drive mechanism, causing a rod cluster control assembly ejection accident.

c. Steam or feedwater system break accident, including a pipe break or a spurious relief or safety valve opening in the secondary steam system which would result in an uncontrolled steam release or a loss of feedwater.

d. A steam generator tube failure.

The primary function of the ECCS is to provide emergency core cooling (ECC) in the event of a LOCA resulting from a break in the primary reactor coolant system (RCS) or to provide emergency boration in the event of a steam/or feedwater break accident.

6.3.1 DESIGN BASES

6.3.1.1 Safety Design Basis

The ECCS is safety-related and is required to function following a DBA to achieve and maintain the plant in a safe shutdown condition.

SAFETY DESIGN BASIS ONE - Except for the refueling water storage tank (RWST), the ECCS is protected from the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, and external missiles (GDC-2). The RWST was designed to seismic Category I requirements only.

SAFETY DESIGN BASIS TWO - The ECCS was designed to remain functional after an SSE and to perform its intended function following the postulated hazards of fire, internal missiles, or pipe break (GDC-3 and 4).

SAFETY DESIGN BASIS THREE - Safety functions can be performed, assuming a single active component failure coincident with the loss of offsite power (GDC-35).

SAFETY DESIGN BASIS FOUR - The active components are capable of being tested during plant operation. Provisions are made to allow for inservice inspection of components at appropriate times specified in the ASME Boiler and Pressure Vessel Code, Section XI (GDC-36 and 37).

SAFETY DESIGN BASIS FIVE - The ECCS was designed and fabricated to codes consistent with the quality group classification assigned by Regulatory Guide 1.26 and the seismic category assigned by Regulatory Guide 1.29. The power supply and control functions are in accordance with Regulatory Guide 1.32.

SAFETY DESIGN BASIS SIX - The capability to isolate components or piping was provided so that the ECCS safety function is not compromised. This includes isolation of components to deal with leakage or malfunctions and to isolate safety-related portions of the system (GDC-35).

SAFETY DESIGN BASIS SEVEN - The containment isolation valves in the system were selected, tested, and located in accordance with the requirements of GDC-54 and 55 and 10 CFR 50, Appendix J, Type A testing.

SAFETY DESIGN BASIS EIGHT - ECCS equipment design qualifications ensures acceptable performance for all environments anticipated under normal, testing, and design basis accident conditions.

SAFETY DESIGN BASIS NINE - The functional requirements of the ECCS are derived from Appendix K limits for fuel cladding temperature, etc., following any of the above accidents, as delineated in 10 CFR 50.46. The subsystem functional parameters are integrated so that the Appendix K requirements are met over the range of anticipated accidents and single failure assumptions.

6.3.1.2 Power Generation Design Basis

There are no power generation design bases for the ECCS function. Portions of the ECCS are also portions of the residual heat removal system (RHRS) and chemical and volume control system (CVCS) and are used during normal power operation. Power generation design bases for these portions of the ECCS are discussed in Sections 5.4.7 and 9.3.4, respectively.

6.3.2 SYSTEM DESCRIPTION

6.3.2.1 General Description

The ECCS components are designed so that a minimum of three accumulators, one centrifugal charging pump, one safety injection pump, and one residual heat removal pump, together with their associated valves and piping, ensure adequate core cooling in the event of a design basis LOCA or provide boration in the event of a steam/or feedwater break accident. The redundant onsite emergency diesels assure adequate emergency power to at least one train of electrically operated components in the event that a loss of offsite power occurs simultaneously with a LOCA.

The P&IDs for the ECCS are shown in Figures 5.4-7, 6.3-1 and 9.3-8. ECCS flow diagrams are shown in Figure 6.3-2. Pertinent design and operating parameters for the components of the ECCS are given in Table 6.3-1. The design parameters shown represent the values specified in procurement specifications. Operating parameters are typical for WCGS, however, minor variations in performance characteristics exist between individual components. The accident analyses contain adequate margin to account for these individual component variations.

The component interlocks used in the different modes of system operation are listed below.

a. The SIS initiates the following actions:

   1. Emergency diesel generators start

   2. Centrifugal charging pumps start

   3. RWST suction valves to charging pumps open

   4. Boron injection tank suction and discharge parallel isolation valves open

   5. Normal charging path valves close

   6. Safety injection pumps start

7. Residual heat removal pumps start

8. Volume control tank outlet isolation valves close

9. RWST discharge isolation valves to the fuel storage pool cooling and cleanup system close

b. Switchover from injection mode to recirculation involves the following interlocks:

   1. The suction valves in the line from the sump to the RHR pumps open when two out of four level transmitters indicate a low-low-1 level in the RWST in conjunction with an SIS. The valves from the RWST to the RHR suction close automatically after the sump suction valves are open.

   2. The safety injection pump and charging pump recirculation suction isolation valves, EJ-HV-8804A and B, can be opened provided that either the safety injection system miniflow isolation valve, BN-HV-8813, or both safety injection pump miniflow isolation valves, EM-HV-8814A and B, are closed. Additionally, one of the two RHR hot leg suction valves on Loop 1, BB-PV-8702A and EJ-HV-8701A, and on Loop 4, BB-PV-8702B and EJ-HV-8701B, must be closed.

6.3.2.2 Equipment and Component Descriptions

Codes and standards applicable to the ECCS are listed in Tables 3.2-1 and 6.3-1.

The component design and operating conditions are specified as the most severe conditions to which each respective component is exposed, during either normal plant operation or operation of the ECCS. For each component, these conditions are considered in relation to the code to which it is designed. By designing the components in accordance with applicable codes, and with due consideration for the design and operating conditions, the fundamental assurance of structural integrity and operability of the ECCS components was maintained. Components of the ECCS are designed to withstand the appropriate seismic loadings, in accordance with their safety class as given in Table 3.2-1. It is important that the ECCS is sufficiently filled with water to ensure that the subsystems can reliably perform their intended function under all LOCA and non-LOCA conditions that require makeup to the RCS. Maintaining the piping from the ECCS pumps to the RCS sufficiently full of water ensures that the system will perform properly, injecting its full capacity into the RCS upon demand and water hammers in the injection line are precluded.

The elevated temperature of the sump solution during recirculation is well within the design temperature of all ECCS components. In addition, consideration has been given to the potential for corrosion of various types of metals exposed to the fluid conditions prevalent immediately after the accident or during long-term recirculation operations.

The following is a discussion of the major components of the ECCS:

Accumulators

The accumulators are pressure vessels partially filled with borated water and pressurized with nitrogen gas. During normal operation, each accumulator is isolated from the RCS by two check valves in series. Should the RCS pressure fall below the accumulator pressure, the check valves open and borated water is forced into the RCS. One accumulator is attached to each of the cold legs of the RCS. Mechanical operation of the swing-disc check valves is the only action required to open the injection path from the accumulators to the core via the cold leg.

Connections are provided for remotely adjusting the level and boron concentration of the borated water in each accumulator during normal plant operation, as required. Accumulator water level may be adjusted either by draining to the recycle holdup tank or by pumping borated water from the RWST to the accumulator. Samples of the solution in the accumulators are taken periodically for checks of boron concentration.

Accumulator pressure is provided by a supply of nitrogen gas, and can be adjusted, as required, during normal plant operation. However, the accumulators are normally isolated from this nitrogen supply. Gas relief valves on the accumulators protect them from pressures in excess of design pressure. Accumulator gas pressure is monitored by indicators and alarms. Solenoid-operated vent valves are provided to depressurize the accumulators during emergencies, if needed.

The accumulators are located within the containment but outside of the secondary shield wall which protects the tanks from missiles generated from a postulated LOCA.

Refueling Water Storage Tank

The borated refueling water storage facility consists of a large outside storage tank (i.e., RWST) with connections for borated demineralized water delivery to and receipt from the fuel pool cooling and cleanup system, the chemical and volume control system, the containment spray system, and the ECCS.

The RWST is a passive seismic Category I component and is required only during the short term following a LOCA, MSLB, or any other accident requiring ECCS. Therefore, neither redundancy nor tornado missile protection is required. The safety-related level instrumentation and the temperature monitoring instrumentation associated with the RWST are designed with redundancy.

The RWST is vented directly to the atmosphere. Tank overflow is directed to the waste holdup tank in the liquid radwaste system via the floor and equipment drain system. Sample connections are also provided to allow periodic analysis of the RWST contents.

Prior to accepting makeup water from the CVCS, the current RWST sample results must be used to ensure the proper final boron concentration in the tank.

Samples are taken periodically from the RWST for analysis to assure that the quality of the contents meets the water chemistry specifications given in Table 9.2-16. If the tank contents require purification, they are circulated through the fuel pool cooling and cleanup system. To maintain the boron concentration within specification, a strong boric acid solution (4 wt percent) or reactor makeup water can be added via the chemical and volume control system.

An automatic heater system is provided to prevent the contents of the RWST from freezing. The heater system consists of steam coils wrapped around the outside of the RWST, insulation on the RWST, electrical heat tracing on the exposed nonessential piping, and a heated enclosure for the essential piping, valves, and instrumentation. These steam coils are serviced by the auxiliary steam system. For freeze protection during colder periods of the year, the RWST is automatically maintained above a nominal 50°F temperature. A temperature control valve is provided to control steam flow to the steam coil heaters. A continuous steam flow is maintained to the heating coils during plant winterization via the temperature control valve bypass line. This ensures that the condensate return lines will not freeze. Provisions are in place to put the RWST in continuous recirculation through its return line when necessary to assure minimum flow capability of the SI pump recirculation line. Redundant temperature instrumentation is provided to inform the operator of any degradation of the heating capability for the RWST.

Since the RWST is not normally used as a source of water during power operation, the tank level is administratively maintained. The water level is maintained above the minimum level (94%) consistent with the requirements for injection, transfer allowances, and instrument error allowances. A tank level above 94% assures that the RWST contains a volume greater than 394,000 gallons. The RWST levels and volumes shown on Figure 6.3-7 are based on using the most conservative instrument uncertainty associated with each RWST level setpoint. For example, if the use of indication error results in a more conservative calculated volume, it is assumed that the operator will use indication instead of alarm for establishing the RWST level.

Injection Mode Allowance

The injection mode of ECCS operation consists of the ECCS pumps (centrifugal charging pumps, safety injection pumps, and residual heat removal pumps) and the containment spray pumps taking suction from the RWST and delivering to the reactor coolant system (RCS) and containment, respectively. The minimum RWST volume available for ECCS pump injection mode operation is 236,993 gallons. The maximum RWST volume available for ECCS pump injection is 261,302 gallons. This is the volume between 94% level and Lo-Lo-1 setpoint or full tank level and Lo-Lo-1 setpoint. See Figure 6.3-7.

Containment and RCS pressures are conservatively assumed to be 0 psig to maximize flow out of the RWST.

Flow out of the RWST during the injection mode includes conservative allowances for two pumps of each type operating at the following flow rates:

Safety injection pump	450 gpm per pump
Centrifugal charging pump	450 gpm per pump
RHR pump	4,500 gpm per pump
Containment spray pump	3,725 gpm per pump

Total RWST outflow rate during injection mode operation is 18,250 gpm.

Based on the above minimum available RWST volume for injection mode operation and maximum total flow rate out of the RWST, the shortest injection mode operation time is approximately 13.0 minutes.

ECCS Pumps Transfer Allowance - RHR, Charging, SI

This is the volume of water between Lo-Lo-1 and Lo-Lo-2 level setpoints.

Upon receipt of the RHR auto switchover alarm (Lo-Lo-1), the operator initiates the manual operations required to complete switchover as described in Table 6.3-11 in a timely manner.

The ECCS switchover from injection to cold leg recirculation is initiated automatically upon receipt of the RHR auto switchover signal and is completed via timely operator action at the main control board. Switchover is initiated via automatic opening of the containment recirculation sump isolation valves (8811 A/B). This automatic action aligns the suction of the RHR pumps to the containment recirculation sump to ensure continued availability of a suction source. Manual actions as described in Table 6.3-11 must be performed following switchover initiation prior to loss of the ECCS transfer allowance to ensure that all ECCS pumps are protected with suction flow available from the containment sump. The ECCS switchover procedure is structured to facilitate the operator in accomplishing the switchover of both trains of the ECCS from injection to recirculation without the loss of suction head to any pumps.

The time available for switchover is dependent on the flow rate out of the RWST as the switchover manual actions are performed. As ECCS valves are repositioned, the flow rate out of the RWST is reduced in magnitude. In order to analyze the time available for switchover, the following conservative bases are established:

1. The minimum ECCS transfer allowance available for ECCS pump switchover is 90,469 gallons. The maximum ECCS transfer allowance is 107,711 gallons.
2. Containment and RCS pressures for large break conditions are conservatively assumed to be 0 psig. Thus, no credit is taken for the reduction in RWST outflow that will result with higher containment and RCS pressures following a large break.

Based on the above criteria, the minimum time available for the operator to accomplish the switchover of the ECCS pumps is 9.46 minutes. The large break with single failure constitutes the condition where RWST outflow is the greatest. The worst single failure is for RWST/RHR isolation valve (8812A or 8812B) not to close. This failure increases the backflow from RWST to the containment. The operators must take additional manual actions as described in Table 6.3-12 to secure the affected RHR pump and the associated containment recirculation sump/RHR (8811A or 8811B) isolation valve. The minimum time available for the operator to accomplish the switchover of the ECCS pumps for a large break and the single failure is 8.15 min.

Containment Spray Pumps Transfer Allowance

The RWST volume between the Lo-Lo-2 setpoint and the empty setpoint is required for containment spray pump switchover from the RWST to the sump. The minimum available volume is 11,930 gallons. With both spray pumps operating, this volume provides a minimum switchover time of 2.18 minutes. The maximum volume available for containment spray pumps transfer is 31,756 gallons.

Combined Transfer Allowance for ECCS and CSS Pumps

The water volumes shown on Figure 6.3-7 for ECCS and CSS pump transfer allowance do not include the water within the instrument uncertainty band for Lo-Lo-2 setpoint. This water is depleted and provides additional allowance. The minimum combined transfer allowance is 113,293 gallons and the maximum combined allowance is 128,573 gallons.

Total RWST Water Available for Containment

The minimum water volume available for transferring to the containment based on a tank level of 94% and EMPTY level setpoint is 356,481 gallons. The maximum water volume between a full tank level and EMPTY level setpoint is 384,519 gallons.

Setpoints and Instrument Error

The level measurement system for the RWST includes four level transmitters, each of which have five setpoints, High, Low, Lo-Lo-1, Lo-Lo-2, and Empty. Two out of four level transmitters sensing a Lo-Lo-1 condition will initiate the automatic action and the associated alarm. One out of four level transmitters sensing a High, Low, Lo-Lo-2, or Empty condition initiates the appropriate alarm for operator action. The operators maintain water in the RWST during normal plant operation above the Low Alarm. The minimum required volume is assured by taking periodic readings on the level indication in the control room. A level indication greater than 94% assures that the RWST contains the minimum required volume of 394,000 gallons.

The maximum instrument uncertainty for the control room indication is +3.6/-3.1%. The maximum uncertainty for the Lo-Lo-1 at which the automatic switchover of the RHR pumps occurs is assumed to be ±3.3%. Since the emergency procedures used for ECCS and CSS pumps switchover from injection mode to recirculation allow the operators to use alarms as well as indication, the Injection, ECCS and CSS pumps' transfer volumes are based on the most limiting instrument errors, assuming a starting RWST level of 94% or full tank level.

Boron Injection Tank

During the preliminary design phase, provisions of heat tracing and fluid recirculation were made in the BIT system to accommodate highly concentrated boric acid. It has been determined that an RWST concentration of only 2,400-2,500 ppm boron is required for plant safety considerations. The heat tracing and fluid recirculation provisions will not be operated and have been permanently disabled. This change does not affect the favorable conclusions of the safety analysis. During normal operation, the boron concentration in the BIT will likely vary between the RCS and RWST concentration.

The boron injection tank (BIT) is connected to the discharge of the centrifugal charging pumps. Upon actuation by an SIS, the isolation valves associated with the BIT open automatically, and the centrifugal charging pumps inject the boric acid solution from the RWST into the RCS.

Boron Injection Surge Tank

The boron injection surge tank (BIST) has no safety significance now that the BIT boron concentration is analyzed for 0 ppm. The recirculation lines to and from the BIST have been permanently disconnected from high head injection lines. This system has been abandoned in place and is not planned to be used.

Residual Heat Removal Pumps

Two residual heat removal (RHR) pumps are provided. Each pump is a single-stage, vertical, centrifugal pump. In the event of a LOCA, the RHR pumps are started automatically on receipt of an SIS. The RHR pumps take suction from the RWST during the injection phase and from the containment sump during the recirculation phase.

A minimum flow bypass line is provided for each pump to recirculate and return the pump discharge fluid to the pump suction should these pumps be started with the RCS pressure above their shutoff head. Once flow is established to the RCS, the bypass line is automatically closed. This line prevents deadheading of the pumps and permits pump testing during normal operation.

The RHR pumps are discussed further in Section 5.4.7. A typical pump performance curve is given in Figure 6.3-3.

Centrifugal Charging Pumps

Two centrifugal charging pumps are provided. Each pump is a multistage diffuser design, barrel-type casing with vertical suction and discharge nozzles. In the event of an accident, the centrifugal charging pumps are started automatically on receipt of an SIS and are automatically aligned to take suction from the RWST during the injection phase. These high head pumps deliver flow through the BIT to the RCS at the prevailing RCS pressure. During the recirculation phase, suction is provided from the RHR pump discharge.

A minimum flow bypass line is provided on each pump discharge to recirculate flow to the pump suction after cooling, via the seal water heat exchanger, during normal plant operation. Each minimum flow bypass line contains a motor operated valve that is normally open during operations.

Upon receipt of an SIS signal, each valve will close at a calculated flow assuming minimum safeguards actuation. This ensures that peak clad temperatures will not exceed those assumed in the analysis. Depending upon the number of pumps injecting via the Boron Injection Tank (BIT) the flow switch will function to ensure that the minimum recirculation valve opens to maintain at least 60 gallons per minute for pump protection during RCS repressurization.

The SIS also aligns the parallel suction valves from the RWST and closes the series valves from the volume control tank.

The centrifugal charging pumps may be tested during power operation via the minimum flow bypass line.

A typical pump performance curve for the centrifugal charging pumps is presented in Figure 6.3-4. The required pump performance curve, based upon the accident analysis, lies below this characteristic curve.

Safety Injection Pumps

Two safety injection pumps are provided. Each pump is a multi-stage, diffuser design, split-case centrifugal pump with side suction and side discharge.

In the event of an accident, the safety injection pumps are started automatically on receipt of an SIS; take suction from the RWST via normally open, motor-operated valves and deliver water to the RCS during the injection phase; and take suction from the containment sump via the RHR pumps during the recirculation phase.

A minimum flow bypass line is provided on each pump discharge to recirculate flow to the RWST in the event that the pumps are started with the RCS pressure above pump shutoff head. This line also permits pump testing during normal plant operation. Two parallel valves in series, with a third valve located in a downstream common header, are provided in this line. These valves are manually closed from the control room as part of the ECCS realignment from the injection to the recirculation mode. A typical pump performance curve for the safety injection pumps is presented in Figure 6.3-5. The required pump performance curve based upon the accident analysis lies below this characteristic curve.

Boron Injection Recirculation Pumps

These pumps provide the capability to recirculate boric acid solution continuously around a closed loop consisting of the BIT, the BIST, and associated piping. The pumps were initially provided when the BIT concentration was to be 12 weight percent. The pumps are no longer required and have no safety significance for a BIT boron concentration of nominal RCS concentration. The pumps have been permanently disabled from operation.

RHR Heat Exchangers

The RHR heat exchangers are conventional shell and U-tube type units. During normal cooldown operation, the RHR pumps recirculate reactor coolant through the tube side while component cooling water flows through the shell side. During the ECCS operation, water from the containment sump flows through the tube side. The tubes are seal welded to the tube sheet.

A further discussion of the RHR heat exchangers is found in Section 5.4.7.

Valves

Design features employed to minimize valve leakage include:

a. Valves which are normally open, except check valves and those which perform a control function, are provided with backseats to limit stem leakage.

b. Normally, closed globe valves are installed with recirculation fluid pressure under the seat to prevent stem leakage of recirculated (radioactive) water.

c. Relief valves are enclosed, i.e., they are provided with a closed bonnet.

Motor-Operated Valves

The seating design of the motor-operated valves is of the Crane flexible wedge design. This design releases the mechanical holding force during the first increment of travel so that the motor operator works only against the frictional component of the hydraulic unbalance on the disc and the packing box friction. The disc is guided throughout the full disc travel to prevent chattering and to provide ease of gate movement. The seating surfaces are hard faced to prevent galling and to reduce wear.

Where a gasket is employed for the body-to-bonnet joint, it is either a fully trapped, controlled compression, spiral wound asbestos gasket with provisions for seal welding, or it is of the pressure seal design with provisions for seal welding. The valve stuffing boxes are packed with a full set of graphite packing. A full set of packing is defined as a depth of packing equal to 1-1/2 times the stem diameter. Figure 6.3-6 illustrates a typical motor-operated valve.

Maximum opening and closing times for the motor-operated valves used in the ECCS operations are given in Table 6.3-1.

The motor operator incorporates a "hammer blow" feature that allows the motor to impact the discs away from the backseat upon opening or closing. This "hammer blow" feature not only impacts the disc but allows the motor to attain its operational speed prior to impact. Valves which must function against system pressure are designed so that they function with a pressure drop equal to full system pressure across the valve disc.

Manual Globes, Gates, and Check Valves

Gate valves employ a wedge design and are straight through. The wedge is either split or solid. All gate valves have backseat and outside screw and yoke.

Globe valves, "T" and "Y" style, are full ported with outside screw and yoke construction.

Check valves are spring loaded, lift piston types for sizes 2 inches and smaller and swing type for sizes 2-1/2 inches and larger. Stainless steel check valves have no penetration welds other than the inlet, outlet, and bonnet. The check hinge is serviced through the bonnet.

The stem packing and gasket of the stainless steel manual globe and gate valves are similar to those described above for motor-operated valves. Carbon steel manual valves are employed to pass nonradioactive fluids only and, therefore, do not contain the seal weld provisions.

Accumulator Check Valves (Swing-Disc)

The accumulator check valve is designed with a low pressure drop configuration with all operating parts contained within the body.

Design considerations and analyses which assure that leakage across the check valves located in each accumulator injection line will not impair accumulator availability are as follows:

a. During normal operation, the check valves are in the closed position with a nominal differential pressure across the disc of approximately 1,650 psi. Since the valves remain in this position except for testing or when called upon to open following an accident and are, therefore, not subject to the abuse of flowing operation or impact loads caused by sudden flow reversal and seating, they do not experience significant wear of the moving parts, and are expected to function with minimal backleakage. This backleakage can be checked via the test connection, as described in Section 6.3.4.

b. Testing is performed on the check valves in accordance with the Technical Specifications. This testing confirms the seating of the disc and whether or not there has been an increase in the leakage since the last test.

c. The experience derived from the check valves employed in the emergency injection systems indicates that the system is reliable and workable; check valve leakage has not been a problem. This is substantiated by the satisfactory experience obtained from operation of the Robert Emmett Ginna plant and subsequent plants where the usage of check valves is identical to WCGS.

d. The accumulators can accept some in-leakage from the RCS without affecting availability. Continuous in-leakage would require, however, that the accumulator water volume and boron concentration be adjusted periodically to meet the Technical Specification requirements.

Relief Valves

Relief valves are installed in various sections of the ECCS to protect lines which have a lower design pressure than the RCS. The valve stem and spring adjustment assembly are isolated from the system fluids by a bellows seal between the valve disc and spindle. The closed bonnet provides an additional barrier for enclosure of the relief valves. Table 6.3-2 lists the system's relief valves with their capacities and setpoints.

Butterfly Valves

Each main residual heat removal line has an air-operated butterfly valve which is normally open and is designed to fail in the open position. The actuator is arranged so that air pressure on the diaphragm overcomes the spring force, causing the linkage to move the butterfly to the closed position. Upon loss of air pressure, the spring returns the butterfly to the open position. These valves are left in the full-open position during normal operation to maximize flow from this system to the RCS during the injection mode of the ECCS operation. These valves are used during normal RHR system operation to control cooldown flowrate.

Each RHR heat exchanger bypass line has an air-operated butterfly valve, which is normally closed and is designed to fail closed. Those valves are used during normal cooldown to avoid thermal shock to the residual heat removal heat exchanger.

Net Positive Suction Head

Available and required net positive suction head (NPSH) for ECCS pumps are shown in Table 6.3-1. Table 6.2.2-7 provides the assumptions and results of the NPSH analyses for the RHR pumps. The safety intent of Regulatory Guide 1.1 is met by the design of the ECCS so that adequate NPSH is provided to system pumps. In addition to considering the static head and suction line pressure drop, the calculation of available NPSH in the recirculation mode assumes that the vapor pressure of the liquid in the sump is equal to the containment ambient pressure. This ensures that the actual available NPSH is always greater than the calculated NPSH. To ensure that the required NPSH is available during the recirculation phase of ECCS operation, restriction orifices are provided in the four discharge lines into the RCS cold legs and in the two discharge lines into the RCS hot legs. The orifices are sized to provide the RHR flow rates specified in the notes to Figure 6.3-2.

Accumulator Motor-Operated Valve

As part of the plant shutdown administrative procedures, the operator is required to close these valves. This prevents a loss of accumulator water inventory to the RCS and is done after the RCS has been depressurized below the safety injection unblock setpoint. The redundant pressure and level alarms on each accumulator would remind the operator to close these valves, if any were inadvertently left open. Power is disconnected at the motor control center after the valves are closed. In the event that the operator is unable to close any of these valves, the accumulator vent valve is opened to depressurize the accumulator and avoid the addition of excess water inventory into the RCS.

During plant startup, the operator is instructed, via procedures, to energize and open these valves before the RCS pressure reaches the safety injection unblock setpoint. Monitor lights in conjunction with an audible alarm will alert the operator should any of these valves be left inadvertently closed once the RCS pressure increases beyond the safety injection unblock setpoint. After these valves have been opened, power to these valves is disconnected at the motor control center.

The accumulator isolation valves are not required to move during power operation or in a post-accident situation, except for valve testing. For a discussion of limiting conditions for operation and surveillance requirements of these valves, refer to Technical Specifications.

For further discussions of the instrumentation associated with these valves, refer to Sections 6.3.5 and 7.6.4.

Motor-Operated Valves and Controls

Remotely operated valves for the injection mode which are under manual control (i.e., valves which normally are in their ready position and do not require an SIS) have their positions indicated on a common portion of the control board. If a component is out of its proper position, its monitor light will indicate this on the control panel. At any time during operation when one of these valves is not in the ready position for injection, this condition is shown visually on the board, and an audible alarm is sounded in the control room.

The ECCS delivery lag times are given in Chapter 15.0. The accumulator injection time varies as the size of the assumed break varies, since the RCS pressure drop will vary proportionately to the break size.

Spurious movement of a motor-operated valve due to an electrical fault in the motor actuation circuitry, coincident with a LOCA, has been analyzed (Ref. 1) and found to be an acceptably low probability event. In addition, power lockout in accordance with BTP ICSB-18 is provided for those valves whose spurious movement could result in degraded ECCS performance. Power lockout is provided by providing a control power isolation switch for each of these valves on the main control board. Table 6.3-3 provides a listing of the motor-operated isolation valves in the ECCS, showing interlocks, automatic features, position indication, and which valves are provided with the power lockout isolation switch.

The supporting auxiliaries which are required to function and support the ECCS are the Class 1E emergency busses, the essential service water system, the component cooling water system, and the engineered safety features ventilation systems. The safeguards electrical busses are required to provide electrical power to the ECCS pumps and motor-operated valves. The essential service water system and the component cooling water system are required to provide cooling for the ECCS pumps and the RHR heat exchanger (during recirculation only). The engineered safety features ventilation system is required to provide cooling for the ECCS pump rooms to maintain the ambient environment within the design of the pump motors.

Periodic visual inspection and operability testing of the motor-operated valves in the ECCS ensures that there is no potential for impairment of valve operability due to boric acid crystallization which could result from valve stem leakage.

In addition, the location of all motor-operated valves within the containment have been examined to identify any motor operators which may be submerged following a postulated LOCA. Based on a maximum post-LOCA flood level at El.2004'-6", none of the valves require qualification for submerged operation. The submerged valves are either not required for accident mitigation, not closed prior to being flooded, or not required to change position after a LOCA. Failure modes after flooding have been evaluated for potential effects on valve position and operator information. Therefore, the flooding of these motor operators and any resultant postulated failure do not present any problems for either the short- or long-term ECCS operations, containment isolation, or any other safety-related function.

6.3.2.3 Applicable Codes and Construction Standards

The applicable codes and construction standards for the ECCS are identified in Tables 3.2-1 and 6.3-1 and discussed in Section 3.2.

6.3.2.4 Material Specifications and Compatibility

Materials employed for components of the ECCS are given in Table 6.3-4. Materials are selected to meet the applicable material requirements of the codes in Table 3.2-1 and the following additional requirements:

a. All the parts of the components in contact with borated water are fabricated of or clad with austenitic stainless steel or equivalent corrosion-resistant material.

b. All the parts of the components in contact (internal) with the sump solution during recirculation are fabricated of austenitic stainless steel or equivalent corrosion-resistant material.

c. Valve seating surfaces are hard faced with Stellite Number 6, or equivalent, to prevent galling and to reduce wear.

d. Valve stem materials are selected for their corrosion resistance, high tensile properties, and resistance to surface scoring by the packing.

6.3.2.5 System Reliability

Reliability of the ECCS is considered in all aspects of the system, from initial design to periodic testing of the components during plant operation. The ECCS is a two train, fully redundant, standby emergency safety feature. The system has been designed and proven by analysis to withstand any single credible active failure during injection or active or passive failure during recirculation and maintain the performance objectives desired in Section 6.3.1. Two trains of pumps, heat exchangers, and flow paths are provided for redundancy as only one train is required to satisfy the performance requirements. The initiating signals for the ECCS, as described in Section 7.3, are derived from independent sources as measured from process (e.g., low pressurizer pressure) or environmental variables (e.g., containment pressure).

Redundant, as well as functionally independent variables, are measured to initiate the safety injection signals. Each train is physically separated and protected, where necessary, so that a single event cannot initiate a common failure. Power sources for the ECCS are divided into two independent trains supplied from the Class 1E emergency busses from offsite power. Sufficient diesel generating capacity is maintained onsite to provide required power to each train. The diesel generators and their auxiliary systems are completely independent and each supplies power to one of the two ECCS trains.

The reliability program extended to the procurement of the ECCS components so that only designs which were proven by past use in similar applications were acceptable for use. For example, the ECCS pumps (safety injection, centrifugal charging, and residual heat removal pumps) are the same type of pumps that have been used extensively in other operating plants. Their function during recurrent normal power and cooldown operations in such plants as Zion, D.C. Cook, Trojan, and Farley has successfully demonstrated their performance capability. Reliability tests and inspections (see Section 6.3.4.2) further confirmed their long-term operability. Nevertheless, design provisions were included that would allow maintenance on ECCS pumps if necessary during long-term operation.

The preoperational testing program assured that the systems, as designed and constructed, met the functional requirements calculated in the design.

The ECCS is designed with the ability for on-line testing of most components so the availability and operational status can be readily determined.

In addition to the above, the integrity of the ECCS is assured through examination of critical components during the routine inservice inspection.

A failure modes and effects analysis is provided in Table 6.3-5. Consideration of an active failure of any Westinghouse nuclear steam supply system (NSSS) check valve is excluded from Tables 6.3-5 and 6.3-6 since the NSSS check valves are not considered to be active (powered) components per the Westinghouse ECCS design, particularly with respect to ECCS failure modes and effects and single active failure analyses. As discussed in Section 3.9(N).3.2.1, NSSS check valves are characteristically simple in design and their operation is not affected by seismic accelerations or the maximum applied nozzle loads. Their design is compact and there are no extended structures or masses whose motion could cause distortions that could restrict operation of the valve. The nozzle loads due to maximum seismic excitation do not affect the functional ability of the valve since the valve disc is typically designed to be isolated from the body wall. The clearance supplied by the design around the disc prevents the disc from becoming bound or restricted due to any body distortions caused by nozzle loads. Therefore, the design of the these valves is such that once the structural integrity of the valve is ensured using standard methods, the ability of the valve to operate is ensured by the design features.

Although the design of the NSSS check valves provides assurance of their ability to operate, these NSSS check valves undergo in-shop hydrostatic and seat leakage testing (prior to installation) as well as periodic in-situ valve exercising and inspection to ensure their functional capability. (As discussed in Section 3.1.1.1, the definition of an active component for the purpose of supporting the pump and valve operability program includes NSSS check valves. These check valves, although not powered components, meet the definition of having mechanical motion and are therefore included in Table 3.9(N)-11.)

a. Active Failure Criteria

The ECCS is designed to accept a single failure following the incident without loss of its protective function. The system design will tolerate the failure of any single active component in the ECCS itself or in the necessary associated service systems at any time during the period of required system operations following the incident.

A single active failure analysis is presented in Table 6.3-6, and demonstrates that the ECCS can sustain the failure of any single active component in either the short or long term and still meet the level of performance for core cooling.

Since the operation of the active components of the ECCS following a steam line rupture is identical to that following a LOCA, the same analysis is applicable, and the ECCS can sustain the failure of any single active component and still meet the level of performance for the addition of shutdown reactivity.

b. Passive Failure Criteria

The following philosophy provides for necessary redundancy in the component and system arrangement to meet the intent of the GDC on single failure, as it specifically applies to failure of passive components in the ECCS. Thus, for the long term, the system design is based on accepting either a passive or an active failure.

A single passive failure analysis is presented in Table 6.3-7. It demonstrates that the ECCS can sustain a single passive failure during the long-term phase and still retain an intact flow path to the core to supply sufficient flow to keep the core covered and effect the removal of decay heat. The procedure followed to establish the alternate flow path also isolates the component that failed.

Redundancy of Flow Paths and Components for Long-Term Emergency Core Cooling

The following criteria were utilized in the design of the ECCS:

1. During the long-term cooling period following a postulated loss-of-coolant accident, the emergency core cooling flow paths shall be separable into two subsystems, either of which can provide minimum core cooling functions and return spilled water from the floor of the containment back to the RCS.

2. Either of the two subsystems can be isolated and removed from service in the event of a leak outside the containment.

3. Should one of these two subsystems be isolated in this long-term period, the other subsystem remains operable.

4. Adequate redundancy of the check valves is provided to tolerate failure of a check valve during the long term as a passive component.

5. Provisions are made in the design to detect leakage from components outside the containment, collect this leakage, and provide for maintenance of the affected equipment. For further discussion, see Section 9.3.3 concerning the equipment and floor drainage system.

Thus, for the long-term emergency core cooling function, adequate core cooling capacity exists with one flow path removed from service.

Subsequent Leakage from Components in the ECCS

Leakage from mechanical equipment outside the containment will be detected before it propagates to major proportions by a program for periodic visual inspection and leak detection. A review of the equipment in the system indicates that the largest sudden leak potential would be the sudden failure of a pump shaft seal. Evaluation of leak rate, assuming only the presence of a seal retention ring around the pump shaft, showed flows less than 7.5 gpm would result. Piping leaks, valve packing leaks, or flange gasket leaks have been of a nature to build up slowly with time and are considered less severe than the pump seal failure. The auxiliary building floor and equipment drain system leakage detection capability is discussed in Section 9.3.3.

Larger leaks in the ECCS are prevented by the following:

1. The piping is classified in accordance with ANS Safety Class 2 and receives a quality assurance program in accordance with 10 CFR 50, Appendix B (refer to Section 3.2).

2. The piping, equipment, and supports are designed to ANS Safety Class 2 seismic classification, permitting no loss of function for the SSE (refer to Section 3.2).

3. The system piping is located within a controlled area of the plant.

4. The piping system receives periodic pressure tests, and is accessible for periodic visual inspection.

5. The piping is austenitic stainless steel which, due to its ductility, can withstand severe distortion without failure.

Process Flow Diagram

Figure 6.3-2 is a simplified illustration of the ECCS. The notes provided with Figure 6.3-2 contain information relative to the operation of the ECCS in its various modes. The modes of operation illustrated are full operation of all ECCS components, cold leg recirculation with RHR pump B operating, and hot leg recirculation with RHR pump A operating. These are representative of the operation of the ECCS during accident conditions.

Lag Times

Lag times for initiation and operation of the ECCS are limited by pump startup time and consequential loading sequence of these motors onto the Class 1E busses. Most valves are normally in the required position for the ECCS to fulfill its safety function.

Therefore, valve opening time is not considered for these valves. Power to the valve operators is available anytime the Class 1E busses are energized. If there is no loss of offsite power, all pump motors are still sequenced on the Class 1E busses upon receipt of an SIS. In the case of a loss of offsite power, a 12-second delay is assumed for diesel startup, then pumps are loaded according to the sequencer. For sequencer times, see Figure 8.3-2.

Potential Boron Precipitation

Boron precipitation in the reactor vessel after a postulated LOCA is precluded by a backflush of cooling water through the core to reduce boil-off and resulting concentration of boric acid in the water remaining in the reactor vessel. This is accomplished by switching from cold leg to hot leg recirculation approximately 10 hours following an accident.

Three flow paths are available for the hot leg recirculation of sump water. Each safety injection pump can discharge to two hot legs with suction taken from RHR pump discharge either directly or indirectly via the charging pump cross connect. One RHR pump is also aligned to deliver flow to the hot leg injection header.

Loss of one pump or one flow path does not prevent hot leg recirculation since redundant methods are available for use. (e.g., If the RHR hot leg recirculation valve, EJHV8840, does not open due to it being pressure locked, adequate hot leg recirculation flow is provided by the operating safety injection pumps through the safety injection hot leg isolation valves EMHV8802A & B.

6.3.2.6 Protection Provisions

The provisions taken to protect the system from damage that might result from dynamic effects are discussed in Section 3.6. The provisions taken to protect the system from missiles are discussed in Section 3.5. The provisions to protect the system from seismic damage are discussed in Sections 3.7(B) and (N), 3.9(B) and (N), and 3.10(B) and (N). Thermal stresses on the RCS are discussed in Section 5.2.

6.3.2.7 Provisions for Performance Testing

Test lines are provided for performance testing of the ECCS, as well as individual components. These test lines and instrumentation are shown in Figure 6.3-1. All pumps have miniflow lines for use in testing operability. Additional information on testing can be found in Section 6.3.4.2.

6.3.2.8 Manual Actions

No manual actions are required of the operator for proper operation of the ECCS during the injection mode of operation. Only limited manual actions are required by the operator to realign the system for the cold leg recirculation mode of operation, and, after approximately 10 hours, for the hot leg recirculation mode of operation. The actions required to switch to cold leg recirculation are delineated in Table 6.3-8. Based on the containment pressure-temperature analyses provided in Section 6.2.1, which assume runout flows of all pumps, including the containment spray pumps, which draw from the RWST, switchover of the RHR pumps occurs approximately 13.7 minutes after the accident.

The changeover from the injection mode to recirculation mode is initiated automatically and completed manually by operator action from the main control room. Protection logic is provided to automatically open the two safety injection system recirculation sump isolation valves when two out of four RWST level channels indicate an RWST level less than a low-low-1 level setpoint in conjunction with the initiation of the engineered safeguards actuation signal (SIS). When the containment sump recirculation valves are fully opened, RHR pump suction from the RWST is automatically isolated. This automatic action aligns the two RHR pumps to take suction from the containment sump and to deliver water directly to the RCS. The RHR pumps continue to operate during this changeover from injection mode to recirculation mode.

Motor operated valves, such as EJHV8840, are normally electrically operated from the control room but may be manually operated locally based on acceptable radiation levels as delineated in applicable emergency operating procedures (EMG’s)

The two centrifugal charging pumps and the two safety injection pumps continue to take suction from the RWST, following the above automatic action, until manual operator action is taken to align these pumps in series with the RHR pumps.

The RWST level protection logic consists of four level channels with each level channel assigned to a separate process control protection set. Four RWST transmitters provide level signals to corresponding normally de-energized level channel bistables. Each level channel bistable would be energized on receipt of an RWST level signal less than the low-low-1 level setpoint.

A two-out-of-four coincident logic is utilized in both protection cabinets, A and B, to ensure a trip signal in the event that two-out-of-four level channel bistables are energized. This trip signal, in conjunction with the SIS, provides the actuation signal to automatically open the corresponding containment sump isolation valves.

The low-low-1 RWST level signal is also alarmed to inform the operator to initiate the manual action required to realign the centrifugal charging and safety injection pumps for the recirculation mode.

The manual switchover sequence that must be performed by the operator is delineated in Table 6.3-8. Following the automatic and manual switchover sequence, the two RHR pumps take suction from the containment sump and deliver borated water directly to the RCS cold legs. A portion of the A RHR pump discharge flow is used to supply the two centrifugal charging pumps, which also deliver water directly to the RCS cold legs. A portion of the discharge flow from the B RHR pump is used to provide suction to the two safety injection pumps, which also deliver directly to the RCS cold legs. As part of the manual switchover procedure (see Table 6.3-8, Step 4), the suctions of the safety injection and centrifugal charging pumps are cross connected so that one RHR pump can deliver flow to the RCS and both safety injection and centrifugal charging pumps, in the event of the failure of the second RHR pump.

See Section 7.5 for process information available to the operator in the control room following an accident.

The consequences of the operator failing to act altogether will be loss of the high head safety injection pumps and centrifugal charging pumps.

6.3.3 SAFETY EVALUATION

Safety evaluations are numbered to correspond to the safety design bases in Section 6.3.1.1.

SAFETY EVALUATION ONE - Except for the RWST, the ECCS is located in the reactor and auxiliary buildings. These buildings are designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles, and other appropriate natural phenomena. Sections 3.3, 3.4, 3.5, 3.7(B), and 3.8 provide the bases for the adequacy of the structural design of these buildings.

The events which could result in the loss of function of the RWST (i.e., tornado missile) will not also cause a DBA. For these events, the boric acid transfer system is available to provide a borated source of water to achieve and maintain the plant in a safe shutdown. Therefore, no protection of the RWST is required.

SAFETY EVALUATION TWO - The ECCS is designed to remain functional after an SSE. Sections 3.7(B).2, 3.9(B), and 3.9(N) provide the design loading conditions that were considered. Sections 3.5, 3.6, and Appendix 3B provide the hazards analyses to assure that a post accident safe shutdown, as outlined in Section 7.4, can be achieved and maintained.

SAFETY EVALUATION THREE - The ECCS is completely redundant and, as indicated by Tables 6.3-6 and 6.3-7, no single failure compromises the system's safety functions. All vital power can be supplied from either onsite or offsite power systems, as described in Chapter 8.0.

SAFETY EVALUATION FOUR - The ECCS is initially tested with the program given in Chapter 14.0. Periodic inservice functional testing is done in accordance with Section 6.3.4.

Section 6.6 provides the ASME Boiler and Pressure Vessel Code, Section XI requirements that are appropriate for the ECCS.

SAFETY EVALUATION FIVE - Section 3.2 delineates the quality group classification and seismic category applicable to the safety-related portion of this system and supporting systems. Table 6.3-1 shows that the components meet the design and fabrication codes given in Section 3.2. All the power supplies and control functions necessary for safe function of the ECCS are Class 1E, as described in Chapters 7.0 and 8.0.

SAFETY EVALUATION SIX - Section 6.3.2.5 describes provisions made to identify and isolate leakage or malfunction and to isolate the nonsafety-related portions of the system.

SAFETY EVALUATION SEVEN - Sections 6.2.4 and 6.2.6 provide the safety evaluation for the system containment isolation arrangement and testability.

SAFETY EVALUATION EIGHT - As described in Sections 3.11(B) and 3.11(N), all components of the ECCS required to perform a safety function are designed to and environmentally qualified to all environments anticipated under normal, testing, and design basis accident conditions.

SAFETY EVALUATION NINE - Chapter 15.0 accidents that result in ECCS operation.

1. Increase in heat removed by the secondary system
    a. Inadvertent opening of a steam generator atmospheric relief or safety valve.
    b. Steam system piping failure.
2. Decrease in heat removed by the secondary system.
    a. Feedwater system pipe break.
3. Decrease in reactor coolant system inventory.
    a. Steam generator tube failure
    b. Loss of coolant accident from a spectrum of postulated piping breaks within the system.
    c. Spectrum of rod cluster control assembly (RCCA) ejection accidents.
4. Increase in reactor coolant system inventory
    a. Inadvertent operation of the ECCS during power operation.

Safety injection system actuation results from any of the following:

a. Low pressurizer pressure

b. Low steam line pressure

c. High-1 containment pressure

d. Manual actuation

A safety injection signal rapidly trips the main turbine, closes all feedwater control valves, trips the main feedwater pumps, and closes the feedwater isolation valves. However, no direct credit is taken for the turbine trip function, and trip of the main feedwater pumps is not part of the primary success path for accident mitigation.

Following the actuation signal, the suction of the centrifugal charging pumps is diverted from the volume control tank to the RWST. Simultaneously, the valves isolating the BIT from the centrifugal charging pumps and the valves isolating the BIT from the injection header automatically open. The centrifugal charging pumps then force the boron solution from the RWST into the cold legs of each loop. The safety injection pumps also start automatically but operate at shut off head when the RCS is at normal pressure. The passive accumulator system and the low head system also provide no flow at normal RCS pressure.

INCREASE IN HEAT REMOVED BY THE SECONDARY SYSTEM

Inadvertent Opening of a Steam Generator Atmospheric Relief or Safety Valve

The most severe core conditions resulting from an accidental depressurization of the main steam system are associated with an inadvertent opening of a single steam dump, atmospheric relief, or safety valve.

The assumed steam release is typical of the capacity of any single steam dump (Figure 10.3-1-03), atmospheric relief (Figure 10.3-1-01), or safety valve (Figure 10.3-1-02). The ECCS injection of the boron solution provides sufficient negative reactivity to meet the DNB design basis. The cooldown for this case is more rapid than the actual case of steam release from all steam generators through one steam dump, atmospheric relief, or safety valve. The transient is quite conservative with respect to cooldown, since no credit is taken for the energy stored in the system metal other than that of the fuel elements or the energy stored in the steam generators. Since the transient occurs over a period of about 5 minutes, the neglected stored energy is likely to have a significant effect in slowing the cooldown. The analysis provided in Section 15.1.4 demonstrates that there will be no consequential damage to the core or reactor coolant system after reactor trip, assuming a stuck rod cluster control assembly, with offsite power available, and assuming a single failure in the engineered safety features. It also concludes that the DNB design limits are not exceeded.

Steam System Pipe Failure

The steam release arising from a rupture of a main steam pipe would result in energy removal from the RCS, causing a reduction of coolant temperature and pressure. In the presence of a negative moderator temperature coefficient, the cooldown results in an insertion of positive reactivity. There is an increased possibility that the core will become critical and return to power.

The core is ultimately shut down by the boric acid injection delivered by the safety injection system. Capability for injection of the boric acid solution is maintained, assuming any single failure in the safety injection system.

For cases where offsite power is assumed to be available, the sequencing of events in the safety injection system is the following. After the generation of the SIS (appropriate delays for instrumentation, logic, and signal transport included), the appropriate valves begin to operate and the centrifugal charging pumps start. In 12 seconds, the valves are assumed to be in their final position, and the pumps are assumed to be at full speed. This delay, described above, is included in the calculations.

In cases where offsite power is not available, an additional 12-second delay is assumed to start the diesels and to load the necessary safety injection equipment onto them.

The analysis has shown that even assuming a stuck RCCA with or without offsite power, and assuming a single failure in the engineered safeguards, the core remains in place and intact. Radiation doses will not exceed 10 CFR 100 guidelines.

DECREASE IN HEAT REMOVED BY THE SECONDARY SYSTEM

Feedwater System Pipe Break

A major feedwater line rupture is defined as a break in a feedwater line large enough to prevent the addition of sufficient feedwater to the steam generators to maintain shell side fluid inventory in the steam generators. If the break is postulated in a feedwater line between the check valve and the steam generator, fluid from the steam generator may also be discharged through the break. Further, a break in this location could preclude the subsequent addition of auxiliary feedwater to the affected steam generator. (A break upstream of the feedwater line check valve would affect the NSSS only as a loss of feedwater. This case is covered by the evaluation in Sections 15.2.6 and 15.2.7).

Depending upon the size of the break and the plant operating conditions at the time of the break, the break could cause either an RCS cooldown (by excessive energy discharge through the break) or an RCS heatup. Potential RCS cooldown resulting from a secondary pipe rupture is evaluated in Section 15.1.5. Therefore, only the RCS heatup effects are evaluated for a feedwater line rupture.

A feedwater line rupture reduces the ability to remove heat generated by the core from the RCS for the following reasons:

a. Feedwater flow to the steam generators is reduced. Since feedwater is subcooled, its loss may cause reactor coolant temperatures to increase prior to reactor trip.

b. Fluid in the steam generator may be discharged through the break, and would then not be available for decay heat removal after trip.

c. The break may be large enough to prevent the addition of any main feedwater after trip.

An auxiliary feedwater system functions to ensure the availability of adequate feedwater so that:

a. No substantial overpressurization of the RCS occurs (less than 110 percent of design pressures); and

b. Sufficient liquid in the RCS is maintained so that the core remains in place and geometrically intact with no loss of core cooling capability.

The engineered safety systems assumed to function are the auxiliary feedwater system and the safety injection system. For the auxiliary feedwater system, the worst case configuration has been used, i.e., only three nonfaulted steam generators receive auxiliary feedwater following the break. The flow from the motor-driven auxiliary feedwater pump feeding the faulted steam generator was assumed to spill completely through the break. The second motor-driven auxiliary feedwater pump has been assumed to fail. The turbine-driven auxiliary feedwater pump delivers 470 gpm to the three nonfaulted steam generators. This assumption is conservative because it maximizes the purge time in the feedwater lines before auxiliary feedwater enters the unaffected steam generators.

A safety injection signal from either low steamline pressure or high containment pressure initiates flow of cold borated water into the RCS. The amount of safety injection flow is a function of RCS pressure.

Results of the analyses show that for the postulated feedwater line rupture, the assumed auxiliary feedwater system capacity is adequate to remove decay heat, to prevent overpressurizing the RCS, and to prevent uncovering the reactor core. Radioactivity doses from the postulated feedwater line rupture are less than those previously presented for the postulated steamline break. All applicable acceptance criteria are therefore met.

DECREASE IN REACTOR COOLANT SYSTEM INVENTORY

Steam Generator Tube Failure

The accident postulated and analyzed is the complete severance of a single steam generator tube, and is assumed to occur at power.

Assuming normal operation of the various plant control systems, the following sequence of events is initiated by a tube failure:

a. Pressurizer low pressure and low level alarms are actuated and charging pump flow increases in an attempt to maintain pressurizer level. On the secondary side, there is a steam flow/feedwater flow mismatch before the trip as feedwater flow to the affected steam generator is reduced due to the additional break flow which is not being supplied to that unit.

b. The steam generator blowdown liquid monitor and the condenser offgas radiation monitor will alarm, indicating a sharp increase in radioactivity in the secondary system, and will automatically terminate steam generator blowdown.

c. Continued loss of reactor coolant inventory leads to a reactor trip on low pressurizer pressure or over-temperature T. The resultant plant cooldown leads to a continued reduction in pressurizer level and SIS initiation. The SIS automatically terminates normal feedwater supply and initiates auxiliary feedwater addition. After reactor trip, the break flow reaches equilibrium at the point where incoming safety injection flow is balanced by outgoing break flow. The resultant break flow persists from plant trip until operator action is taken to bring the primary system and affected steam generator secondary system pressures into equilibrium.

d. The reactor trip automatically trips the turbine, and if offsite power is available the steam dump valves open, permitting steam dump to the condenser. In the event of a coincident station loss of offsite power, the steam dump valves would automatically close to protect the condenser. The steam generator pressure would rapidly increase, resulting in steam discharge to the atmosphere through the steam generator safety and/or atmospheric relief valves.

e. Following reactor trip, the continued action of the auxiliary feedwater supply and borated safety injection flow (supplied from the RWST) provide a heat sink which absorbs some of the decay heat. Thus, steam bypass to the condenser or, in the case of loss of offsite power, steam relief to the atmosphere is attenuated during the transient until the recovery procedure leading to isolation is being carried out.

A steam generator tube rupture, as demonstrated in the analyses provided in Section 15.6.3, causes no subsequent damage to the RCS or the reactor core. An orderly recovery from the accident can be completed, even assuming simultaneous loss of offsite power.

<u>LOCA From a Spectrum of Postulated Piping Breaks Within the System</u>

<u>Small Break LOCA</u> - Small ruptured pipes, cracks in large pipes, or ejection of a control rod.

A LOCA is defined as a rupture of the RCS piping or of any line connected to the system from which the break flow exceeds the flow capability of the normal makeup/charging system. Ruptures of small cross-sections will cause expulsion of the reactor coolant at a rate which can be accommodated by the charging pumps maintaining an operational water level in the pressurizer, permitting the operator to execute an orderly shutdown.

The maximum break size for which the normal makeup system can maintain the pressurizer level is obtained by comparing the calculated flow from the RCS through the postulated break against the centrifugal charging pump makeup flow at normal RCS pressure, i.e., 2,250 psia. A makeup flow rate from one centrifugal charging pump is adequate to sustain pressurizer level at 2,250 psia for a 0.375-inch-diameter hole. This break results in a loss of approximately 17.5 lb/sec (127 gpm at 130°F and 2,250 psia).

The SIS stops normal feedwater flow by closing the main feedwater isolation valves and initiates emergency feedwater flow by starting the auxiliary feedwater pumps.

The small break analyses deal with breaks of up to 1.0 ft^2 in area, where the safety injection pumps play an important role in the initial core recovery because of the slower depressurization of the RCS.

The analysis of this break, as provided in Section 15.6, demonstrates that the high head portion of the ECCS, together with accumulators, provides sufficient core flooding to keep the calculated peak clad temperature below the required limits of 10 CFR 50.46. Hence, adequate protection is afforded by the ECCS in the event of a small break LOCA.

Large Break LOCA

A major LOCA is defined as a 1.0 ft^2 or larger rupture of the RCS piping, including the double-ended rupture of the largest pipe in the RCS or of any line connected to that system. The boundary considered for LOCA, as related to connecting piping, is defined in Section 3.6.

Should a major break occur, depressurization of the RCS results in a pressure decrease in the pressurizer. Reactor trip occurs and the safety injection system is actuated when the pressurizer low pressure trip setpoint is reached. Reactor trip and safety injection system actuation may be provided by a high containment pressure signal, depending on the actual break size. These countermeasures will limit the consequences of the accident in two ways:

a. Reactor trip and borated water injection provide additional negative reactivity insertion to supplement void formation in causing rapid reduction of power to a residual level corresponding to fission product decay heat.

b. Injection of borated water ensures sufficient flooding of the core to prevent excessive clad temperatures.

When the pressure falls below approximately 600 psi, the accumulators begin to inject borated water. The conservative assumption is made that accumulator water injected bypasses the core and goes out through the break until the expulsion or entrainment mechanisms for bypassing are calculated not to be effective. This conservatism is consistent with the acceptable features of ECCS Evaluation Models, as defined by Appendix K, 10 CFR 50.

The pressure transient in the reactor containment during a LOCA affects ECCS performance in the following ways. The time at which end of blowdown occurs is determined by a zero break flow which is a result of achieving pressure equilibrium between the RCS and the containment. In this way, the amount of accumulator water bypass is also affected by the containment pressure, since the amount of accumulator water discharged during blowdown is dependent on the length of the blowdown phase and RCS pressure at end of blowdown. During the reflood phase of the transient, the density of the steam generated in the core is dependent on the existing containment pressure. The density of this steam affects the amount of steam which can be vented from the core to the break for a given downcomer head, the core reflooding process, and, thus, the ECCS performance. It is through these effects that containment pressure affects ECCS performance.

For breaks up to and including the double-ended severance of a reactor coolant pipe, the ECCS limits the clad temperature to below 2200°F and ensure that the core remains in place and substantially intact with its essential heat transfer geometry preserved. See Section 15.6.5 for ECCS sequence of events.

For these breaks, Section 15.6 demonstrates that the ECCS meets the Acceptance Criteria presented in 10 CFR 50.46. That is:

a. The calculated peak fuel element clad temperature is less than 2,200°F.

b. The amount of fuel element cladding that reacts chemically with water or steam does not exceed 1 percent of the total amount of Zircaloy in the reactor.

c. The clad temperature transient is terminated at a time when the core geometry is still amenable to cooling. The cladding oxidation limits of 17 percent are not exceeded during or after quenching.

d. The core temperature is reduced and decay heat is removed for an extended period of time, as required by the long-lived radioactivity remaining in the core.

INCREASE IN REACTOR COOLANT SYSTEM INVENTORY

Inadvertent Operation Of The Emergency Core Cooling System During Power Operation

Spurious emergency core cooling system (ECCS) operation at power could be caused by operator error or a false electrical actuation signal. A spurious signal may originate from any of the safety injection actuation channels, as described in Section 7.3.

A safety injection signal (SIS) normally results in a reactor trip followed by a turbine trip. However, it cannot be assumed that any single fault that actuates the ECCS will also produce a reactor trip. If a reactor trip is generated by the spurious SIS, the operator should determine if the spurious signal was transient or steady state in nature. The operator must also determine if the SIS should be blocked. For a spurious occurrence, the operator would terminate ECCS and maintain the plant in the hot standby condition.

If the reactor protection system does not produce an immediate trip as a result of the spurious SIS, the reactor experiences a negative reactivity excursion due to the injected boron, causing a decrease in reactor power. The power mismatch causes a drop in T_{AVG} and consequent coolant shrinkage. The pressurizer pressure and water level decrease. Load will decrease due to the effect of reduced steam pressure on load after the turbine throttle valve is fully open. If automatic rod control is used, these effects will be lessened until the rods have moved out of the core. The transient is eventually terminated by the reactor protection system low pressurizer pressure trip or by manual reactor trip.

Results of the analysis show that spurious ECCS operation without immediate reactor trip presents no hazard to the integrity of the RCS.

If the reactor does not trip immediately, the low pressurizer pressure reactor trip is actuated. This trips the turbine and prevents excess cooldown, thereby expediting recovery from the incident.

Criteria Used to Judge the Adequacy of the ECCS

(Reference: 10 CFR 50.46)

a. The peak clad temperature calculated shall not exceed 2,200°F.

b. The calculated total oxidation of the clad shall nowhere exceed 0.17 times the total clad thickness before oxidation.

c. The calculated total amount of hydrogen generated from the chemical reaction of the clad with water or steam shall not exceed 0.01 times the hypothetical amount that would be generated if all of the metal in the clad cylinders surrounding the fuel, excluding the clad around the plenum volume, were to react.

d. Calculated changes in core geometry shall be such that the core remains amenable to cooling.

e. After any calculated successful initial operation of the ECCS, the calculated core temperature shall be maintained at an acceptable low value and decay heat shall be removed for the extended period of time required by long lived radioactivity remaining in the core.

In addition to and as an extension of the Final Acceptance Criteria, two accidents have more specific criteria, as shown below.

In the case of the inadvertent opening of a steam generator atmospheric relief or safety valve, an additional criteria for adequacy of the ECCS is: Assuming a stuck RCCA, offsite power available, and a single failure in the engineered safety features, there will be no return to criticality after reactor trip for a steam release equivalent to the spurious opening with failure to close, of the larger of a single steam dump, relief, or safety valve.

For a steam system piping failure, the added criteria is: Assuming a stuck RCCA with or without offsite power, and assuming a single failure in the engineered safety features, the core remains in place and intact.

Use of Dual Function Components

The ECCS contains components which have no other operating function, as well as components which are shared with other systems. Components in each category are as follows:

a. Components of the ECCS which perform no other function are:

    1. One accumulator for each loop which discharges borated water into its respective cold leg of the reactor coolant loop piping.

2. Two safety injection pumps, which supply borated water for core cooling to the RCS. (May be used during check valve testing also.)

3. One BIT

4. One BIST

5. ssociated piping, valves, and instrumentation

b. Components which also have a normal operating function are as follows:

1. RHR pumps and the RHR heat exchangers

   These components are normally used during the latter stages of normal reactor cooldown and when the reactor is held at cold shutdown for core decay heat removal or for flooding the refueling cavity. However, during all other plant operating periods they are aligned to perform the low head injection function.

2. Centrifugal charging pumps

   These pumps are normally aligned for charging service. As a part of the chemical and volume control system, the normal operation of these pumps is discussed in Section 9.3.4.

3. RWST

   This tank is used to fill the refueling canal for refueling operations and to provide makeup to the fuel storage pool.

   However, during all other plant operating periods it is aligned to the suction of the safety injection pumps and the RHR pumps. The charging pumps are automatically aligned to the suction of the RWST upon receipt of an SIS or a VCT low level alarm. During normal operation, they take suction from the volume control tank.

An evaluation of components required for operation of the ECCS demonstrates that either:

a. The component is not shared with other systems, or

b. If the component is shared with other systems, it is either aligned during normal plant operation to perform its accident function or, if not aligned to its accident function, two valves in parallel are provided to align the system for injection, and two valves in series are provided to isolate portions of the system not utilized for injection. These valves are automatically actuated by the SIS.

Table 6.3-9 indicates the alignment of components during normal operation and the realignment required to perform the accident function.

In all cases of component operation, safety injection has the priority usage such that an SIS will override all other signals and start or align systems for injection.

Limits on System Parameters

The analyses show that the design basis performance characteristic of the ECCS is adequate to meet the requirements for core cooling following a LOCA with the minimum engineered safety features equipment operating. In order to ensure this capability in the event of the simultaneous failure to operate any single active component, reactor operating limits are established (see Technical Specifications).

Normal operating status of the ECCS components is given in Table 6.3-10.

6.3.4 TESTS AND INSPECTIONS

6.3.4.1 ECCS Performance Tests

6.3.4.1.1 Preoperational Test Program at Ambient Conditions

Preliminary operational testing of the ECCS was conducted with the system cold and aligned for normal power operation with the exception that the BIT was filled with refueling water instead of concentrated boric acid. An SIS was initiated, and the breakers on the lines supplying offsite power were tripped manually so that operation of the emergency diesels was tested in conjunction with the safety injection system. System testing provided the following verifications of system performance:

a. Satisfactory SIS generation and transmission

b. Proper operation of the emergency diesel generators, including sequential load pickup

c. Valve operating times

d. Pump starting times

e. Pump delivery rates at runout conditions (one point on the operating curve)

Further details of each preoperational test performed are discussed in Chapter 14.0.

6.3.4.1.2 Components

Pumps

Separate flow tests of the pumps in the ECCS were conducted during the preoperational testing (with the reactor vessel head off) to check capability for sustained operation. The centrifugal charging, safety injection, and RHR pumps discharge into the reactor vessel through the injection lines, the overflow from the reactor vessel passes into the refueling pool. Each pump was tested separately with water drawn from the RWST. Data is taken to determine pump head and flow at this time. Pumps are then run on miniflow circuits and data taken to determine a second point on the head flow characteristic curve.

Section 6.2.2.1.4 discusses the hydraulic model testing used to verify that the available net positive suction head is adequate when the RHR pumps and containment spray pumps take suction from the containment recirculation sumps.

Accumulators

Each accumulator is filled with water from the RWST and pressurized with the motor-operated valve on the discharge line closed. Then the valve is opened and the accumulator allowed to discharge into the reactor vessel as part of the preoperational testing with the reactor cold and the vessel head off.

6.3.4.2 Reliability Tests and Inspections

6.3.4.2.1 Description of Tests Planned

Routine periodic testing of the ECCS components and all necessary support systems at power is planned. Valves which operate after a LOCA are operated through a complete cycle, and pumps are operated individually in this test on their miniflow lines, except the centrifugal charging pumps, if they have been tested by their normal charging function. If such testing indicates a need for corrective maintenance, the redundancy of equipment in these systems permits such maintenance to be performed without shutting down or reducing load under certain conditions. These conditions include considerations, such as the period within which the component should be restored to service and the capability of the remaining equipment to provide the minimum required level of performance during such a period.

The operation of the remote stop valve is tested per the required in-service testing (ASME code, Section XI). The operation of the check valve in each accumulator tank discharge line is tested per the required in-service testing (ASME Code, Section XI).

Where series pairs of check valves form the high pressure to low pressure isolation barrier between the RCS and safety injection system piping outside the reactor containment, periodic testing of these check valves is performed to provide assurance that certain postulated failure modes do not result in a loss-of-coolant from the low pressure system outside the containment with a simultaneous loss of safety injection pumping capacity.

The safety injection system test line subsystem provides the capability for determining the integrity of the pressure boundary formed by series check valves. The tests performed verify that each of the series check valves can independently sustain differential pressure across its disc and also verify that the valve is in its closed position. The required periodic tests are to be performed after each refueling just prior to plant startup, after the RCS has been pressurized. Temporary Modification Order (TMO) 15-015-EM-00 installed a line crimp on a portion of the safety injection system test line subsystem, which blocks a portion of the test line piping. The line crimp is installed to stop leakage of nitrogenated water out of the ‘A’ Accumulator through valve EPHV8879A. TMO 15-015-EM-00 must be removed prior to the next required performance of the testing of the affected check valves, no later than plant startup at the end of Refuel 21 (Fall 2016).

Lines in which the series check valves are to be tested are the safety injection pump cold and hot leg injection lines and the RHR pump cold and hot leg injection lines.

The Technical Specifications state the periodic component testing requirements. During periodic system testing, a visual inspection of pump seals, valve packings, flanged connections, and relief valves is made to detect leakage. Inservice inspection provides further confirmation that no significant deterioration is occurring in the ECCS fluid boundary.

Each ECCS subsystem is demonstrated Operable by performance of a flow test, during shutdown, following completion of modifications to the ECCS subsystems that alter the subsystem flow characteristics.

1. For the centrifugal charging pump lines, with a single pump running, the sum of the injection line flow rates, excluding the highest flow rate, is verified to be greater than or equal to 330 gpm and total pump flow rate is less than or equal to 556 gpm.

2. For the safety injection pump lines, with a single pump running, the sum of the injection line flow rates excluding the highest flow rate, is verified to be greater than or equal to 450 gpm and total pump flow rate is less than or equal to 670 gpm.

3. For the residual heat removal pump lines, with a single pump running, the sum of the injection line flow rates is greater than or equal to 3800 gpm and the total pump flow rate is less than or equal to 5500 gpm.

Design measures have been taken to assure that the following testing can be performed:

a. Active components may be tested periodically for operability (e.g., pumps on miniflow, certain valves, etc.).

b. An integrated system actuation test* can be performed when the plant is cooled down and the RHRS is in operation. The ECCS is aligned so that no flow will be introduced into the RCS for this test.

c. An initial flow test of the full operational sequences can be performed.

The design features which assure this test capability are specifically:

a. Power sources are provided to permit individual actuation of each active component of the ECCS.

b. The safety injection pumps can be tested periodically during plant operation, using the minimum flow recirculation lines provided.

c. The RHR pumps are used every time the RHRS is put into operation. They can also be tested periodically when the plant is at power, using the miniflow recirculation lines.

d. The centrifugal charging pumps are either normally in use for charging service or can be tested periodically on miniflow.

e. Remote-operated valves can be exercised during routine plant maintenance.

f. Level and pressure instrumentation is provided for each accumulator tank, for continuous monitoring of these parameters during plant operation.

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* Details of the testing of the sensors and logic circuits associated with the generation of an SIS, together with the application of this signal to the operation of each active component, are given in Section 7.2.

g. Flow from each accumulator tank can be directed through a test line in order to determine valve operability. The test line can be used, when the RCS is pressurized, to ascertain backleakage through the accumulator check valves.

h. A flow indicator is provided in the centrifugal charging pump, safety injection pump, and RHR pump headers. Pressure instrumentation is also provided in these lines.

i. An integrated system test can be performed when the plant is cooled down and the RHRS is in operation. This test does not introduce flow into the RCS but does demonstrate the operation of the valves, pump circuit breakers, and automatic circuitry, including diesel starting and the automatic loading of ECCS components on the diesels (by simultaneously simulating a loss of offsite power to the vital electrical busses).

See Technical Specifications for the selection of test frequency, acceptability of testing, and measured parameters. A description of the inservice inspection program is included in Section 6.6. ECCS components and systems are designed to meet the intent of the ASME Code, Section XI for inservice inspection.

6.3.5 INSTRUMENTATION REQUIREMENTS

Instrumentation and associated analog and logic channels employed for initiation of ECCS operation are discussed in Section 7.3.

This section describes the instrumentation employed for monitoring ECCS components during normal plant operation and also ECCS postaccident operation. Alarms are annunciated in the control room.

6.3.5.1 Temperature Indication

BIT Temperature

Two temperature indicators provide local indication.

RHR Heat Exchanger Temperature

The fluid temperature at both the inlet and the outlet of each RHR heat exchanger is recorded in the control room.

6.3.5.2 Pressure Indication

BIT Pressure

BIT pressure is indicated in the control room.

Centrifugal Charging Pump Inlet, Discharge Pressure

There is local pressure indication at the suction and discharge of each centrifugal charging pump.

Safety Injection Pump Suction Pressure

There is a locally mounted pressure indicator at the suction of each safety injection pump.

Safety Injection Header Pressure

Safety injection pump discharge header pressure is indicated in the control room.

Accumulator Pressure

Duplicate pressure channels are installed on each accumulator. Pressure indication in the control room and high and low pressure alarms are provided by each channel.

Test Line Pressure

A local pressure indicator used to check for proper seating of the accumulator check valves between the injection lines and the RCS is installed on the leakage test line.

RHR Pump Suction Pressure

Local pressure indication is provided at the inlet to each RHR pump.

RHR Pump Discharge Pressure

RHR discharge pressure for each pump is indicated in the control room. A high pressure alarm is actuated by each channel.

6.3.5.3 Flow Indication

Centrifugal Charging Pump Injection Flow

Injection flow to the reactor cold legs is indicated in the control room.

Safety Injection Pump Header Flow

Flow through the safety injection pump header is indicated in the control room.

Safety Injection Pump Minimum Flow

A flow indicator is installed in the safety injection pump minimum flow line.

Test Line Flow

Local indication of the leakage test line flow is provided to check for proper seating of the accumulator check valves between the injection lines and the RCS, and for testing other check valves in the ECCS.

RHR Pump Cold Leg Injection Flow

The flow from each residual heat removal subsystem to the RCS cold legs is recorded in the control room. These instruments also control the RHR bypass valves, maintaining constant return flow to the RCS during normal cooldown.

RHR Pump Minimum Flow

A flowmeter installed in each RHR pump discharge header provides control for the valve located in the pump minimum flow line.

6.3.5.4 Level Indication

RWST Level

Water level indicator channels, which indicate in the control room, are provided for the RWST. Each channel is provided with a high, low, low-low-1, low-low-2, and empty level alarm. The high level alarm is provided to protect against possible overflow of the RWST. The low level alarm is provided to assure that a sufficient volume of water is always available in the RWST. The low-low-1 level alarm, as well as the level indication, alerts the operator to realign the ECCS from the injection to the recirculation mode following an accident and automatically opens the sump isolation valves. The low-low-2 level alarm, as well as the level indication, alerts the operator to realign the containment spray pumps for recirculation. The empty alarm indicates that the usable volume of the RWST has been exhausted.

Accumulator Water Level

Duplicate water level channels are provided for each accumulator. Both channels provide indication in the control room and actuate high and low water level alarms.

6.3.5.5 Valve Position Indication

Motor/Air-Operated Valves

Valve positions are indicated on the control boards by red and green position indication lights associated with the control switch for the valve. In addition, a status monitoring panel is provided which indicates that a valve is in its proper position for safety features system operation by a white light. A potential bypass of automatic operation is indicated by an amber light. See Section 7.5.2.2.1 for additional discussion.

Manual Valves

Control room position indication and alarms are provided for the following ECCS manual valves to ensure correct system alignment.

RWST discharge (VOll on Figure 6.3-1, Sheet 1)
RHR recirculation (8717 on Figure 6.3-1, Sheet 1)

Accumulator Isolation Valve Position Indication

The accumulator motor-operated valves are provided with red (open) and green (closed) position indicating lights located at the control switch for each valve. These lights are powered by valve control power and actuated by valve motor operator limit switches.

A monitor light that is on when the valve is not fully open is provided in an array of monitor lights that are all off when their respective valves are in proper position. This light is energized from a separate monitor light supply and actuated by a valve motor-operator limit switch. Additionally, an ESF status panel bypass indication is provided whenever any of these valves leaves the fully open position.

An alarm annunciator point is activated by both a valve motor operator limit switch and by a valve position limit switch activated by stem travel whenever an accumulator valve is not fully open for any reason with the system at pressure (the pressure at which the safety injection block is unblocked is approximately 1,970 psig). A separate annunciator point is used for each accumulator valve.

6.3.6 REFERENCE

1. Hill, R.A., et al., "Evaluation of Mispositioned ECCS Valves," WCAP-9207 (Proprietary) and WCAP-8966 (Non-Proprietary), September 1977

2. Westinghouse Electric Corporation Reference Safety Analysis Report, RESAR-3, Appendix 6A, Pages 6A-1 through 6A-4 dated June 1972.

TABLE 6.3-1

EMERGENCY CORE COOLING SYSTEM COMPONENT PARAMETERS

Accumulators	
Number	4
Design pressure, psig	700
Design temperature, F	300
Operating temperature, F	45* to 120*
Normal operating pressure, psig	602 to 648
Minimum pressure, psig	585
Total volume, ft^3 (each)	1350
Normal operating water volume, ft^3 (each)	850
Volume N_2 gas, ft^3 (each)	500
Boric acid concentration, ppm boron (range)	2,300 to 2,500
Relief valve setpoint, psig	700
Seismic	Category I
Design code	ASME III, Class 2
Material	Stainless steel
Centrifugal Charging Pumps	
Number	2
Design pressure, psig	2,800
Design temperature, F	300
Design flow (A), gpm	150
Design head, ft	5,800
Maximum flow, gpm	550
Head at maximum flow, ft	1,400
Discharge head at shutoff, ft	6,200
Required NPSH at maximum flow, ft	28
Available NPSH, ft	44
Design code	ASME III, Class 2
Seismic design	Category I
Driver:	
Type	Electric motor
Horsepower, hp	600
Rpm	1,800
Power	4,160 V, 60 Hz, 3-phase, Class IE
Start time	<5 sec
Design code	NEMA

(A) Includes miniflow

*The accumulator operating conditions, as stated in the ASME Section III design specification, are 60°F to 150°F. The accumulator tanks can operate at temperatures as low as 45°F based on an ASME Section XI evaluation. Operation is limited to 120°F by the initial containment temperature assumed in the containment integrity accident analyses.

TABLE 6.3-1 (Sheet 2)

Safety Injection Pumps	
Number	2
Design pressure, psig	1,750
Design temperature, F	300
Design flow rate, gpm	440
Design head, ft	2,780
Maximum flow rate, gpm	660
Head at maximum flow rate, ft	1,760
Discharge head at shutoff, ft	3,645
Required NPSH	25
Available NPSH	44
Design code	ASME III, Class 2
Seismic design	Category I
Driver:	
Type	Electric motor
Horsepower, hp	450
Rpm	3,600
Power	4,160 V, 60 Hz, 3-phase, Class IE
Start time	<5 sec
Design code	NEMA
Seismic design	Category I
Residual Heat Removal Pumps	
Number	2
Design pressure, psig	600
Design temperature, F	400
Design flow, gpm	3,800
Design head, ft	350
NPSH required at 4,760 gpm, ft	21.01
Available NPSH at 4,760 gpm, ft	23.79*
Design code	ASME III, Class 2
Seismic design	Category I
Driver:	
Type	Electric motor
Horsepower, hp	500
Rpm	1,800
Power	4,160 V, 60 Hz, 3-phase, Class IE
Start time	<5 sec
Design code	NEMA
Seismic design	Category I
Residual Heat Exchangers	
(See Section 5.4.7 for design parameters)	

* Includes 1.724 ft. total head loss across the sump strainer with both the Spray Pump and RHR Pump running in Recirculation, and a 0.56 ft. allowance for EDG frequency uncertainties.

TABLE 6.3-1 (Sheet 3)

<u>Refueling Water Storage Tank</u>	
Quantity	1
Maximum volume (to overflow), gal	419,000
Minimum Water Volume Required, gal	394,000
Boric acid concentration, ppm boron (range)	2,400 to 2,500
Type	Vertical, field erected
Diameter, ft-in	40-0
Side height, ft-in	46-0
Design pressure, psig	Atmospheric
Design temperature, F	120/-60
Material	Austenitic stainless steel
Design code	ASME III, Class 2
Seismic design	Category I
<u>Boron Injection Tank</u>	
Number	1
Total volume, gal	900
Usable volume at operating conditions, solution, gal	900
Boron concentration, ppm (nominal)	*
Design pressure, psig	2,735
Operating pressure	Atmospheric
Design temperature, F	300
Operating temperature, F	Ambient
Heaters **	
Type	Strip
Design code	ASME III, Class 2
Seismic design	Category I
<u>Boron Injection Surge Tank**</u>	
Number	1
Total volume, gal	75
Boron concentration, ppm (nominal)	0
Design pressure	Atmospheric
Operating pressure	Atmospheric
Design temperature, F	200
Operating temperature, F	Ambient
Heaters **	
Type	Immersion
Design code	ASME III, Class 3
Seismic design	Category I

* Between 2400 ppm and RCS concentration

** Heaters, pumps, and Boron Injection Surge Tank are no longer required due to lower system boron concentration. They remain installed but have been permanently disabled.

TABLE 6.3-1 (Sheet 4)

Boron Injection Tank Recirculation Pumps**	
Number	2
Design pressure, psig	150
Design temperature, F	250
Design flow rate, gpm	20
Design head, ft	100
Design code	ASME III, Class 3
Seismic design	Category I

Motor-Operated Valves	Maximum Opening Or Closing Time
Up to and including 8 inches, time, sec	15
Over 8 inches, time, sec*	$\dfrac{\text{Valve size (inches)}}{49 \dfrac{\text{inches}}{\text{min}}} \times \dfrac{1 \text{ min}}{60 \text{ sec}}$

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* Excluding valves EJ-HV-8809A,B and EJ-HV-8840 and EJ-HV-8716A,B, which have 15-second maximum opening/closing times. Other exceptions are:

EMHV8801A/B	20 seconds
EMHV8803A/B	20 seconds
BNHV8812A/B	25 seconds
EJHV8804A/B	30 seconds

** Heaters, pumps, and Boron Injection Surge Tank are no longer required due to lower system boron concentration. They remain installed but have been permanently disabled.

TABLE 6.3-2

EMERGENCY CORE COOLING SYSTEM RELIEF VALVE DATA

Description	Fluid Discharged	Fluid Inlet Temperature Normal (F)	Set Pressure (psig)	Backpressure Constant (psig)	Maximum Total Backpressure (psig)	Capacity
N_2 supply to accumulators	N_2	120	700	0	0	1,500 scfm
Safety injection pump discharge	Water	120	1,825	0 to 15	50	20 gpm
Residual heat removal pump safety injection line	Water	120	600	0 to 15	50	20 gpm
Safety injection pumps suction header	Water	100	220	0 to 15	50	25 gpm
Accumulator to containment	N_2 Gas	120	700	0	0	1,500 scfm

TABLE 6.3-3

MOTOR-OPERATED ISOLATION VALVES IN THE EMERGENCY CORE COOLING SYSTEM

Location	Valve Identification	Interlocks	Automatic Features	Position Indication	Alarms
Accumulator isolation valves	8808 A,B,C,D	Power lockout provided	Opens on SIS if power on valve and RCS pressure unblock	MCB	Yes-out of position
Safety injection pump suction from RWST	8806 A&B 8923 A&B	None	None	MCB	Yes-out of position
RHR suction from RWST	8812 A&B	Cannot be opened unless sump valve closed	Closes on SIS coincident with RWST low-low-1 level and sump valve fully open	MCB	Yes-out of position
RHR discharged to safety injection/ charging pump suction	8804 A&B	Cannot be opened unless safety injection pump miniflow isolated and RHR suction valve from RCS closed	None	MCB	Yes-out of position
Safety injection hot leg injection	8802 A&B	Power lockout provided	None	MCB	Yes-out of position
RHR hot leg injection	8840	Power lockout provided	None	MCB	Yes-out of position
Containment sump isolation valve	8811 A&B	Cannot be opened in normal operation unless RHR suction valves from RWST & from RCS closed	Opens on RWST low-low-1 with SIS	MCB	Yes-out of position

TABLE 6.3-3 (Sheet 2)

MOTOR-OPERATED ISOLATION VALVES IN THE EMERGENCY CORE COOLING SYSTEM

Location	Valve Identification	Interlocks	Automatic Features	Position Indication	Alarms
CVCS suction from RWST	LCV-112 D&E	SIS	Open on SIS	MCB	Yes-out of position
CVCS normal suction	LCV-112 B&C	SIS	Closes on SIS if CVCS suction valves from RWST open	MCB	Yes-out of position
Safety injection pump to cold leg	8835	Power lockout provided	None	MCB	Yes-out of position
CVCS normal discharge	8105 8106	SIS	Closes on SIS	MCB	None
Boron injection tank suction	8803 A&B	SIS	Opens on SIS	MCB	Yes-out of position
Boron injection tank discharge	8801 A&B	SIS	Opens on SIS	MCB	Yes-out of position
Charging pump / safety injection pump crossover	8801 A&B 8924	None	None	MCB (8807 A&B Only))	Yes-out of position
RHR to RCS cold legs	8809 A&B	Power lockout provided	None	MCB	Yes-out of position
Safety Injection pump miniflow	8813 8814 A&B	Cannot be opened unless RHR discharge to safety injection & to charging pumps closed. Power lockout on 8813 only	None	MCB	Yes-out of position

TABLE 6.3-3 (Sheet 3)

MOTOR-OPERATED ISOLATION VALVES IN THE EMERGENCY CORE COOLING SYSTEM

Location	Valve Identification	Interlocks	Automatic Features	Position Indication	Alarms
RHR cross connect	8716 A&B	None	None	MCB	Yes-out of position
Safety injection pump cross connect	8821 A&B	None	None	MCB	Yes-out of position
Charging pump miniflow	8110 8111	SIS	Closed on SIS	MCB	Yes-out of position

MCB - main control board

TABLE 6.3-4

MATERIALS EMPLOYED FOR EMERGENCY CORE COOLING SYSTEM COMPONENTS

Component	Material
Accumulators	Carbon steel clad with austenitic stainless steel
Boron injection tank	Austenitic stainless steel
Boron injection surge tank	Austenitic stainless steel
Pumps	
Centrifugal charging	Austenitic stainless steel
Safety injection	Austenitic stainless steel
Residual heat removal	Austenitic stainless steel
RHR heat exchangers	
Shell	Carbon steel
Shell end cap	Carbon steel
Tubes	Austenitic stainless steel
Channel	Austenitic stainless steel
Channel cover	Austenitic stainless steel
Tube sheet	Austenitic stainless steel
Valves	
Motor-operated valves containing radioactive fluids	
Pressure containing parts	Austenitic stainless steel or equivalent
Body-to-bonnet bolting and nuts	Low alloy steel
Seating surfaces	Stellite No. 6 or equivalent
Stems	Austenitic stainless steel or 17-4 PH stainless

TABLE 6.3-4 (Sheet 2)

Component	Material
Diaphragm valves	Austenitic stainless steel
Accumulator check valves	
Parts contacting borated water	Austenitic stainless steel
Clapper arm shaft	17-4 PH stainless
Relief valves	
Stainless steel bodies	Stainless steel
Carbon steel bodies	Carbon steel
All nozzles, discs, spindles, and guides	Austenitic stainless steel
Bonnets for stainless steel valves without a balancing bellows	Stainless steel or plated carbon steel
All other bonnets	Carbon steel
Piping	
All piping in contact with borated water	Austenitic stainless steel

TABLE 6.3-5

FAILURE MODE AND EFFECTS ANALYSIS - EMERGENCY CORE COOLING SYSTEM - ACTIVE COMPONENTS

	Component***	Failure Mode	ECCS Operation Phase	Effect On System Operation*	Failure Detection Methods**	Remarks
1.	Motor-operated gate valve LCV-112B (LCV-112C analogous)	Fails to close on demand	Injection - cold legs of RC loops	Failure reduces redundancy of providing VCT discharge isolation. No effect on safety for system operation; isolation valves LCV-112C and 8440 provide back-up tank discharge isolation.	Valve position indication (open to closed position change) at MCB. Valve close position monitor light and alarm for group monitoring of components at MCB.	Valve is electrically interlocked with isolation valve LCV-112D. Valve closes on actuation by an SIS provided isolation valve LCV-112D is at a full open position.
2.	Motor-operated gate valve LCV-112D (LCV-112E analogous)	Fails to open on demand	Injection - cold legs of RC loops	Failure reduces redundancy of providing fluid flow from RWST to suction of HHSI/CH pumps. No effect on safety for system operation. Alternate isolation valve LCV-112E opens to provide back-up flow path to suction of both HHSI/CH pumps.	Same methods of detection as those stated for item 1, except open position monitor light and alarm for group monitoring of components, and closed to open position change indication at MCB.	Valve is electrically interlocked with the instrumentation that monitors fluid level of the VCT. Valve opens upon actuation by a "low-low level" VCT signal.
3.	Centrifugal charging pump 1 (pump 2 analogous)	Fails to deliver working fluid	Injection and recirculation - cold legs of RC loops	Failure reduces redundancy of providing emergency coolant to the RCS via the BIT at prevailing incident RCS pressure. Fluid flow from HHSI/CH pump 1 will be lost. Minimum flow requirements at prevailing high RCS pressures will be met by HHSI/CH pump 2 delivery via BIT.	HHSI/CH pump discharge header flow (FI-917A) at MCB. BIT discharge pressure (PI-947) at MCB. Open pump switchgear circuit breaker indication on MCB. Circuit breaker close position monitor light for group monitoring of components at MCB. Common breaker trip alarm at MCB.	One HHSI/CH pump is used for normal charging of RCS during plant operation. Pump circuit breaker aligned to close on actuation by an SIS.

* See list at end of table for definition of acronyms and abbreviations used.

** As part of plant operation, periodic tests, surveillance inspections, and instrument calibrations are made to monitor equipment and performance. Failures may be detected during such monitoring of equipment in addition to detection methods noted.

*** NSSS check valves are not considered to be active (powered) components in the Westinghouse design with respect to the active components considered in this Emergency Core Cooling System (ECCS) Failure Modes and Effects Analysis (FMEA).

TABLE 6.3-5 (Sheet 2)

	Component***	Failure Mode	ECCS Operation Phase	Effect On System Operation*	Failure Detection Methos**	Remarks
4.	Motor-operated globe valve 8110 (8111 analogous)	Fails to close on demand	Injection - cold legs of RC loops	Failure prevents isolation of HHSI/CH pump 1 (pump 2) miniflow line. No effect on safety for system operation. Alternate isolation valve 8111 in HHSI/CH pump 2 (pump 1) provides miniflow isolation and assures adequate HHSI/CH pump flow.	Same methods of detection as those stated for item 1.	Valve aligned to close upon actuation by a coincident SIS and charging pump flow > 258.9 gpm. =
		Fails to open on demand	Injection - cold legs of RC loops	Failure prevents opening of HHSI/CH pump 1 (pump 2) miniflow line. No effect on safety for system operation. Alternate valve 8111 (8110) in HHSI/CH pump 2 (pump 1) provides adequate miniflow.	Same methods of detection as those stated for item 1.	Valve aligned to open a coinicident SIS and charging pump flow > 173.5 gpm. =
5.	Motor-operated gate valve 8105 (8106 analogous)	Fails to close on demand	Injection cold legs of RC loops	Failure reduces redundancy of providing isolation of HHSI/CH pump discharge to normal charging line of CVCS. No effect on safety for system operation. Alternate isolation valve 8106 provides back-up normal CVCS charging line isolation.	Same methods of detection as those stated for item 1.	Valve aligned to close upon actuation by an SIS.
6.	Motor-operated gate valve 8803A (8803B analogous)	Fails to open on demand	Injection - cold legs of RC loops	Failure reduces redundancy of fluid flow paths from HHSI/CH pumps to the RCS via BIT. No effect on safety for system operation. Alternate isolation valve 8803B opens to provide back-up flow path from HHSI/CH pumps to BIT.	Same methods of detection as those stated for item 2.	Valve aligned to open upon actua tion by an SIS.

TABLE 6.3-5 (Sheet 3)

	Component***	Failure Mode	ECCS Operation Phase	Effect On System Operation*	Failure Detection Method**	Remarks
7.	Motor-operated gate valve 8801A (8801B analogous)	Fails to open on demand	Injection - cold legs of RC loops	Failure reduces redundancy of fluid flow paths from HHSI/CH pumps to the RCS via BIT. No effect on safety for system operation. Alernate isolation valve 8801B opens to provide back-up flow path from HHSI/CH pumps to BIT.	Same methods of detection as those stated for item 2.	Valve aligned to open upon actuation by an SIS.
8.	Motor-operated gate valve FCV-610 (FCV-611 analogous)	a. Fails to close on demand	Injection - cold legs of RC loops	Failure reduces working fluid delivered to RCS from RHR pump 1. Minimum flow requirements for LHSI will be met by LHSI/RHR pump 2 delivering working fluid to RCS.	Valve position indication (open to closed position change) at MCB. RHR pump return line to cold legs flow indication (FI-618) at MCB.	Valve is regulated by signal from flow transmitter located in pump discharge header. The control valve opens when the RHR pump discharge flow is less than ~816 gpm and closes when the flow exceeds ~1,650 gpm.

TABLE 6.3-5 (Sheet 4)

Component***	Failure Mode	ECCS Operation Phase	Effect On System Operation*	Failure Detection Method**	Remarks
	b. Fails closed	Injection - cold legs of RC loops	Failure results in an insufficient fluid flow through LHSI/RHR pump 1 for a small LOCA or steam line break resulting in possible pump damage. If pump becomes inoperatrive minimum flow requirements for LHSI will be met by LHSI/RHR pump 2 delivering working fluid to RCS.	Same methods of detection as those stated for item 8.a, except closed to open position change indication at MCB.	
9. RHR pump 1 (pump 2 analogous)	Fails to deliver working fluid	Injection - cold legs of RC loops	Failure reduces redundancy of providing emergency collant to the RCS from the RWST at low RCS pressure (195 psig). Fluid flow from LHSI/RHR pump 1 will be lost. Minimum flow requirements for LHSI will be met by LHSI/RHR pump 2 delivering working fluid.	RHR pump return line to coldlegs flow indication (FI-618) and low flow alarm at MCB. RHR pump discharge pressure (PI-614) at MCB. Open pump switchgear circuit breaker indication at MCB Circuit breaker close positioni monitor lighjt and alarm for group monitoring of components at MCB. Common breaker trip alarm at MCB.	The RHR pump is sized to deliver reactor coolant through the RHR heat exchanger to meet plant cooldown requirements and is used during plant cooldonw and startup operations. The pump circuit breaker is aligned to close on actuation by on SIS.
10. SI pump 1 (pump 2 analogous)	Fails to deliver working fluid	Injection - cold legs of RC loops	Failure reduces redundancy of providing emergency coolant to the RCS from the RWST at high RCS pressure (1,520 psi). Fluid flow from HHSI/SI pump 1 will be lost. Minimum flow requirements for HHSI will be met by HHSI/SI pump 2 delivering working fluid.	SI pumps discharge pressure (PI-919) at MCB. SI pump discharge flow (FI-918) at MCB. Open pump switchggear circuit breaker indication at MCB. Circuit breaker close position monitor light and alamr for group monitoring of components at MCB. Commmon breaker trip alarm at MCB.	Pump circuit breaker aligned to close on actuation by an SIS.

TABLE 6.3-5 (Sheet 5)

	Component***	Failure Mode	ECCS Operation Phase	Effect On System Operation*	Failure Detection Method**	Remarks
11.	Motor-operated gate valve 8811A (8811B analogous)	Fails to open on demand	Recirculation - cold legs of RC loops	Failure reduces redundancy of providing fluid from the containment sump to the RCS during recirculation. LHSI/RHR pump 1 will not provide recirculation flow. Minimum LHSI flow requirements will be met through opening of isolation valve 8811B and recirculation of fluid by LHSI/RHR pump 2.	Same methods of detection as those stated for item 2. In addition, failure may be detected through monitoring of RHR pump return line to cold legs flow indication (FI-618) and RHR pump discharge pressure (PI-614) at MCB.	Valve is actuated to open by an SIS in coincidence with two out of four "low-low-1 level" RWST signals. Valve is electrically interlocked from remotely being opened from MCB by isolation valves 8812A, 8701A, and 8702A.
12.	Motor-operated gate valve 8812A (8812B analogous)	Fails to close on demand	Recirculation - cold legs of RC loops	Failure reduces redundancy of providing flow isolation of containment sump from RWST. No effect on safety for system operation. Alternate check isolation valve 8958A provides back-up isolation.	Same methods of detection as those stated for item 1.	Valve is electrically interlocked with isolation valve 8811A and may not be opened unless valve 8811A is closed.
13.	Motor operated gate valve 8716A (8716B analogous)	Fails to close on demand	Recirculation - cold legs of RC loops	Failure reduces redundancy of providing LHSI/RHR pump train separation for recirculation of fluid to cold legs of RCS. No effect on safety for system operation. Alternate isolation valve 8716B provides back-up isolation for LHSI/RHR pump train separation.	Same methods of detection as those stated for item 1.	

TABLE 6.3-5 (Sheet 6)

	Component***	Failure Mode	ECCS Operation Phase	Effect On System Operation*	Failure Detection Method**	Remarks
14.	Motor-operated globe valve 8813	Fails to close on demand	Recirculation - cold legs of RC loops	Failure reduces redundancy of providing isolation of HHSI/SI pumps miniflow line isolation from RWST. No effect on safety for system operation. Alternate isolation valve 8814A and 8814B in each pumps miniflow line provide back-up isolation.	Same methods of detection as those stated for item 1.	Valve is electrically interlocked with isolation valves 8804A and 8804B and may not be opened unless these valves are closed.
15.	Motor-operated globe valve 8814A (8814B analogous)	Fails to close on demand	Recirculation - cold legs of RC loops	Failure reduces redundancy of providing isolation of HHSI/SI pump 1 miniflow isolation from RWST. No effect on safety for system operation. Alternate isolation valve 8813 in main miniflow line provides back-up isolation.	Same methods of detection as those stated for item 1.	Same remark as that stated for item 16.
16.	Motor-operated gate valve 8804A	Fails to open on demand	Recirculation - cold legs of RC loops	Failure reduces redundancy of providing NPSH to suction of HHSI/CH pumps from LHSI/RHR pumps. No effect on safety for system operation. Minimum NPSH to HHSI/CH pump suction will be met by flow from LHSI/RHR pump 2 via cross-tie line and opening of isolation valve 8807A or 8807B and isolation valve 8804B.	Same methods of detection as those stated for item 2.	Valve is electrically interlocked with isolation valves 8814A, 8814B, 8813, 8701A and 8702A. Valve cannot be opened unless valve 8813 or valves 8814A and 8814B are closed and valve 8701A or 8702A is closed.

TABLE 6.3-5 (Sheet 7)

	Component***	Failure Mode	ECCS Operation Phase	Effect On System Operation*	Failure Detection Method**	Remarks
17.	Motor-operated gate valve 8804B	Fails to open on demand	Recirculation - cold legs of RC loops	Failure reduces redundancy of providing NPSH to suction of HHSI/SI pumps from LHSI/RHR pumps. No effect on safety for system operation. Minimum NPSH to HHSI/SI pump suction will be met by flow from LHSI/RHR pump 1 via cross-tie line and opening of isolation valve 8807A or 8807B and isolation valve 8804A. closed.	Same methods of detection as those stated for item 2.	Valve is electrically interlocked with isolation valves 8814A, 8814B, 8813, 8701B, and 8702B. Valve cannot be opened unless valve 8813 or valves 8814A and 8814B are closed and valve 8701B or 8702B is
18.	Motor-operated gate valve 8807A (8807B analogous)	Fails to open on demand	Recirculation - cold legs of RC loops	Failure reduces redundancy of providing fluid flow through cross-tie between suction of HHSI/CH pumps and HHSI/SI pumps. No effect on safety for system operation. Alternate isolation valve 8807B open to provide back-up flow path through cross-tie line.	Same methods of detection as those stated for item 2.	
19.	Motor-operated gate valve 8806A (8806B analogous)	Fails to close on demand	Recirculation - cold legs of RC loops	Failure reduces redundancy of providing flow isolation of HHSI/SI pump suction from RWST. No effect on safety for system operation. Alternate check isolation valve 8926A provides back-up isolation.	Same methods of detection as those stated for item 1.	
20.	Motor-operated gate valve LCV-112D (LCV-112E analogous)	Fails to close on demand	Recirculation - cold legs of RC loops	Failure reduces redundancy of providing flow isolation of suction of HHSI/CH pumps from RWST. No effect on safety for system operation. Alternate check isolation valve 8546 provides back-up isolation.	Same methods of detection as those stated for item 2.	

TABLE 6.3-5 (Sheet 8)

	Component***	Failure Mode	ECCS Operation Phase	Effect On System Operation*	Failure Detection Method**	Remarks
21.	RHR pump 1 (pump 2 analogous)	Fails to deliver working fluid	Recirculation - cold legs of RC loops	Failure reduces redundancy of providing recirculation of coolant to the RCS from the containment sump. Fluid flow from LHSI/RHR pump 1 will be lost. Minimum recirculation flow requirements for LHSI flow will be met by LHSI/RHR pump 2 delivering working fluid.	Same methods of detection as those stated for item 11.	
22.	SI pump 1 (pump 2 analogous)	Fails to deliver working fluid	Recirculation - cold or hot legs of RC loops	Failure reduces redundancy of providing recirculation of coolant to the RCS from the containment sump to cold legs of RC loops via RHR and SI pumps. Fluid flow from HHSI/SI pump 1 will be lost. Minimum recirculation flow requirements for HHSI flow will be met by HHSI/SI pump 2 delivering working fluid.	Same methods of detection as those stated for item 12.	
23.	Motor-operated gate valve 8809A	Fails to close on demand	Recirculation - hot legs of RC loops	Failure reduces redundancy of providing recirculation of coolant to the RCS from the containment sump to hot legs of RC loops. Fluid flow from LHSI/RHR pump 1 will continue to flow to cold legs of RC loops. Minimum recirculation flow requirements to hot legs of RC loops will be met by LHSI/RHR pump 2 recirculation fluid to RC hot legs via HHSI/SI pumps.	Same methods of detection as those stated for item 1.	

TABLE 6.3-5 (Sheet 9)

	Component***	Failure Mode	ECCS Operation Phase	Effect On System Operation*	Failure Detection Method**	Remarks
24.	Motor-operated gate valve 8716A (8716B analogous)	Fails to open on demand	Recirculation - hot legs of RC loops	Failure reduces redundancy of providing recirculation of coolant to the RCS from the containment sump to the hot legs of RC loops. Fluid flow from LHSI/RHR pump 1 will be lost. Minimum recirculation flow requirements to hot legs of RC loops will be met by LHSI/RHR pump 2 recirculating fluid to RC hot legs via HHSI/SI pumps.	Valve position indication (closed to open position change) at MCB. Valve close position monitor light and alarm at MCB. In addition, RHR pump discharge pressure (PI-614) at MCB.	
25.	Motor-operated gate valve 8840	Fails to open on demand	Recirculation - hot legs of RC loops	Same effect on system operation as that stated for item 26.	Same methods of detection as those stated for item 2. In addition, RHR pump discharge pressure (PI-614) at MCB.	
26.	Motor-operated gate valve 8809B	Fails to close on demand	Recirculation - hot legs of RC loops	Failure reduces redundancy of providing recirculation of coolant to the RCS from the containment sump to the hot legs of RC loops. Fluid flow from LHSI/RHR pump 2 will continue to flow to cold legs of RC loops. Minimum recirculation flow requirements to hot legs of RC loops will be met by LHSI/RHR pump 1 recirculating fluid to RC hot legs.	Same methods of detection as those stated for item 1.	
27.	Motor-operated gate valve 8821A (8821B analogous)	Fails to close on demand	Recirculation - hot legs of RC loops	Failure reduces redundancy of providing flow isolation of HHSI/SI pump flow to cold legs of RC loops. No effect on safety for system operation. Alternate isolation valve 8835 provides back-up isolation against flow to cold legs of RC loops.	Same methods of detection as those stated for item 1.	

TABLE 6.3-5 (Sheet 10)

	Component***	Failure Mode	ECCS Operation Phase	Effect On System Operation*	Failure Detection Method**	Remarks
28.	Motor-operated gate valve 8802A (8802B analogous)	Fails to open on demand	Recirculation - hot legs of RC loops	Failure reduces redundancy of providing recirculation of coolant to the hot legs of RCS from the containment sump via HHSI/SI pumps. Minimum recirculation flow requirements to hot legs of RC loops will be met by LHSI/RHR pump 1 recirculating fluid from containment sump to hot legs of RC loops and HHSI pump 2 recirculating fluid to hot legs 1 and 4 of RC loops through the opening of isolation valve 8802B.	Same methods of detection as those stated for item 2. In addition, SI pump discharge pressure (PI-919) and flow (FI-918) at MCB.	
29.	Motor-operated gate valve 8835	Fails to close on demand	Recirculation - hot legs of RC loops	Failure reduces redundancy of providing flow isolation of HHSI/SI pump flow to cold legs of RC loops. No effect on safety for system operation. Alternate isolation valves 8821A and 8821B in cross-tie line between HHSI/SI pumps provide back-up isolation against flow to cold legs of RC loops.	Same methods of detection as those stated for item 1.	
30.	RHR pump 1 (pump 2 analogous)	Fails to deliver working fluid	Recirculation - hot legs of RC loops	Failure reduces redundancy of providing recirculation of coolant to the RCS from the containment sump to the hot legs of RC loops. Fluid flow from LHSI/RHR pump 1 will be lost. Minimum flow requirements to hot legs of RC loop will ve met by LHSI/RHR pump 2 recirculating fluid to RC hot legs via HHSI/SI pumps.	Same methods of detection as those stated for item 11.	

TABLE 6.3-5 (Sheet 11)

<u>List of acronyms and abbreviations</u>

BIT - Boron injection tank
BIST - Boron injection surge tank
CH - Charging
HHSI - High head safety injection
LHSI - Low head safety injection
MCB - Main control board
NPSH - Net positive suction head
RC - Reactor coolant
RCD - Reactor coolant system
RHR - Residual heat removal
RWST - Refueling water storage tank
SI - Safety Injection
VCT - Volume control tank

TABLE 6.3-6

SINGLE ACTIVE FAILURE ANALYSIS FOR EMERGENCY CORE COOLING SYSTEM COMPONENTS

Component	Malfunction	Comments
Injection Phase		
1. Pumps		
a. Centrifugal charging	Fails to start	Two provided; evaluation based on operation of one.
b. Safety injection	Fails to start	Two provided; evaluation based on operation of one.
c. Residual heat removal	Fails to start	Two provided; evaluation based on operation of one.
2. Automatically operated valves		
a. Boron injection tank isolation		
(1) Inlet	Fails to open	Two parallel paths; each path consisting of two isolation valves in parallel lines; one valve in either line required to open.
(2) Outlet	Fails to open	Two parallel lines; one valve in either line required to open.

TABLE 6.3-6 (Sheet 2)

Component	Malfunction	Comments
b. Centrifugal charging pumps		
(1) Suction line from refueling water storage tank	Fails to open	Two parallel valves; only one valve required to open.
(2) Discharge line to the normal charging path	Fails to close	Two valves in series; only one valve required to close.
(3) Miniflow bypass line	Fails to close	Two parallel valves; only one valve required to close.
(4) Suction from volume control tank	Fails to close	Two valves in series; only one valve required to close.
Recirculation Phase		
1. Valves operated automatically during switchover to recirculation		
a. Residual heat removal pumps		
(1) Suction line from containment sump	Fails to open	Two parallel lines; only one valve in either line required to open.
(2) Suction line from refueling water storage tank	Fails to close	Check valve in series with a gate valve in each parallel line; operation of only one valve in each line required.

TABLE 6.3-6 (Sheet 3)

Component	Malfunction	Comments
2. Valves operated manually from the control room		
a. Safety injection pump suction line from refueling water storage tank	Fails to close	Check valve in series with two gate valves in each parallel line; operation of only one valve in each line required.
b. Centrifugal charging pump suction line from refueling water storage tank	Fails to close	Check valve in series with a gate valve in each parallel line; operation of only one valve in each line required.
c. High head pump suction line at discharge of residual heat exchanger	Fails to open	Separate and independent paths to safety injection pumps and charging pumps take suction from discharge of residual heat exchangers; operation of only one valve required.
d. Residual heat removal cross-connect line	Fails to close	Two valves in series; operation of one required.
e. Safety injection pump miniflow lines	Fails to close	Two parallel valves provided in series with a third; operation of either both parallel valves or the single series valve required.
f. Safety injection/charging cross-connect line in suction header	Fails to open	Two parallel valves provided; operation of one required.
g. Safety injection/residual heat removal hot leg isolation valves	Fails to open	Three flow paths available; adequate flow to core is assured by any two.
h. Safety injection/residual heat removal cold leg isolation valves	Fails to close	Redundant valves provided with suitable arrangements.

TABLE 6.3-7

EMERGENCY CORE COOLING SYSTEM RECIRCULATION PIPING PASSIVE FAILURE ANALYSIS LONG-TERM PHASE

Flow Path	Indication of Loss of Flow Path	Alternate Flow Path
Low Head Recirculation		
From containment sump to low head injection header via the residual heat removal pumps and the residual heat exchangers	Accumulation of water in a residual heat removal pump compartment or auxiliary building sump	Via the independent, identical low head flow path, utilizing the second residual heat exchanger and residual heat removal pump
High Head Recirculation		
From containment sump to the high head injection header via residual heat removal pump, residual heat exchanger, and the high head injection pumps	Accumulation of water in a residual heat removal pump compartment or the auxiliary building sump	From containment sump to the high head injection headers via alternate residual heat removal pump, residual heat ex-injection, or charging pump

TABLE 6.3-8

SEQUENCE OF CHANGEOVER OPERATION FROM INJECTION TO RECIRCULATION

Without being stopped, the RHR pumps are realigned for the recirculation mode by the automatic opening of the sump isolation valves, which occurs upon receipt of the RWST low-low-1 level signal and an SIS. The isolation valve in each RHR suction line from the RWST is then automatically closed. At the same time, the Component Cooling Water System is automatically aligned to provide cooling to the RHR heat exchanger, and to terminate flow to the fuel pool cooling heat exchangers. The following remote manual operator actions from the control room are required to complete the changeover operation from the injection mode to the recirculation mode.

1. Close the two remote motor-operated valves in the crossover line downstream of the residual heat removal heat exchangers (8716 A and B).

2. Close the three motor-operated isolation valves in the safety injection pump miniflow lines (8814 A and B; 8813).

3. Open the motor-operated valve in the line from the A RHR pump discharge to the charging pump suction and the motor-operated valve in the line from the B RHR pump discharge to the safety injection pump suction (8804 A and B).

4. Open the two parallel motor-operated valves in the common suction line between the charging pump suction and the safety injection pump suction (8807 A and B).

5. Close the two parallel motor-operated valves in the line from the RWST to the charging pump suction and the valves in the line from the RWST to the safety injection pump suction (LCV 112 D and E; 8806 A and B).

NOTE: These operator actions do not include all the steps listed in the emergency operating procedures. The operators are trained to accomplish the ECCS pumps switchover in timely manner within the available time.

TABLE 6.3-9

EMERGENCY CORE COOLING SYSTEM SHARED FUNCTIONS EVALUATION

Component	Normal Operating Arrangement	Accident Arrangement
Refueling water storage tank	Lined up to suction of safety injection and residual heat removal pumps	Lined up to suction of centrifugal charging, safety injection and residual heat removal pumps
Centrifugal charging pumps	Lined up for charging service suction from volume control tank, discharge via normal charging line	Suction from refueling water storage tank, discharge lined up to inlet of boron injection tank. Valves for realignment meet single failure criteria
Residual heat removal pumps	Lined up to cold legs of reactor coolant piping	Lined up to cold legs of reactor coolant piping
Residual heat exchangers	Lined up to cold legs of reactor coolant piping	Lined up to cold legs of reactor coolant piping

TABLE 6.3-10

NORMAL OPERATING STATUS OF EMERGENCY CORE COOLING SYSTEM COMPONENTS FOR CORE COOLING

Number of safety injection pumps operable	2
Number of centrifugal charging pumps operable	2
Number of RHR pumps operable	2
Number of RHR heat exchangers operable	2
RWST volume, gallons, min maintained	394,000
Boron concentration in RWST, ppm (range)	2,400 to 2,500
Boron concentration in accumulator tank, ppm (range)	2,300 to 2,500
Number of accumulator tanks	4
Minimum accumulator pressure, psig	585
Nominal accumulator water volume, ft^3	850
System valves, interlocks, and piping required for the above components which are operable	All

TABLE 6.3-11

RWST OUTFLOW (LARGE BREAK) - NO FAILURES

Auto/Manual Actions	Min Time Available (Min)	RWST Outflow (gals)	RWST Volume Avail Min/Max (gals)
Transfer suction of RHR pumps to containment recirculation sumps (Automatic); Reset SIS; Transfer suction of CCPs and SIPs to the discharge of RHRHX; Reset CIS Phases A and B and CSS actuation.	9.46	90,469	90,469/107,711
Transfer suction of CSPs to containment recirculation sumps	2.18	11,930	11,930/31,756

NOTES:

(1) See Table 6.3-8 for additional details for the transfer of ECCS pumps for cold leg recirculation.

(2) See Table 6.2.2-3 for a description of CSPs switchover.

(3) The operators are trained to accomplish the switchover of the ECCS and CSS pumps within the available time per emergency operating procedures.

(4) The RWST volume available is the minimum and maximum volumes of water between Lo-Lo-1 and Lo-Lo-2 or Lo-Lo-2 and Empty level setpoints.

(5) The minimum time available is based on the RWST outflow and maximum RWST depletion rate.

TABLE 6.3-12

RWST OUTFLOW (LARGE BREAK) - WORST SINGLE FAILURE

Auto/Manual Actions	Min Time Available (Min)	RWST Outflow (gals)	RWST Volume Avail Min/Max (gals)
Transfer suction of RHR pumps to containment recirculation sumps (Automatic); Reset SIS; Secure the affected RHR pump and sump valve of the train with the failed valve; Transfer suction of CCPs and SIPs to the discharge of RHR pumps; Reset CIS Phases A and B and CSS actuation.	8.15	90,469	90,469/107,711
Transfer suction of CSPs to containment recirculation sumps	2.18	11,930	11,930/31,756

NOTES:

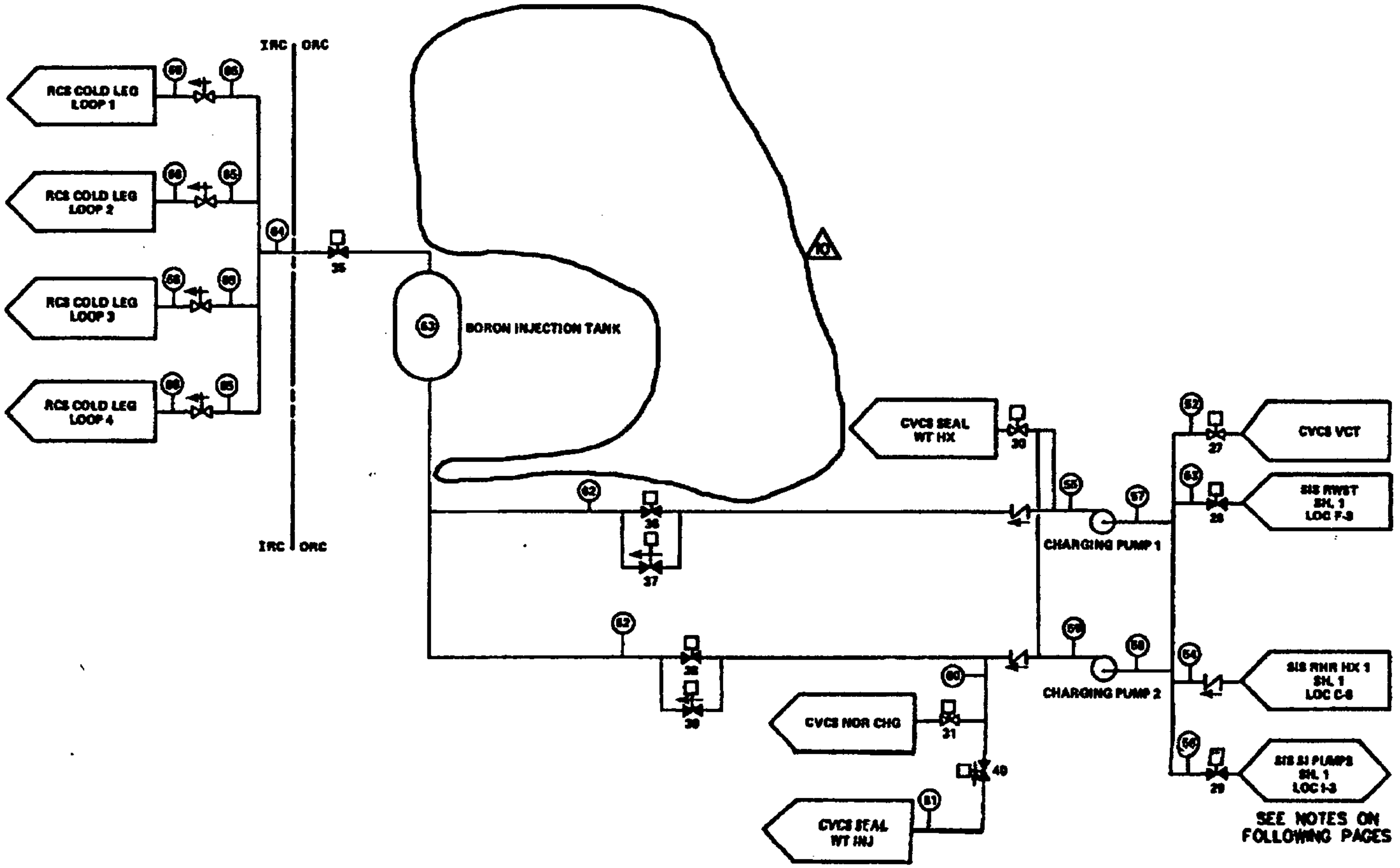
(1) The worst single active failure is the failure of one of the RWST supply valves to RHR pumps to close following the opening of containment recirculation sump valves. The opertor mitigates the consequences of this failure by securing the affected RHR pump and the associated containment recirculation sump valve.

(2) If a single active failure of Valves BNHV0003 or BNHV0004 were to occur (valve fails to close), the operator has 2.25 minutes for accomplishing the switchover of the CSS pumps and secure the pump on the faulted train. The risk associated with this failure is minimal as only one train is required for protection.

(3) The operators are trained to accomplish the switchover of the ECCS and CSS pumps within the available time per emergency operating procedures.

(4) The RWST volume available is the minimum and maximum volumes of water between Lo-Lo-1 and Lo-Lo-2 or Lo-Lo-2 and Empty level setpoints.

(5) The minimum time available is based on the RWST outflow and maximum RWST depletion rate.



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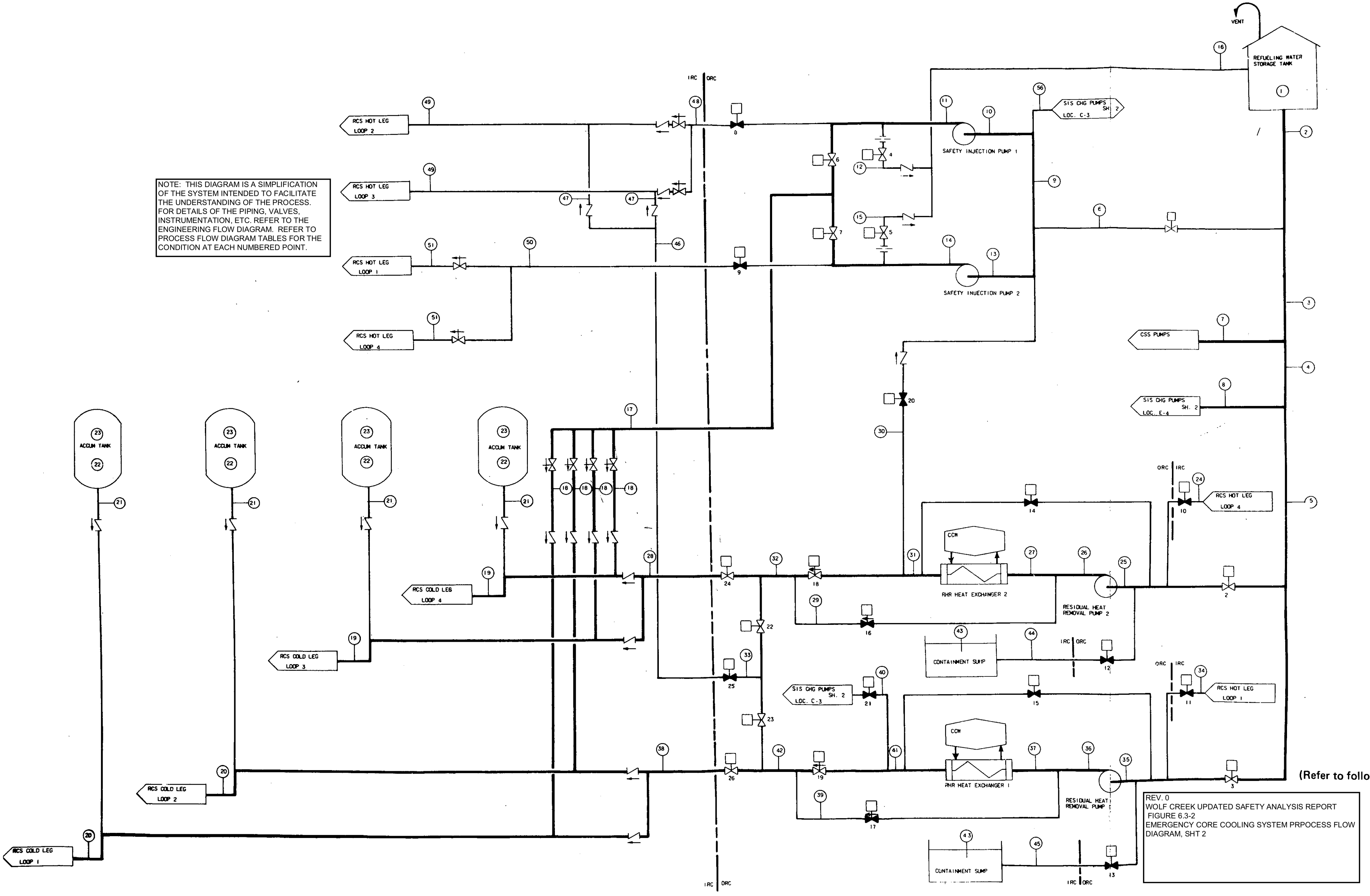
UPDATED SAFETY ANALYSIS REPORT

FIGURE 6.3-2 (SHEET 1)

EMERGENCY CORE COOLING SYSTEM
PROCESS FLOW DIAGRAM



NOTE: THIS DIAGRAM IS A SIMPLIFICATION OF THE SYSTEM INTENDED TO FACILITATE THE UNDERSTANDING OF THE PROCESS. FOR DETAILS OF THE PIPING, VALVES, INSTRUMENTATION, ETC. REFER TO THE ENGINEERING FLOW DIAGRAM. REFER TO PROCESS FLOW DIAGRAM TABLES FOR THE CONDITION AT EACH NUMBERED POINT.

(Refer to following notes)

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FIGURE 6.3-2
EMERGENCY CORE COOLING SYSTEM PRPOCESS FLOW DIAGRAM, SHT 2

NOTES TO FIGURE 6.3-2

MODES OF OPERATION

Mode A - Injection

This mode presents the process conditions for the case of maximum safeguards, i.e., all pumps operating, following accumulator delivery. Two residual heat removal (RHR) pumps, two safety injection (SI) pumps, and two centrifugal charging (CC) pumps operate, taking suction from the RWST and delivering to the reactor through the cold leg connections. Note that the flow from each pump is less than its maximum runout since the pump discharge piping is shared by the two pumps of each subsystem. Note also that the SI pump branch connections to the residual lines are assumed very close to their discharge into the accumulator lines, thereby eliminating any increase in RHR branch line head loss due to the combined flows of the RHR and SI pumps. The RHR line resistance was assumed to be the minimum of the allowable bank presented in the limiting pressure drop and elevation head design requirements, allowing maximum RHR injection flow.

Mode B - Cold Leg Recirculation

This mode presents the process conditions for the case of cold leg recirculation, assuming RHR pump number 2 operating, SI pumps numbers 1 and 2 operating, and CC pumps numbers 1 and 2 operating.

In this mode, the ECCS pumps operate in series, with only the RHR pump capable of taking suction from the containment sump. The recirculation coolant is then delivered by the RHR pump to both of the SI pumps which deliver to the reactor through their cold leg connections and to both of the CC pumps, which deliver to the reactor through their cold leg connections. The RHR pump also delivers flow directly to the reactor through two cold legs since the RHR discharge cross-connect valves are closed when making the transfer from injection to recirculation.

Mode C - Hot Leg Recirculation

This mode presents the process conditions for the case of hot leg recirculation, assuming RHR pump number 1 operating, CC pumps numbers 1 and 2 operating, and SI pumps numbers 1 and 2 operating.

NOTES TO FIGURE 6.3-2 (Sheet 2)

In this mode, the ECCS pumps again operate in series with only the RHR pump taking suction from the containment sump. The recirculated coolant is then delivered by the RHR pump to both of the CC pumps which continue to deliver to the reactor through their cold leg connections and to both of the SI pumps which deliver to the reactor through their hot leg connections. The RHR pump also delivers directly to the reactor through two hot leg connections.

NOTES TO FIGURE 6.3-2 (Sheet 3)

VALVE ALIGNEMNT CHART

Valve No.	Operational Modes A	Operational Modes B	Operational Modes C
1	O	C	C
2	O	C	C
3	O	C	C
4	O	C	C
5	O	C	C
6	O	O	C
7	O	O	C
8	C	C	O
9	C	C	O
10	C	C	C
11	C	C	C
12	C	O	O
13	C	O	O
14	C	C	C
15	C	C	C
16	C	C	C
17	C	C	C
18	O	O	O
19	O	O	O
20	C	O	O
21	C	O	O
22	O	C	C
23	O	C	O
24	O	O	C
25	C	C	O
26	O	O	C
27	C	C	C
28	O	C	C
29	C	O	O
30	C	C	C
31	C	C	C
32	O	O	O
35	O	O	O
36	C	C	C
37	C	C	C
38	C	C	C
39	C	C	C
40	C	C	C

O - open
C - closed

NOTES TO FIGURE 6.3-2 (Sheet 4)

MODE A - INJECTION PHASE (RUNOUT CONDITIONS FOLLOWING ACCUMULATOR DELIVER)

Location	Fluid	Pressure (psig)	Temperature (F)	Flow		Volume (gal)
				(gpm)(a)	(lb/sec)	
1	Refueling water	Atm tank	100	-	-	370,000
2	"	(a)	100	16,905	2,333	-
3	"	13 psia	100	16,025	2,211	-
4	"	-	100	9,695	1,338	-
5	"	-	100	8,856	1,222	-
6	"	11 psia	100	880	121	-
7	"	-	100	6,330	873	-
8	"	>10 psia	100	839	116	-
9	"	>10 psia	100	440	61.5	-
10	"	10 psia	100	440	61.5	-
11	"	1165	100	440	61.5	-
12	"	<25	100	39	5	-
13	"	10 psia	100	440	61.5	-
14	"	1165	100	440	61.5	-
15	"	<25	100	39	5	-
16	"	-	100	78	11	-
17	"	1050	100	802	111	-
18	"	73	100	200.5	28	-
19	"	-	100	2,414.5	333	-
20	"	-	100	2,414.5	333	-
21	Borated Water	0	100	0	0	-
22	Borated Water	0	100	0	0	850 (ft^3) (b)
23	Nitrogen	0	100	0	0	500 (ft^3)
24	Reactor coolant	-	100	0	0	-

NOTES TO FIGURE 6.3-2 (Sheet 5)

Location	Fluid	Pressure (psig)	Temperature (F)	Flow		Volume (gal)
				(gpm)[(a)]	(lb/sec)	
25	Refueling water	0	100	4,428	611	-
26	"	138	100	4,428	611	-
27	"	-	100	4,428	611	-
28	"	47	100	4,428	611	-
29	"	86	100	0	0	-
30	"	-	100	0	0	-
31	"	-	100	4,428	611	-
32	"	86	100	4,428	611	-
33	"	86	100	0	0	-
34	Reactor coolant	-	100	0	0	-
35	Refueling water	0	100	4,428	611	-
36	"	138	100	4,428	611	-
37	"	-	100	4,428	611	-
38	"	47	100	4,428	611	-
39	"	86	100	0	0	-
40	"	-	100	0	0	-
41	"	-	100	4,428	611	-
42	"	86	100	4,428	611	-
43	Recirc. Coolant	Containment pressure	120	0	0	-
44	"	"	120	0	0	-
45	"	"	120	0	0	-
46	Refueling water	Low Pressure	100	0	0	-
47	"	"	100	0	0	-
48	"	"	100	0	0	-
49	"	"	100	0	0	-
50	"	"	100	0	0	-

NOTES TO FIGURE 6.3-2 (Sheet 6)

Location	Fluid	Pressure (psig)	Temperature (F)	Flow (gpm)[a]	Flow (lb/sec)	Volume (gal)
51	Refueling water	Low pressure	100	0	0	-
52	"	"	100	0	0	-
53	"	>10 psia	100	839	116	-
54	"	-	100	0	0	-
55	"	1,519	100	419	58	-
56	"	-	100	0	0	-
57	"	10 psia	100	419	58	-
58	"	10 psia	100	419	58	-
59	"	1,519	100	419	58	-
60	"	1,516	100	124	17	-
61	"	~0	100	124	17	-
62	"	1,456	100	714	99	-
63	2000 ppm boron	-	100	714	99	900
64	Refueling water	1,396	100	714	99	-
65	"	1,008	100	178.5	24.6	-
66	"	388	100	178.5	24.6	-

NOTES:

(a) At reference conditions, 100 F and 0 psig

(b) Minimum allowable volume at normal operating conditions

NOTES TO FIGURE 6.3-2 (Sheet 7)

MODE B - COLD LEG RECIRCULATION (PUMP NUMBER 2 OPERATING)

Location	Fluid	Pressure (psig)	Temperature (F)	Flow		Volume (gal)
				(gpm)$^{(a)}$	(lb/sec)	
1	Refueling water	Atm tank	100	-	-	<5000
2	"	-	100	0	0	-
3	"	-	100	0	0	-
4	"	-	100	0	0	-
5	"	-	100	0	0	-
6	Recirc. coolant	-	186	0	0	-
7	Refueling water	-	100	0	0	-
8	"	-	100	0	0	-
9	Recirc. water	~35	186	1,278	170	-
10	"	~35	186	440	59	-
11	"	~1,165	186	~440	59	-
12	Refueling water	-	100	0	0	-
13	Recirc. coolant	~35	186	440	59	-
14	"	~1,165	186	~440	59	-
15	Refueling water	-	100	0	0	-
16	"	-	100	0	0	-
17	Recirc. coolant	1,050	186	880	117	-
18	"	73	186	220	29	-
19	"	-	186	1,761	235	-
20	"	-	186	220	29	-
21	Nitrogen	0	Ambient	0	0	-
22	Nitrogen	0	Ambient	0	0	950(ft^3)$^{(b)}$
23	"	0	Ambient	0	0	400(ft^3)

NOTES TO FIGURE 6.3-2 (Sheet 8)

Location	Fluid	Pressure (psig)	Temperature (F)	Flow (gpm)(a)	Flow (lb/sec)	Volume (gal)
24	Recirc. coolant	-	212	0	0	-
25	"	~12	212	4,800	640	-
26	"	113	212	4,800	640	-
27	"	-	212	4,800	640	-
28	"	29	186	3,082	411	-
29	"	56	186	0	0	-
30	"	60	186	1,718	229	-
31	"	65	186	4,800	640	-
32	"	55	186	3,082	411	-
33	"	0	186	0	0	-
34	"	-	212	0	0	-
35	Refueling water	-	100	0	0	-
36	"	-	100	0	0	-
37	"	-	100	0	0	-
38	"	-	100	0	0	-
39	"	-	100	0	0	-
40	"	-	100	0	0	-
41	"	-	100	0	0	-
42	"	-	100	0	0	-
43	Recirc. coolant	Containment pressure	212	-	-	~350,000
44	"	"	212	4,800	640	-
45	"	"	212	0	0	-
46	Refueling water	Low pressure	100	0	0	-
47	"	"	100	0	0	-
48	"	"	100	0	0	-
49	"	"	100	0	0	-
50	"	"	100	0	0	-

NOTES TO FIGURE 6.3-2 (Sheet 9)

Location	Fluid	Pressure (psig)	Temperature (F)	Flow (gpm)[a]	Flow (lb/sec)	Volume (gal)
51	Refueling water	Low pressure	100	0	0	-
52	Recirc. Coolant	-	186	0	0	-
53	"	-	186	0	0	-
54	"	-	186	0	0	-
55	"	~1519	186	~1,419	56	-
56	"	730	186	838	111	-
57	"	~30	186	419	56	-
58	"	~30	186	419	56	-
59	"	~1,519	186	419	56	-
60	"	1,516	186	124	16	-
61	"	0	186	124	16	-
62	"	1,456	186	714	95	-
63	"	-	186	714	95	-
64	Recirc. Coolant	1,396	186	714	95	-
65	"	1,008	186	178.5	24	-
66	"	388	186	178.5	24	-

NOTES:

(a) At reference conditions, 212 F and 0 psig

(b) Minimum water volume at operating conditions.

NOTES TO FIGURE 6.3-2 (Sheet 10)

Location	Fluid	Pressure (psig)	Temperature (F)	Flow (gpm)[a]	Flow (lb/sec)	Volume (gal)
1	Refueling water	Atm tank	100	-	-	<5000
2	"	-	100	0	0	-
3	"	-	100	0	0	-
4	"	-	100	0	0	-
5	"	-	100	0	0	-
6	Recirc. Coolant	-	182	0	0	-
7	Refueling water	-	100	0	0	-
8	"	-	100	0	0	-
9	Recirc. Coolant	~25	<186	660	88	-
10	"	~25	<186	660	88	-
11	"	~715	<186	660	88	-
12	Refueling water	-	100	0	0	-
13	Recirc. Coolant	~25	<186	660	88	-
14	"	~715	<186	660	88	-
15	Refueling water	-	100	0	0	-
16	"	-	100	0	0	-
17	Recirc. Coolant	0	<186	0	0	-
18	"	-	<186	0	0	-
19	"	-	186	0	0	-
20	"	-	186	0	0	-

NOTES TO FIGURE 6.3-2 (Sheet 11)

Location	Fluid	Pressure (psig)	Temperature (F)	Flow		Volume (gal)
				(gpm)(a)	(lb/sec)	
21	Nitrogen	-	Ambient	0	0	-
22	Nitrogen	0	Ambient	0	0	950 (ft^3) (b)
23	"	0	Ambient	0	0	400 (ft^3)
24	Recirc. Coolant	-	212	0	0	-
25	"	-	<212	0	0	-
26	"	-	<212	0	0	-
27	"	-	<212	0	0	-
28	"	-	<186	0	0	-
29	"	-	<186	0	0	-
30	"	-	<186	0	0	-
31	"	-	<186	0	0	-
32	"	-	<186	0	0	-
33	"	50	<186	2,641	352	-
34	"	-	212	0	0	-
35	"	12	212	4,800	640	-
36	"	113	212	4,800	640	-
37	"	-	212	4,800	640	-
38	"	-	<186	0	0	-
39	"	55	<186	0	0	-
40	"	60	<186	2,158	288	-
41	"	65	<186	4,800	640	-
42	"	55	<186	2,641	352	-
43	Recirc. Coolant	Containment pressure	212	-	-	-
44	"	"	212	0	0	-
45	"	"	212	4,800	640	-
46	"	7	<186	2,642	352	-
47	"	5	<186	1,321	176	-
48	"	645	<186	660	88	-
49	"	-	<186	1,651	220	-
50	"	645	<186	660	88	-

NOTES TO FIGURE 6.3-2 (Sheet 12)

Location	Fluid	Pressure (psig)	Temperature (F)	Flow (gpm)[a]	Flow (lb/sec)	Volume (gal)
51	"	-	<186	330	44	-
52	"	-	<186	0	0	-
53	"	-	<186	0	0	-
54	"	-	<186	2,158	288	-
55	"	~1,519	<186	419	56	-
56	"	<35	<186	1,320	180	-
57	"	~35	<186	418	56	-
58	"	~35	<186	419	56	-
59	"	~1,519	<186	419	56	-
60	"	1,516	<186	124	16	-
61	"	~0	<186	124	16	-
62	"	1,456	<186	714	95	-
63	-	-	<186	714	95	-
64	Recirc. Coolant	1,896	<186	714	95	-
65	"	1,008	<186	178.5	24	-
66	"	388	<186	178.5	24	-

NOTES:

(a) At reference conditions, 212F and 0 psig.

(b) Minimum water volume at operating conditions.

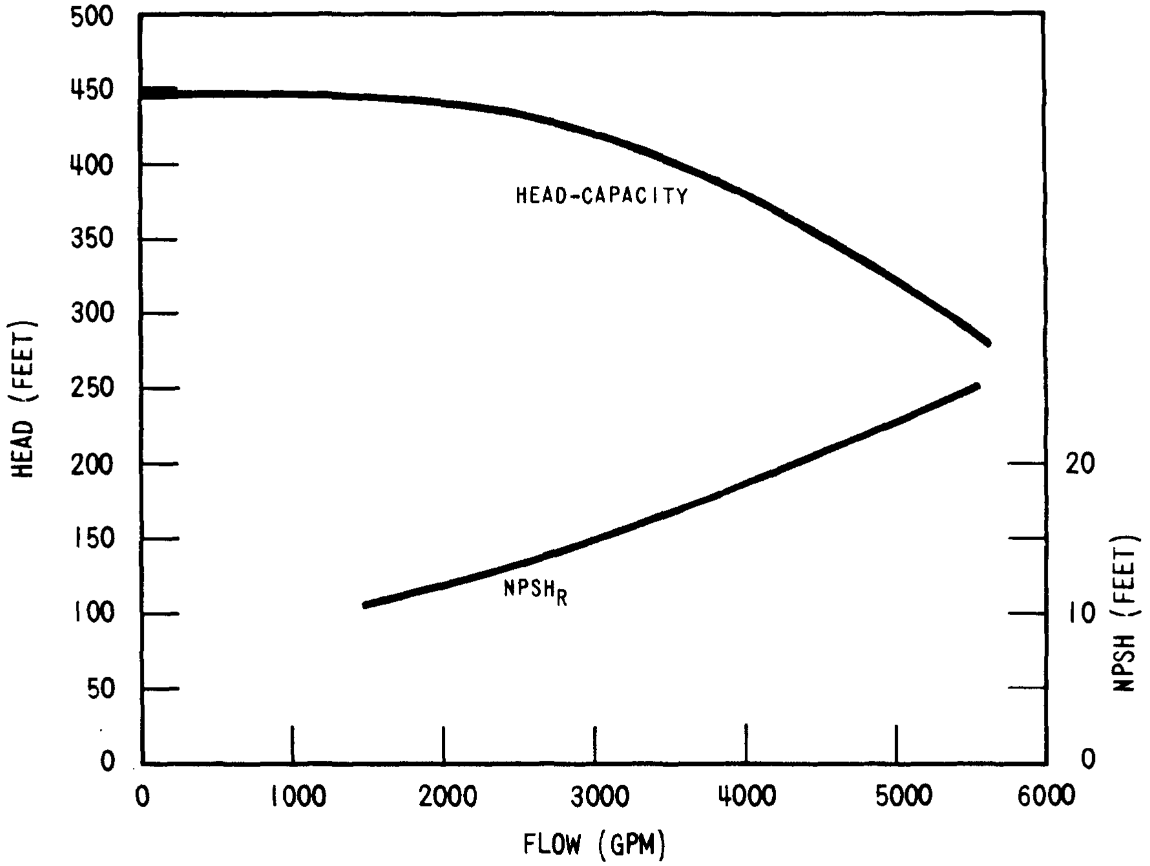

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FIGURE 6.3-3

TYPICAL RESIDUAL HEAT REMOVAL PUMP PERFORMANCE CURVE

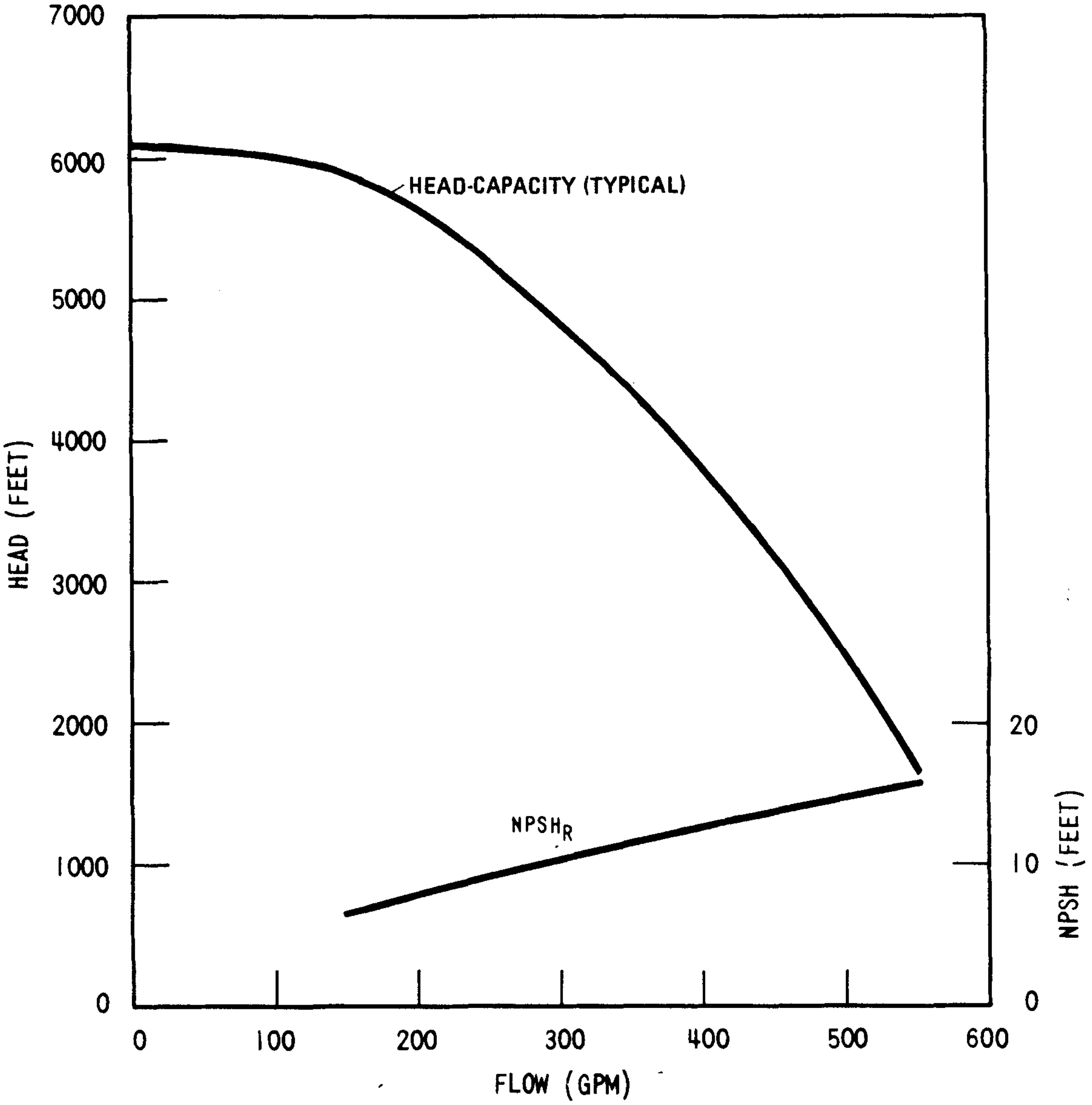

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FIGURE 6.3-4

TYPICAL CENTRIFUGAL CHARGING PUMP PERFORMANCE CURVE

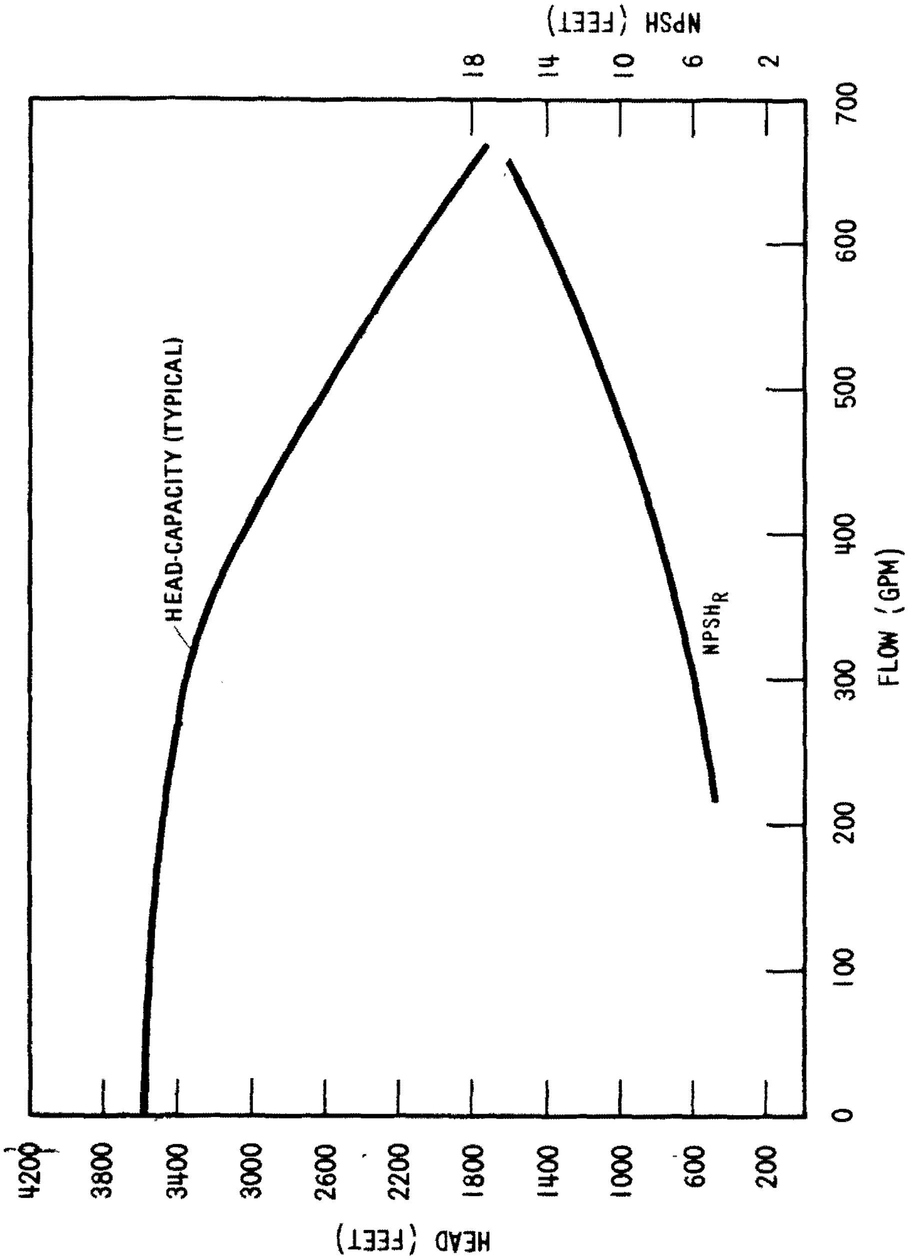

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FIGURE 6.3-5

TYPICAL SAFETY INJECTION PUMP PERFORMANCE CURVE

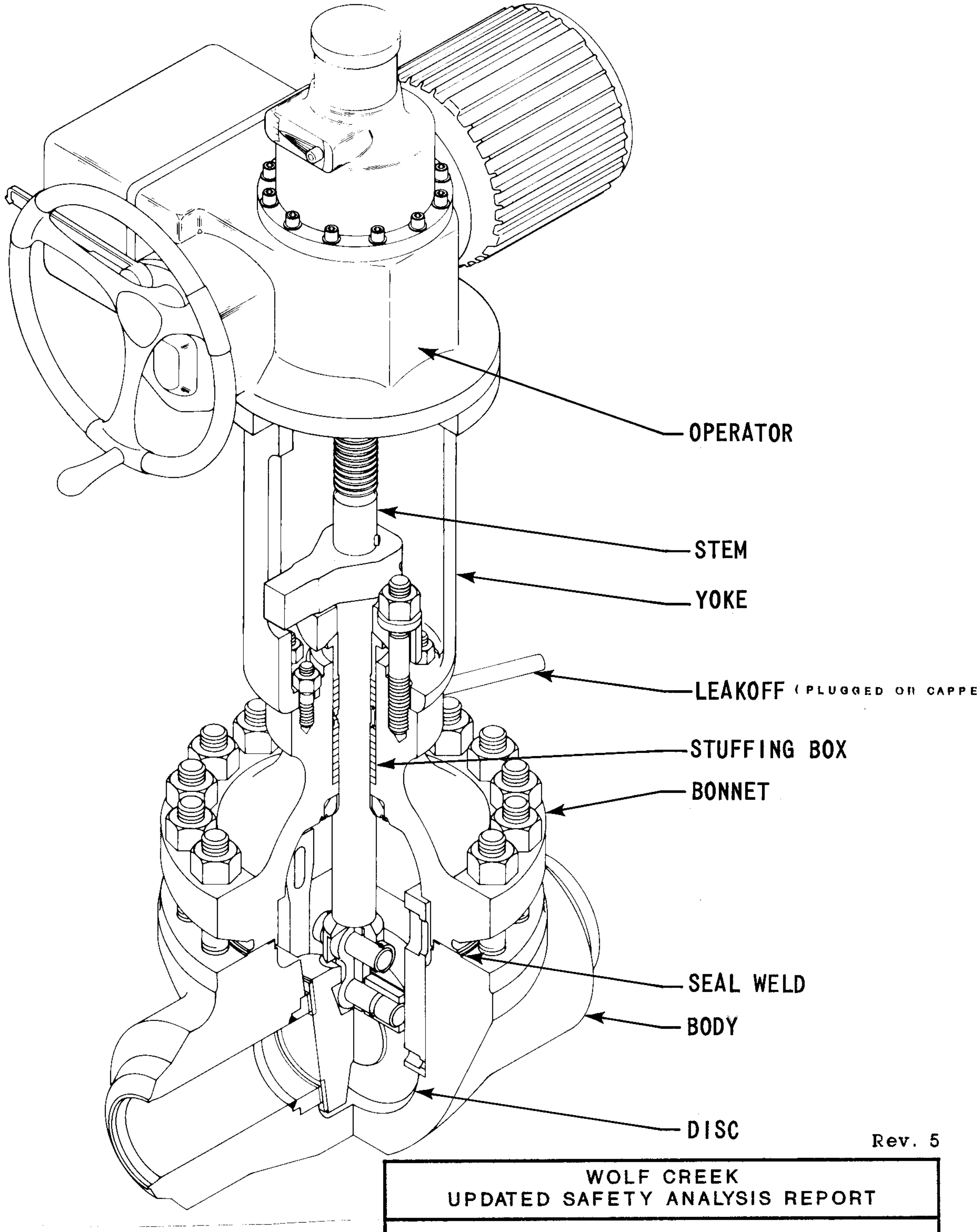

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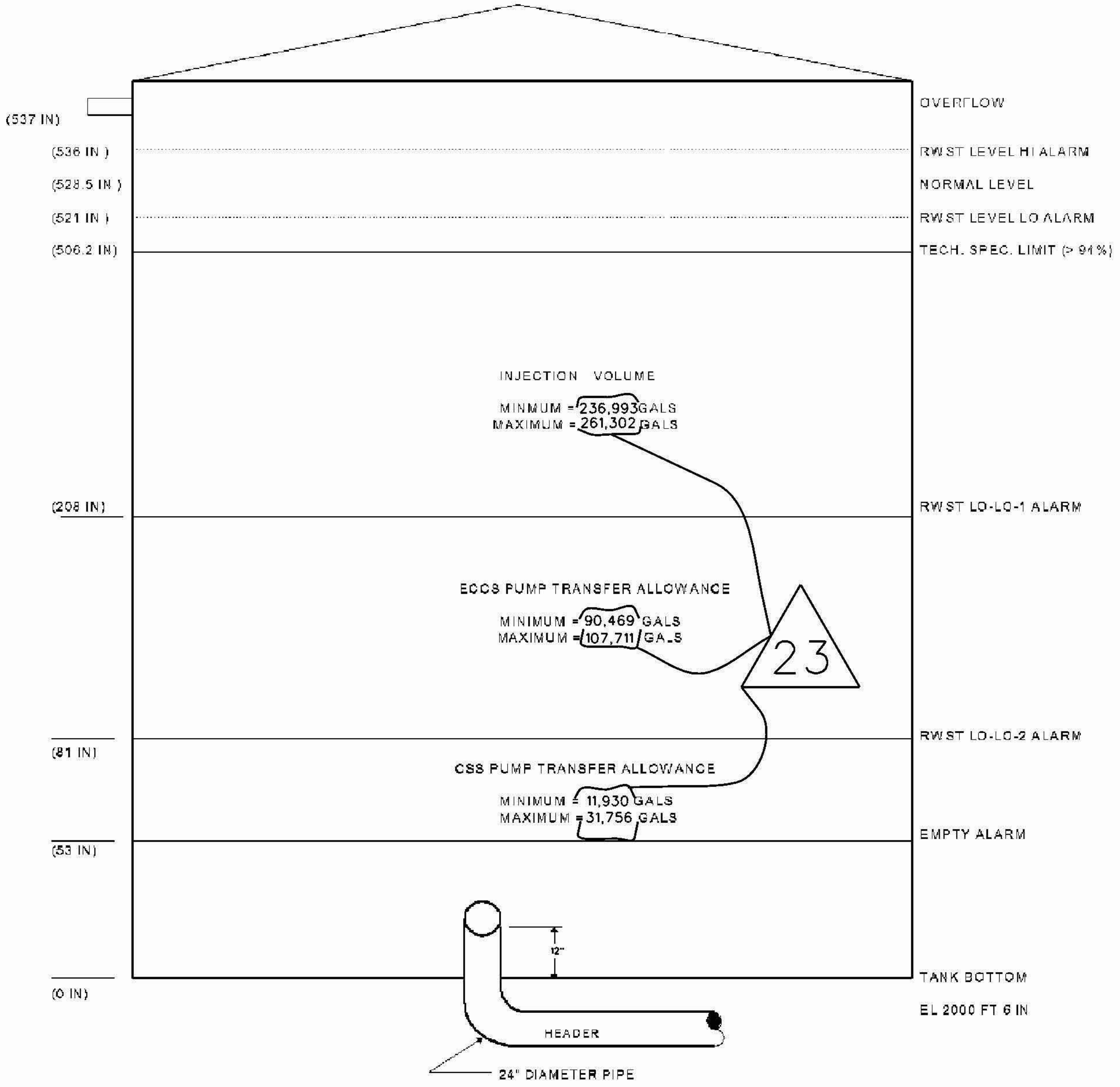
FIGURE 6.3-6

GATE VALVE ASSEMBLY



NOTES:

1. The minimum volume (394,000 gals) required by Tech. Spec. is assured by verifying that the RWST level is greater than 94 %. The maximum volume (419,000 gals) is up to the overflow nozzle.
2. The minimum/maximum volumes are dependent on instrument uncertainties. The injection volumes represent water volume between 94%level or overflow nozzle & LOLO-1, ECCS transfer volumes represent water volumes between LOLO-1 & LOLO-2 and CSS transfer volumes represent water volumes between LOLO-2 and EMPTY setpoints.
3. The RHR pumps auto switchover occurs @ LOLO-1 and the Operators initiate CSS pumps switchover @ LOLO-2.
4. Tank volume (gal./ft) is as follows:

0 in. to 184 in. - 9361 gal./ft.
184 in. to 276 in. - 9371 gal./ft.
276 in. to 368 in. - 9376 gal./ft.
368 in. to 537 in. - 9385 gal./ft.

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Figure 6.3-7

RWST LEVELS
AND VOLUMES

6.4 HABITABILITY SYSTEMS

The control room habitability systems include missile protection, radiation shielding, radiation monitoring, and smoke detection capability, control room filtration, pressurization and air conditioning, lighting, personnel support, and manual fire protection. These habitability systems are provided to permit access to and occupancy of the control room during normal plant operations, as well as during and following emergency conditions.

There is no equipment located within the control room boundary, such as batteries, which emits noxious gases.

The only potential sources for the release of any gases into the control room are the discharge of the fire extinguishers, the discharge of the Halon system into the cable trenches and chases, and leakage of the control room air-conditioning unit refrigerant. The release of any one of these gases would not result in a toxicity level which would be hazardous to the control room operators.

For a discussion of the control room ventilation, refer to USAR Section 9.4.1.

The ventilation and air-conditioning equipment discussed in this section is the same control room and control building equipment discussed in Section 9.4.1, Control Building HVAC. This section only addresses emergency service requirements and responses, including operation of control room ventilation and air-conditioning equipment under emergency conditions. Lighting systems are discussed fully in Section 9.5.3, and are not discussed herein. Other equipment and systems are described only as necessary to define their connection with control room habitability and, accordingly, reference is made to other appropriate sections.

6.4.1 DESIGN BASES

6.4.1.1 Safety Design Bases

The control room filtration, pressurization and air-conditioning systems, and the radiation monitoring system, the emergency lighting system, the isolation dampers in the control building supply air, exhaust, and access control exhaust ducting are treated as safety-related items and are required to function under emergency conditions. These habitability systems are required to function following a DBA to enable the plant operators to achieve and/or maintain the plant in a safe shutdown condition. The following safety design bases are met:

SAFETY DESIGN BASIS ONE - The habitability systems are housed within a structure capable of withstanding the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, and external missiles (GDC-2).

SAFETY DESIGN BASIS TWO - The habitability systems are designed to remain functional after an SSE and to perform their intended function following a postulated hazard, such as a fire, internal missiles, or pipe break (GDC-3 and 4).

SAFETY DESIGN BASIS THREE - Habitability system redundancy is provided so that safety functions can be performed, assuming a single active component failure coincident with a loss of offsite power.

SAFETY DESIGN BASIS FOUR - The habitability systems are designed so that the active components are capable of being tested during plant operation. Provisions are made to allow for inservice inspection of appropriate components of the control room air-conditioning system.

SAFETY DESIGN BASIS FIVE - The habitability systems are designed and fabricated according to codes consistent with the quality group classification assigned by Regulatory Guide 1.26 and the seismic category assigned by Regulatory Guide 1.29. The power supply and control functions are in accordance with Regulatory Guide 1.32.

SAFETY DESIGN BASIS SIX - The capability to isolate all nonsafety-related HVAC system penetrations of the control building boundary is provided, if required, so that the occupation and habitability of the control room will not be compromised.

SAFETY DESIGN BASIS SEVEN - The radiation exposure of control room personnel throughout the duration of any one of the postulated DBAs discussed in Chapter 15.0 does not exceed the guideline values of GDC-19.

SAFETY DESIGN BASIS EIGHT - Throughout the duration of any one of the postulated hazardous chemical releases discussed in Section 2.2 or DBAs discussed in Chapter 15.0, the habitability systems maintain the control room atmosphere at environmental conditions suitable for occupancy per GDC-19. The habitability systems comply with Regulatory Guides 1.78 and 1.95.

SAFETY DESIGN BASIS NINE - The control room ventilation system is capable of automatic transfer from its normal operational mode to its emergency mode upon detection of conditions which could result in accidental radiation exposure of control room personnel in excess of GDC-19 limits.

6.4.1.2 Power Generation Design Bases

The control room ventilation and air-conditioning system power generation design bases are discussed in Section 9.4.1.1.2.

6.4.2 SYSTEM DESIGN

6.4.2.1 Definition of Control Room Envelope

The control room envelope includes the control room and all areas in or adjacent to the control room containing plant information and equipment that may be needed during an emergency, including pantry, sanitary facilities, and Class 1E air-conditioning equipment rooms (the control room air-conditioning units are located in the Auxiliary Building).

6.4.2.2 Ventilation System Design

The control building (including the control room) HVAC systems are described in Section 9.4.1 and shown in Figure 9.4-1. Codes and standards applicable to the control building HVAC systems are listed in Table 3.2-1. Elevation and plan views are shown in Figures 1.2-25, 1.2-27, and 1.2-28.

The control room ventilation and air-conditioning system is a recirculation system. The system is designed to control the level of airborne contamination in the control room atmosphere and to control the temperature and humidity for personnel safety and comfort.

Upon actuation of the system to the emergency mode of operation, as outlined in Section 9.4.1, the control building exhaust isolation dampers and the control building supply air isolation dampers close; the air-conditioning system switches to emergency recirculation.

Redundant control room emergency pressurization systems are used to pressurize the control room envelope during emergency recirculation. Supply air and exhaust system isolation dampers close in less than 10 seconds, in accordance with Regulatory Guide 1.95.

Redundant radiation monitors are provided to control ventilation system operation. The radiation monitors are located in the control building supply air system ductwork, downstream of the supply unit.

6.4.2.3 Leaktightness

During the emergency mode of operation, the control room is maintained at an overpressure of 1/4 inch w.g. (minimum) by the control room pressurization system to prevent infiltration from surrounding areas of unfiltered air. Potential leak paths are listed in Section 9.4.1.2.3.

Detailed design calculations for control room leakage rates and required pressurization system design conditions have been performed.

For an analysis of the radiological consequences to the control room occupants in the unlikely event of a LOCA, see Section 15.6.5.

6.4.2.4 Interaction With Other Zones and Pressure-Containing Equipment

The control room envelope is isolated and pressurized during the accident involving the release of radioactive gases in the surrounding zones. The control room air-conditioning system is operated in the emergency recirculation mode, with outside filtered air used to maintain control room pressurization. The control room pressurization system maintains the control room at a slight positive pressure during emergency operation. If smoke is detected in the control building supply air system, it is alarmed in the control room.

Those doors which form part of the control room pressure boundary are designed to maintain their specified leaktightness at a positive control room pressure of ¼ inch w.g.

The use of fire extinguishers located in the control room envelope does not yield a hazardous concentration of toxic gas. Piping not connected or related to control room equipment is routed outside the pressurized boundary. Portable self-contained breathing apparatus that satisfy Regulatory Guide 1.95 guidelines are readily available for use by the control room operators.

6.4.2.5 Shielding Design

A description of the radiation sources and shielding required to maintain the habitability of the control room during normal operations and during the course of postulated accidents is provided in Section 12.3. The shielding design is based on the requirements specified in GDC-19. A plan view drawing of the control room and associated structures identifying distances and shield thicknesses is shown in Figure 12.3-3.

6.4.3 SYSTEM OPERATIONAL PROCEDURES

NORMAL MODE - Control room ventilation system operation in the normal mode is described in Section 9.4.1.2.3. Normal operation of the fire protection system is described in Section 9.5.1.2.3.

EMERGENCY MODE - Control room ventilation system operation in the emergency mode is described in Section 9.4.1.2.3.

6.4.4 DESIGN EVALUATIONS

Safety evaluations are numbered to correspond with the safety design bases.

SAFETY EVALUATION ONE - The safety-related portions of the habitability systems are located in the auxiliary and control buildings. These buildings are designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles, and other appropriate natural phenomena. Sections 3.3, 3.4, 3.5, 3.7(B), and 3.8 provide the bases for the adequacy of the structural design of these buildings.

SAFETY EVALUATION TWO - The safety-related portions of the habitability systems are designed to remain functional after an SSE. Sections 3.7(B).2 and 3.9(B) provide the design loading conditions that were considered. Sections 3.5, 3.6, and 9.5.1 provide the hazards analyses to assure that a safe shutdown, as outlined in Section 7.4, can be achieved and maintained.

SAFETY EVALUATION THREE - The system design for the safety-related portions of the habitability systems provides for complete redundancy, and, as indicated by Table 9.4-5, no single failure will compromise the systems' safety functions. All vital power can be supplied from either onsite or offsite power systems, as described in Chapter 8.0.

SAFETY EVALUATION FOUR - The habitability systems were initially tested with the program given in Chapter 14.0. Periodic inservice functional testing is done in accordance with Section 6.4.5.

Section 6.6 provides the ASME Boiler and Pressure Vessel Code, Section XI requirements that are appropriate for portions of the control room air-conditioning system.

SAFETY EVALUATION FIVE - Section 3.2 delineates the quality group classification and seismic category applicable to the safety-related portions of these systems and supporting systems. The power supplies and control functions necessary for safe functioning of the safety-related portions of the habitability systems are Class 1E, as described in Chapters 7.0 and 8.0.

SAFETY EVALUATION SIX - Section 9.4.1.2.3 describes the provisions made to assure the isolation of the control room.

SAFETY EVALUATION SEVEN - The direct radiation exposure of a control room occupant throughout the duration of any one of the postulated DBAs discussed in Chapter 15.0 does not exceed GDC-19 requirements. A detailed discussion of the dose calculation model for control room operators is discussed in Appendix 15A. Control room shielding design, based on the most limiting design basis LOCA fission product release, is discussed in Section 12.3.

SAFETY EVALUATION EIGHT - Throughout the duration of any of the postulated hazardous chemical releases discussed in Section 2.2 or DBAs discussed in Chapter 15.0, the habitability system maintains the control room environmental conditions below those established by Regulatory Guides 1.78 and 1.95 and GDC-19. Compliance with Regulatory Guides 1.78 and 1.95 is provided in Tables 6.4-1 and 6.4-2, respectively.

SAFETY EVALUATION NINE - Upon detection of high radiation in the induction trunk, the control room ventilation system is capable of automatic transfer from normal to emergency mode so as to minimize the exposure of control room personnel.

6.4.5 TESTS AND INSPECTIONS

Testing and inspection of control room HVAC systems are described in Section 9.4.1.4.

The emergency mode of the control room HVAC system has been subjected to an acceptance test to verify that the system will maintain a 1/4-inch w.g. positive pressure in the emergency zone. Testing complies with Regulatory Guide 1.95, as described in Table 6.4-2.

The control room is classified as Type B per Regulatory Guide 1.78. Since the air exchange rate exceeds 0.06 air exchanges per hour for the control room, periodic testing of the control room pressurization system is not required per the exclusion provisions of regulatory guides 1.78 and 1.95. The periodic testing is not required based on the adequacy of a 400 cfm pressurization flow rate (Ref. 1).

The control room pressurization system flow rate is an optimized value, based on detailed design calculations, which provides acceptable protection for the control room operators during both radiological and toxic gas accidents. The pressurization makeup rate provides for approximately 0.24 volume changes per hour. Periodic verification testing of the presurization system is, therefore, not justified in this case.

During the PSAR review stage, the issue of periodic testing of the pressurization system flow was discussed in detail as open item B-8, "Outstanding Issues and Positions for the Callaway Plant," for Supplement 1 to the Callaway SER. During a meeting with the NRC staff on June 26, 1975, the NRC staff agreed that periodic testing was not required for the SNUPPS (Wolf Creek and Callaway) units based on the adequacy of a 400 cfm pressurization flow rate. Refer to the NRC meeting summary dated September 8, 1975.

6.4.6 INSTRUMENTATION REQUIREMENT

Safety-related instrumentation and isolation signals are discussed in Sections 9.4.1.2.3 and 7.3.

> Indication of all fan operational status is provided in the control room.
>
> An indication of the position of all isolation dampers is provided in the control room.
>
> All instrumentation associated with filtration units complies with Regulatory Guide 1.52, as described in Table 9.4-2.

Alarms indicate induction trunk airborne gaseous radioactivity per the nominal values listed in Table 11.5-3. A smoke detector is also provided in the control building supply air intake with an alarm in the control room.

Redundant chlorine detectors are installed in the control building supply air intake duct. With the removal of one-ton storage containers from the WCGS site, the chlorine detectors will not be maintained operable and will not initiate control room ventilation isolation. These chlorine detectors are spared in place. If single chlorine containers greater than 150 lbs are brought back on site, the chlorine detectors shall be made operable and provide alarm indication at the control room and automatically isolate the control room in seven seconds for chlorine concentrations of 5 ppm or grater in control building supply air intake duct. Chlorine accident analysis will be performed and the USAR and Technical Specifications revised to reflect the use of greater than 150 lb. containers of chlorine.

A discussion of the range, alarm points, isolation setpoint, and minimum sensitivity for the redundant radiation monitors installed in the control building supply air induction trunk is presented in Section 11.5.

6.4.7 REFERENCE

1. NRC Staff meeting summary for June 26, 1975, dated September 8, 1975.

TABLE 6.4-1

COMPARISON OF THE DESIGN TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.78, DATED JUNE 1974 TITLED "ASSUMPTIONS FOR EVALUATING THE HABITABILITY OF A NUCLEAR POWER PLANT CONTROL ROOM DURING A POSTULATED HAZARDOUS CHEMICAL RELEASE"

Regulatory Guide 1.78 Position	WCGS Position
In evaluating the habitability of a nuclear power plant control room during a postulated hazardous chemical release, the following assumptions should be made:	
1. If major depots or storage tanks of hazardous chemical such as the chemical listed in Table C-1 of the guide are known or projected to be present within a five-mile radius of the reactor facility, these chemicals should be considered in the evaluation of control room habitability. Whether a major depot or storage area constitutes a hazard is determined on the basis of the quantity of stored chemicals, the distance from the nuclear plant, the inleakage characteristics of the control room, and the applicable toxicity limits (see Regulatory Position 4 for definition). Table C-2 gives the criteria to be used in evaluating the hazards of chemicals to control rooms. A procedure for adjusting the quantities given to Table C-2 to appropriately account for the toxicity limit of a specific chemical, meteorology conditions of a particular site, and air exchange rate of a control room is present in Appendix A of this guide.	1. See Section 2.2.

TABLE 6.4-1 (Sheet 2)

Regulatory Guide 1.78 Position	WCGS Position
Chemical stored or situated at distances greater than five miles from the facility need not be considered because, if a release occurs at such a distance, atmospheric dispersion will dilute and disperse the incoming plume to such a degree that there should be sufficient time for the control room operators to take appropriate action. In addition, the probability of a plume remaining within a given sector for a long period of time is quite small.	
2. If hazardous chemicals such as those indicated in Table 1 are known or projected to be frequently shipped by rail, water, or road routes within a five-mile radius of a nuclear power plant, estimates of these shipments should be considered in the evaluation of control room habitability. The weight limits of Table C-2 (adjusted for the appropriate toxicity limit, meteorology, and control room air exchange rate) apply also to frequently shipped quantities of hazardous chemicals. Shipments are defined as being frequent if there are 10 per year for truck traffic, 30 per year for rail traffic, or 50 per year for barge traffic. If the quantity, per shipment, of hazardous chemicals frequently shipped past a site is less than the adjusted quantity shown on Appendix A for the control room type being evaluated, the shipments need not be considered in the analysis.	2. See Section 2.2.

TABLE 6.4-1 (Sheet 3)

Regulatory Guide 1.78 Position	WCGS Position
3. In the evaluation of control room habitability during normal operation, the release of any hazardous chemical to be stored on the nuclear plant site in a quantity greater than 100 pounds should be considered. Any hazardous chemical stored onsite should be accompanied by instrumentation that will detect its escape, set off an alarm, and provide a readout in the control room.	3. See Section 2.2.
4. The toxicity limits should be taken from appropriate authoritative sources, such as those listed in the References section. For each chemical considered, the values of importance are the human detection threshold and the maximum concentration that can be tolerated for two minutes without physical incapacitation of an average human (i.e., severe coughing, eye burn, or severe skin irritation). The latter concentration is considered the "toxicity limit." Table 1 gives the toxicity limits (in ppm by volume and mg/m^3) for the chemicals listed. Where these data are not available, a determination of the values to be used is made on a case-by-case basis.	4. See Section 2.2.
5. Two types of industrial accidents should be considered for each source of hazardous chemicals; maximum concentration chemical accidents and maximum concentration-duration chemical accidents.	5. See Section 2.2.

TABLE 6.4-1 (Sheet 4)

Regulatory Guide 1.78 Position	WCGS Position
a. For a maximum concentration accident, the quantity of the hazardous chemical to be considered is the instantaneous release of the total contents of one of the following: (1) The largest storage container falling within the guidelines of Appendix A and located at a nearby stationary facility, (2) the largest shipping container (or for multiple containers of equal size, the failure of only one container unless the failure of that container could lead to successive failures) falling within the guidelines of Appendix A and frequently transported near the site, or (3) the largest container stored onsite (normally the total release from this container unless the containers are interconnected in such a manner that a single failure could cause a release from several containers.)	
For chemicals that are not gases at 100 F and normal atmospheric pressure but are liquids with vapor pressures in excess of 10 torr, consideration should be given to the rate of flashing and boiloff to determine the rate of release to the atmosphere and the appropriate time duration of the release.	
The atmospheric diffusion model to be used in the evaluation should be the same as or similar to the model presented in Appendix B of the guide.	
b. For a maximum concentration-duration accident, the continuous release of hazardous chemicals from the largest	

TABLE 6.4-1 (Sheet 5)

Regulatory Guide 1.78 Position	WCGS Position
safety relief valve on a stationary, mobile, or onsite source falling within the guidelines of Appendix A should be considered. Guidance on the atmospheric diffusion model is presented in Regulatory Guide 1.3, "Assumptions used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Boiling Water Reactors," and Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Pressurized Water Reactors."	
6. The value of the atmospheric dilution factor between the release point and the control room that is used in the analysis should be that value that is exceeded only 5 percent of the time. When boiloff or a slow leak is analyzed, the effects of density on vertical diffusion may be considered if adequately substantiated by reference to data from experiments. Density effect to heavier-than-air gases should not be considered for releases of a violent nature or for material that becomes entrained in the turbulent air near buildings.	6. See Section 2.2.
7. For both types of accidents described in Regulatory Position 5 above, the capability of closing the air ducts of the control room with dampers and thus isolating the control room should be considered in the evaluation of control room habitability.	7. See Section 2.2 for those hazardous chemicals stored onsite.

TABLE 6.4-1 (Sheet 6)

Regulatory Guide 1.78 Position	WCGS Position
In particular, the time required to shut off or redirect the intake flow should be justified. The detection mechanism for each hazardous chemical should be considered. Human detection may be appropriate if the buildup of the hazardous chemical in the control room is at a slow rate due to slow air turnover. The air flows for infiltration, makeup, and recirculation should be considered for both normal and accident conditions. The volume of the control room and all other rooms that share the same ventilating air, during both normal conditions and accident conditions, should be considered. The time required for buildup of a hazardous chemical from the detection concentration to the toxicity limit should be considered. Table C-3 of the guide contains a sample list of the chemical and control room data needed for the evaluation of control room habitability.	
8. In the calculation of the rate of air infiltration (air leaking into the control room from ducts, doors, or other openings) with the control room isolated and not pressurized, use of the following assumptions is suggested:	8. See below.
a. A pressure differential of 1/8-inch water gauge across all leak paths.	a. Complies.
b. The maximum design pressure differential for fresh air dampers on the suction side of recirculation fans.	b. Not applicable. Control room isolation isolates all systems and stops all fans which penetrate the control room boundary.

TABLE 6.4-1 (Sheet 7)

Regulatory Guide 1.78 Position	WCGS Position
9. When the makeup air flow rate required to pressurize the control room is calculated, a positive pressure differential of 1/4-inch water gauge should be assumed in the control room relative to the space surrounding the control room.	9. Complies.
10. To account for the possible increase in air exchange due to ingress or egress, an additional 10 cfm of unfiltered air should be assumed for those control rooms without airlocks. This additional leakage should be assumed whether or not the control room is pressurized.	10. Complies.
11. If credit is taken in the evaluation for the removal of hazardous chemicals by filtration or other means, the experimental basis for the dynamic removal capability of the removal system for the particular chemical being considered should be established.	11. Complies. No credit is taken for removal.
12. Concurrent chemical release of container contents during an earthquake, tornado, or flood should be considered for chemical container facilities that are not designed to withstand these natural events. It may also be appropriate to consider release from a single onsite container or pipe coincident with the radiological consequences of a design basis loss-of-coolant accident, if the container facilities are not designed to withstand an earthquake.	12. See Section 2.2.

TABLE 6.4-1 (Sheet 8)

Regulatory Guide 1.78 Position	WCGS Position
13. If consideration of possible accident for any hazardous chemical indicates that the applicable toxicity limits may be exceeded, self-contained breathing apparatus of at least one-half hour capacity or a tank source of air with manifold outlets and protective clothing, if required, should be provided for each operator in the control room. Additional air capacity with appropriate equipment should be provided if a chemical hazard can persist longer than one-half hour. For accidents of long duration, sufficient air for six hours (coupled with provisions for obtaining additional air within this time period) is adequate. Each operator should be taught to distinguish the smells of hazardous chemicals peculiar to the air. Instruction should include a periodic refresher course. Practice drills should be conducted to ensure that personnel can don breathing apparatus within two minutes.	13. Complies per the requirements of Regulatory Guide 1.95. See Emergency Plans. There are six self-contained breathing apparatus stored in the Control Room. An eight-hour supply of air, which includes spare bottles for changeout, is available. Standard annual respiratory protection training is required and the equipment is inventoried and cleaned on a monthly basis. It is estimated that the length of time for deploying and donning the equipment is two minutes.
14. Detection instrumentation, isolation systems, filtration equipment, air supply equipment, and protective clothing should meet the single-failure criterion. (In the case of self-contained breathing apparatus and protective clothing, this may be accomplished by supplying one extra unit for every three units required.)	14. The single failure criterion is met, as described in Sections 2.2, 6.4 and 9.4.1.

TABLE 6.4-1 (Sheet 9)

Regulatory Guide 1.78 Position	WCGS Position
15. Emergency procedures to be initiated in the event of a hazardous chemical release within or near the station should be written. These procedures should address both maximum concentration accidents, and maximum concentration-duration accidents and should identify the most probably chemical releases at the station. Methods of detecting the event by station personnel, both during normal workday operation and during minimum staffing periods (late night and weekend shift staffing), should be discussed. Special instrumentation that has been provided for the detection of hazardous chemical releases should be described, including sensitivity, action initiated by detecting instrument, level at which this action is initiated, and Technical Specification limitations on instrument availability. Criteria should be defined for the isolation of the control room, for the use of protective breathing apparatus or other protective measures, and for orderly shutdown or scram. Criteria and procedures for evacuating nonessential personnel from the station should also be defined.	15. See Section 2.2. Emergency supplies are maintained onsite to take care of the needs of 25 individuals for one week. These supplies consist of dehydrated, frozen and/or canned food. Sealed containers of potable water are also stored. A standard 36-unit first aid kit plus an emergency stretcher is available.
Arrangement should be made with federal, state, and local agencies or other cognizant organizations for the prompt notification of the nuclear power plant when accidents involving hazardous chemicals have occurred within five miles of the plant.	

TABLE 6.4-2

COMPARISON OF THE DESIGN TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.95, REVISION 1, DATED JANUARY 1977, TITLED "PROTECTION OF NUCLEAR POWER PLANT CONTROL ROOM OPERATORS AGAINST AN ACCIDENTAL CHLORINE RELEASE"

Regulatory Guide 1.95 Position	WCGS Position
Control room operators should be protected against the effects of an accidental chlorine release as described below.	
1. Liquified chlorine should not be stored within 100 meters of a control room or its fresh air inlets. (Small quantities for laboratory use, 20 pounds or less, are exempt.)	1. See Section 2.2.
2. If a chlorine container having an inventory of 150 pounds or less is stored more than 100 meters from the control room or its fresh air inlets, the capability for manual isolation of the control room should be provided.	2. The capability for remote manual isolation is provided at the control room.
3. For single container quantities exceeding 150 pounds, the maximum allowable chlorine inventory in a single container stored at specified distances from the control room or its fresh air inlet is given in Table 1 for control room Types I through VI (described below). For each control room type, the maximum allowable chlorine inventory in a single container is given as a function of distance from the control room. If there are several chlorine containers, only the failure of the largest container is normally considered unless the containers are interconnected in such a manner that failure of a single container could cause a chlorine release from several containers.	3. Not applicable.

TABLE 6.4-2 (Sheet 2)

COMPARISON OF THE DESIGN TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.95, REVISION 1, DATED JANUARY 1977, TITLED "PROTECTION OF NUCLEAR POWER PLANT CONTROL ROOM OPERATORS AGAINST AN ACCIDENTAL CHLORINE RELEASE"

Regulatory Guide 1.95 Position	WCGS Position
a. Type I control rooms should include the following protective features:	
(1) Quick-response chlorine detectors located in the fresh air inlets. Within 10 seconds after arrival of the chlorine, detection should initiate complete closure of isolation dampers to the control room.	(1) Not applicable.
(2) A normal fresh air makeup rate of less than one air change per hour. The fresh air inlet should be at least 15 meters above grade.	(2) Complies.
(3) Low-leakage construction with an equivalent air exchange rate of less than 0.06 hr-1 when all penetrations are exposed to a 1/8-inch water gage pressure differential. Construction details should be provided to show that this limit is met.	(3) Leakage criteria complies for 1/8-inch differential. However, the WCGS design utilizes 1/4-inch (minimum) differential. Applicable construction details are shown in Figure 6.4-1.
(4) Low-leakage dampers or valves installed on the upstream side of recirculation fans or other locations where negative systems pressure exists and where inleakage from chlorine-contaminated outside air is possible.	(4) Not applicable.

TABLE 6.4-2 (Sheet 3)

COMPARISON OF THE DESIGN TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.95, REVISION 1, DATED JANUARY 1977, TITLED "PROTECTION OF NUCLEAR POWER PLANT CONTROL ROOM OPERATORS AGAINST AN ACCIDENTAL CHLORINE RELEASE"

Regulatory Guide 1.95 Position	WCGS Position
b. Type II control rooms should include the protective features of Paragraph a, except that the isolation time should be 4 seconds or less rather than 10 seconds or less.	b. Not applicable.
c. Type III control rooms should include the protective features of Paragraph a, except that the normal fresh air makeup rate should be limited to 0.3 air change per hour or less.	c. Not applicable.
d. Type IV control rooms should include the protective features of Paragraph a, except that the isolation time and the normal air exchange rate should be equal to or less than 4 seconds and 0.3 air change per hour, respectively. In addition, the control room isolated air exchange rate should be reduced to 0.015 air change per hour or less (see description of required leak rate verification test in Regulatory Position 5).	d. Not applicable.
e. Type V control rooms should include the protective features of Paragraph a, with the addition of remote chlorine detectors located at the chlorine storage and unloading location. These additional detectors should be placed and the detector trip points adjusted so as to ensure detection of either a leak or a container rupture. A detector trip signal should accomplish automatic isolation of the control room before chlorine arrives at the isolation dampers. The detector trip signal should also set off an alarm and provide a readout in the control room.	e. Not applicable.

TABLE 6.4-2 (Sheet 4)

COMPARISON OF THE DESIGN TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.95, REVISION 1, DATED JANUARY 1977, TITLED "PROTECTION OF NUCLEAR POWER PLANT CONTROL ROOM OPERATORS AGAINST AN ACCIDENTAL CHLORINE RELEASE"

Regulatory Guide 1.95 Position	WCGS Position
An alternative to the installation of remote detectors would be to provide an isolation system using local detectors but having an isolation time of effectively zero. This can be accomplished by ensuring that the time required for chlorine to travel from the chlorine detector to the isolation damper, within the inlet ducting, is equal to or greater than the time required to detect the chlorine and close the isolation damper.	
f. Type VI control rooms should include the protective features in Paragraph e, except that the control room isolated air exchange rate should be reduced to 0.015 air change per hour or less. For isolated exchange rates between 0.015 hr-1 and 0.06 hr-1, linear interpolation of the weights given for control room Types V and VI in Table 1 can be made. Verification testing is required within this range of exchange rates (see Regulatory Position 5).	f. Not applicable.
4. The following should be applied to all control room types (I through VI):	4. See below.
a. Immediately after control room isolation, the emergency recirculating charcoal filter or equivalent equipment designed to remove or otherwise limit the accumulation of chlorine within the control room should be started up and operated.	a. Complies. Initiations of control room isolation also initiate operation of control room filtration system.

TABLE 6.4-2 (Sheet 5)

COMPARISON OF THE DESIGN TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.95, REVISION 1, DATED JANUARY 1977, TITLED "PROTECTION OF NUCLEAR POWER PLANT CONTROL ROOM OPERATORS AGAINST AN ACCIDENTAL CHLORINE RELEASE"

Regulatory Guide 1.95 Position	WCGS Position
b. Steps should be taken to ensure that the isolated exchange rate is not inadvertently increased by design or operating error. For instance, the following should be considered:	b. See below.
(1) An administrative procedure should require that all doors leading to the control room be kept closed when not in use.	(1) After transfer to the emergency mode, administrative controls require closure of any open door leading to the control room when not in use.
(2) Ventilation equipment for the control room and for the adjacent zones should be reviewed to ensure that enhanced air exchange between the isolated control room and the outside will not occur (e.g., if there is a chlorine release, exhaust fans should be stopped and/or isolated from the control room ventilation zone by low-leakage dampers or valves).	(2) Complies. Automatic isolation of the control room also automatically stops all fans and isolates all systems which penetrate the control building boundary.
(3) A control room exit leading directly to the outside of the building should have two low-leakage doors in series.	(3) Not applicable.
c. The use of full-face self-contained pressure-demand-type breathing apparatus (or the equivalent) and the use of protective clothing should be considered in the development of a chlorine release emergency plan. Because calculations indicate that chlorine concentrations may increase rapidly, emergency plan provisions and rehearsal of emergency plan provisions are necessary to ensure donning of breathing apparatus on detection of high chlorine concentrations.	c. Complies. Full-face, self-contained pressure-demand-type breathing apparatus are provided.

TABLE 6.4-2 (Sheet 6)

COMPARISON OF THE DESIGN TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.95, REVISION 1, DATED JANUARY 1977, TITLED "PROTECTION OF NUCLEAR POWER PLANT CONTROL ROOM OPERATORS AGAINST AN ACCIDENTAL CHLORINE RELEASE"

Regulatory Guide 1.95 Position	WCGS Position
Storage provisions for breathing apparatus and procedures for their use should be such that operators can begin using the apparatus within two minutes after an alarm. Adequate air capacity for the breathing apparatus (at least six hours) should be readily available onsite to ensure that sufficient time is available to transport additional bottled air from offsite locations. This offsite supply should be capable of delivering several hundred hours of bottled air to members of the emergency crew. A minimum emergency crew should consist of those personnel required to maintain the plant in a safe condition, including orderly shutdown or scram of the reactor. As a guideline, a minimum of five units of breathing apparatus should be provided for the emergency crew.	
d. The air supply apparatus should meet the single failure criterion and be designated Seismic Category I. (In the case of self-contained breathing apparatus, the single failure criterion may be met by supplying one extra unit for every three units required.)	d. Complies. Self-contained breathing apparatus are supplied to meet the single failure criterion, as specified in Regulatory Guide 1.95.
The isolation system components should be of a quality that ensures high reliability and availability. One method to meet these goals is to provide a system that meets the requirements of IEEE-279, "Criteria for Protection Systems for Nuclear Power Generating Stations." In all cases, the	Complies.

TABLE 6.4-2 (Sheet 7)

COMPARISON OF THE DESIGN TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.95, REVISION 1, DATED JANUARY 1977, TITLED "PROTECTION OF NUCLEAR POWER PLANT CONTROL ROOM OPERATORS AGAINST AN ACCIDENTAL CHLORINE RELEASE"

Regulatory Guide 1.95 Position	WCGS Position
isolation system, recirculating filter system, and air conditioning system should meet IEEE-279 since they are required to maintain a habitable environment in the control room during design basis radiological events.	
Specific acceptance criteria for the chlorine detection system and allied actuating electronics are as follows:	
(1) Chlorine Concentration Level. Detectors should be able to detect and signal a chlorine concentration of 5 ppm.	(1) Not applicable.
(2) System Response Time. The system response time, which incorporates the detector response time, the valve closure time, and associated instrument delays, should be less than or equal to the required isolation time.	(2) Not applicable
(3) Single Failure Criteria. The chlorine detection system should be redundant and physically separate to accomplish decoupling of the effects of unsafe environmental factors, electric transients, physical accident, and component failure.	(3) Not applicable.
Local detectors should consist of two physically separate channels for each fresh air inlet. Each channel should consist of a separate power supply, detector, actuating electronics, and interconnecting cabling. Remote detectors should also consist of two	

TABLE 6.4-2 (Sheet 8)

COMPARISON OF THE DESIGN TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.95, REVISION 1, DATED JANUARY 1977, TITLED "PROTECTION OF NUCLEAR POWER PLANT CONTROL ROOM OPERATORS AGAINST AN ACCIDENTAL CHLORINE RELEASE"

Regulatory Guide 1.95 Position	WCGS Position
separate channels having detectors located at the chlorine unloading facility.	
(4) Seismic Qualification. The chlorine detection system should be designated as Seismic Category I and be qualified as such.	(4) Not applicable.
(5) Environmental Qualification. The detection system should be qualified for all expected environments and for severe environments that could clearly lead to or be a result of chlorine release. The installation should ensure that they are protected from adverse temperature effects.	(5) Not applicable.
(6) Maintenance, Testing, and Calibration. The manufacturer's maintenance recommendations are acceptable provided they follow sound engineering practice and are compatible with the proposed application. A routine operational check should be conducted at one-week intervals. Verification testing and calibration of the chlorine detectors and verification testing of the system response time should be conducted at six-month intervals.	(6) Not applicable
5. The gross leakage characteristic of the control room should be determined by pressurizing the control room to 1/8-inch water gage and determining the pressurization flow rate. (The use of a higher pressure differential is acceptable provided the flow	5. Complies. Pressurization flow rate is 400 cfm. The air exchange rate is greater than 0.06 per hour. Therefore, periodic testing is not required.

TABLE 6.4-2 (Sheet 9)

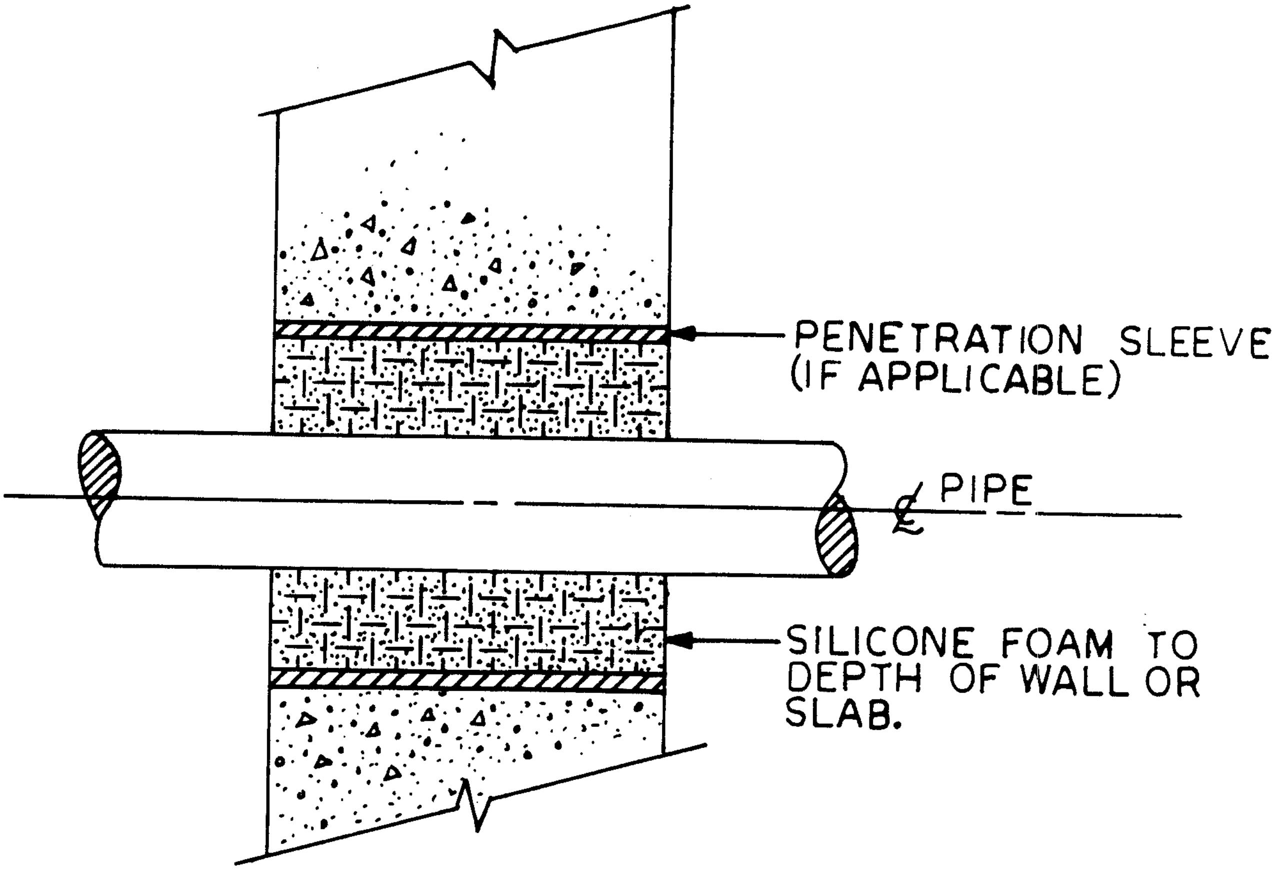
COMPARISON OF THE DESIGN TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.95, REVISION 1, DATED JANUARY 1977, TITLED "PROTECTION OF NUCLEAR POWER PLANT CONTROL ROOM OPERATORS AGAINST AN ACCIDENTAL CHLORINE RELEASE"

Regulatory Guide 1.95 Position	WCGS Position
rate is conservatively adjusted to correspond to 1/8-inch water gage). For air exchange rates of less than 0.06 hr-1, periodic verification testing should be performed. An acceptable method for periodic testing would be the use of a permanently installed calibrated pressurization fan. The system would have a known pressure-versus-flow characteristic so that the leak rate could be determined by measuring the control room pressure differential.	
Testing should be conducted at least every six months and after any major alteration that may affect the control room leakage.	
6. Emergency procedures to be initiated in the event of a chlorine release should be provided. Methods of detecting the event by station personnel, both during normal workday operation and during minimum staffing periods (late night and weekend shift staffing), should be discussed. Instrumentation that has been provided for the detection of chlorine should be described including sensitivity; action initiated by detecting instrument and level at which this action is initiated; technical specification limitations on instrument availability; and instructions for maintenance, calibration, and testing. Criteria should be defined for the isolation of the control room, for the use of protective breathing apparatus and	6. See Chapter 13.0

TABLE 6.4-2 (Sheet 10)

COMPARISON OF THE DESIGN TO REGULATORY POSITIONS OF REGULATORY GUIDE 1.95, REVISION 1, DATED JANUARY 1977, TITLED "PROTECTION OF NUCLEAR POWER PLANT CONTROL ROOM OPERATORS AGAINST AN ACCIDENTAL CHLORINE RELEASE"

Regulatory Guide 1.95 Position	WCGS Position
other protective measures, and for maintenance of the plant in a safe condition including the capability for orderly shutdown or scram of the reactor. Criteria and procedures for evacuating nonessential personnel from the station should also be defined.	



Note: Other typical penetration seals were also utilized (Reference: M-663-00017).

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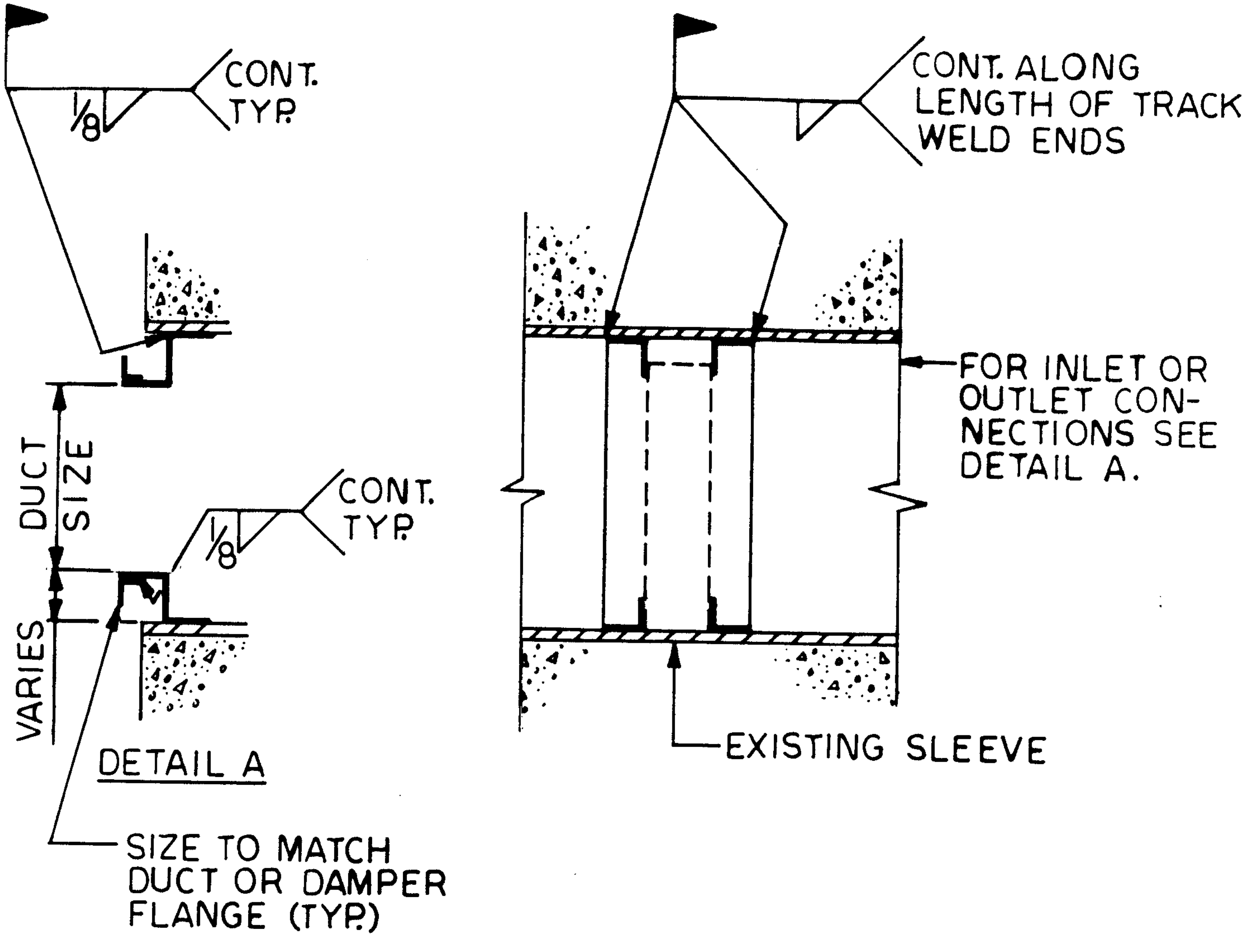
FIGURE 6.4-1

TYPICAL DETAIL SEALING OF PIPING
PENETRATION THROUGH
CONT. RM. FL. OR WALL
(SHEET 1)



Note: Other ductwork typical details were also utilized (Reference: M-OH1904 and M-OH1905).

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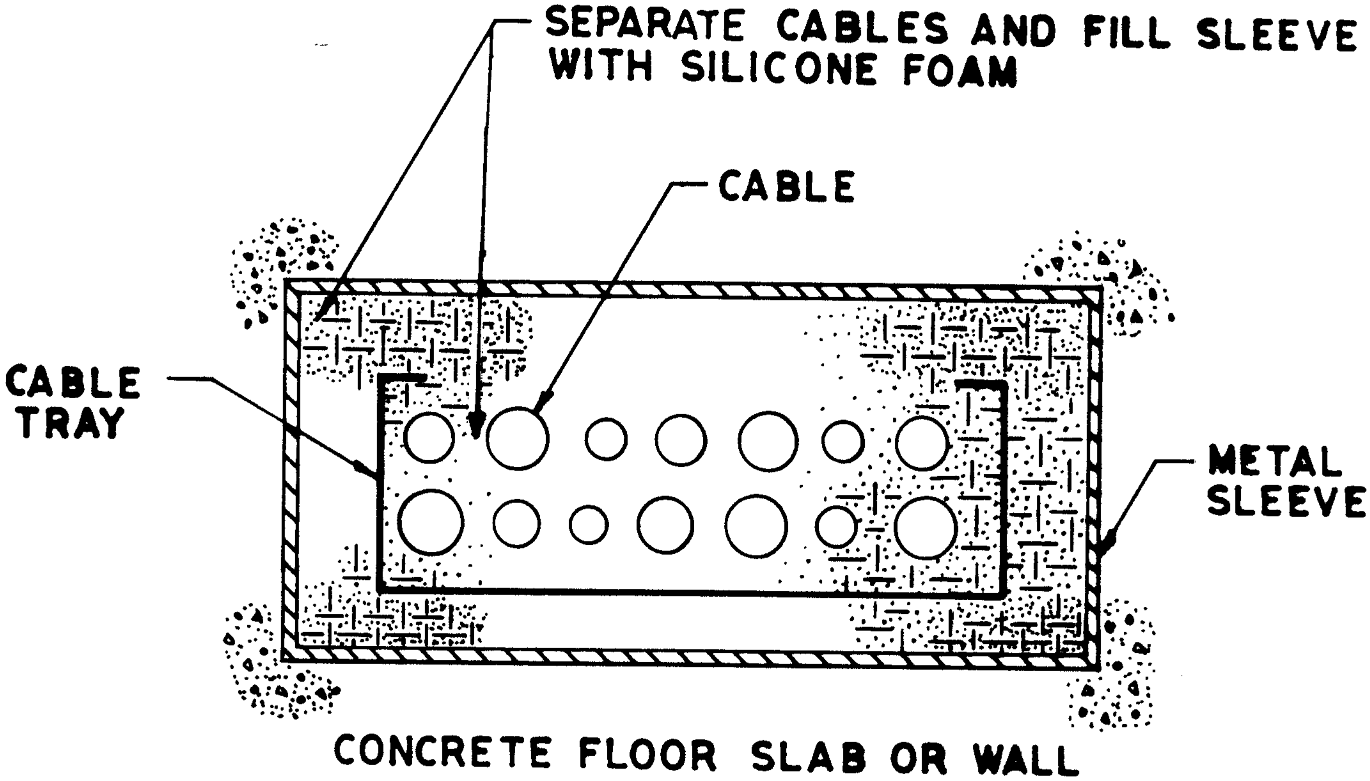
FIGURE 6.4-1

TYPICAL DETAIL SEALING OF DUCTWORK
PENET. THROUGH
CONT. RM. FL. OR WALL
(SHEET 2)



Note: Other typical penetration seals were also utilized (Reference: M-663-00017).

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FIGURE 6.4-1

TYPICAL DETAIL SEALING OF CABLE TRAY PENET. THROUGH CONT. RM. FL. OR WALL
(SHEET 3)

6.5 FISSION PRODUCT REMOVAL AND CONTROL SYSTEMS

Several plant features serve to reduce or limit the release of fission products following a postulated LOCA or fuel handling accident. This section provides a discussion of the function of the containment, containment spray system, and emergency filter systems to mitigate the consequences of an accident. The design of each of these engineered safety features is discussed in other referenced sections. Chapter 15.0 addresses the radiological consequences of postulated accidents and demonstrates the adequacy of the fission product removal and control systems.

Other sections provide the design bases and safety evaluations, which demonstrate that the design and construction of these systems is commensurate with acceptable practices for engineered safety features. This includes, but is not limited to, assuring redundancy, isolation from nonsafety-related portions, seismic classification, compliance with Regulatory Guide 1.52, suitability of material for the intended service, Class IE power supply from onsite or offsite sources, qualification testing, and the capability for inspection and testing.

6.5.1 ENGINEERED SAFETY FEATURE (ESF) FILTER SYSTEMS

The ESF filter systems include the emergency exhaust system, discussed in Sections 9.4.2 and 9.4.3, and the control building HVAC systems, discussed in Sections 6.4 and 9.4.1. The emergency exhaust system would operate following a LOCA to control and reduce fission product releases from the auxiliary building. It also would operate after a fuel handling accident to control and reduce fission product releases from the fuel building (see Section 9.4.2). The control building HVAC systems operate to maintain control room habitability by removing fission products from air entering the control room (see Section 6.4). This section discusses the design basis and safety evaluation of the functional requirements of the ESF filter systems.

6.5.1.1 Design Basis

6.5.1.1.1 Safety Design Basis

SAFETY DESIGN BASIS ONE - An emergency exhaust system is provided to reduce the fission product release from the plant, following a fuel handling accident in the fuel building or a LOCA that could potentially result in radioactive leakage into the auxiliary building.

SAFETY DESIGN BASIS TWO - A control building HVAC system is provided to isolate the control building and provide the control room with a filtered supply of fresh air.

6.5.1.1.2 Power Generation Design Basis

The ESF filter systems have no power generation design basis.

6.5.1.2 System Design

6.5.1.2.1 General Description

The emergency exhaust system is shown in Figure 9.4-2, and the control building HVAC system is shown in Figure 9.4-1. A detailed description of these systems is provided in Sections 9.4.1, 9.4.2, and 9.4.3.

The ESF filter systems comply with Regulatory Guide 1.52, as discussed in Table 9.4-2.

Table 6.5-1 lists the system design parameters used in the radiological consequences analysis presented in Chapter 15.0.

6.5.1.2.2 Component Description

The emergency exhaust system components are described in Sections 9.4.2 and 9.4.3. The control room HVAC system components are described in Section 9.4.1.

6.5.1.2.3 System Operation

In the event of a LOCA, the emergency exhaust system functions to limit and reduce the potential release of fission products from the auxiliary building. Specific details of system operation following a LOCA are provided in Section 9.4.3.

In the event of a fuel handling accident in the fuel building, the emergency exhaust system functions to reduce the fission product release from the fuel building. Specific details of system operation following a fuel handling accident are provided in Section 9.4.2.

In the event of a LOCA or fuel handling accident, the control building HVAC systems function to isolate the control building and provide the control room with a filtered supply of air. Specific details of system operation following a LOCA are discussed in Section 9.4.1.

6.5.1.3 Safety Evaluation

Safety evaluations are numbered to correspond to the safety design bases given in Section 6.5.1.1.1.

SAFETY EVALUATION ONE - Table 6.5-1 lists the ESF filtration systems' design parameters used to determine the radiological consequences for the postulated accidents analyzed in Chapter 15.0. The results of these analyses demonstrate that the emergency exhaust system reduces and controls fission products released from the fuel building following a fuel handling accident or released from the auxiliary building following a LOCA, such that the offsite radiation exposures are within the guidelines of 10 CFR 100. The safety evaluations which demonstrate the design and construction of the ESF filtration systems are provided in Sections 9.4.2 and 9.4.3.

SAFETY EVALUATION TWO - The results of the analyses described in Chapter 15.0 demonstrate that the control building HVAC systems reduce and control fission product release to the control room following a LOCA, such that the offsite radiation exposures are within the guidelines of 10 CFR 100. The safety evaluations which demonstrate the design and construction of these control building HVAC systems are provided in Sections 9.4.1 and 6.4.

6.5.1.4 Tests and Inspections

Tests and inspections for ESF filter systems are described in Section 9.4.

6.5.1.5 Instrumentation Requirements

Instrumentation and controls are provided to facilitate automatic operation and remote control of the system and to provide continuous indication of system parameters. Further descriptions are provided in Section 9.4.

6.5.1.6 Materials

The materials used for ESF filtration systems were chosen considering the environmental conditions and are commensurate with acceptable construction practices. Further information is provided in Section 9.4.

6.5.2 CONTAINMENT SPRAY SYSTEM

The containment spray system (CSS) is an ESF, the functions of which are to reduce pressure and temperature in the containment atmosphere following a postulated LOCA and to remove radioactive fission products from the containment atmosphere. These functions are performed by spraying water into the containment atmosphere through a large number of nozzles on spray headers located in the containment dome. Reduction of pressure and temperature in the containment with the CSS is discussed in Section 6.2.2.

Radioiodine in its various forms is the fission product of primary concern in the evaluation of a LOCA. It is absorbed by the containment spray from the containment atmosphere. To enhance this iodine absorption capacity of the spray, the spray solution is adjusted to an alkaline pH which promotes iodine hydrolysis, in which iodine is converted to nonvolatile forms.

The physical characteristics of the CSS are discussed in Section 6.2.2. Discussed herein are the spray additive portion of the system and the containment spray system's fission product removal capability following a LOCA.

6.5.2.1 Design Bases

6.5.2.1.1 Safety Design Bases

SAFETY DESIGN BASIS ONE - The CSS is designed to provide a spray solution while the spray additive portion of the system is in operation in the pH range of 9.0 to 11.0 and a final containment recirculation sump solution with a pH of at least 8.5.

SAFETY DESIGN BASIS TWO - The CSS is capable of reducing the iodine and particulate fission product inventories in the containment atmosphere such that the offsite radiation exposures resulting from a design basis LOCA are within the plant siting dose guidelines of 10 CFR 100.

Additional safety design bases are included in Section 6.2.2, in which the capability of the spray system to remove heat from the containment atmosphere is discussed.

6.5.2.1.2 Power Generation Design Basis

The CSS has no power generation design basis.

6.5.2.2 System Design

6.5.2.2.1 General Description

The containment spray additive portion of the CSS provides for eduction of 30 weight percent (nominal) sodium hydroxide into the spray injection water. This yields a spray mixture with a pH of from 9.0 to 11.0 during the initial period of operation, when radioiodine is being removed from the containment atmosphere.

The spray additive subsystem of the CSS, shown schematically in Figure 6.2.2-1, consists of one spray additive tank, two eductors, valves, and connecting piping. The system uses the containment spray pumps and spray headers, as described in Section 6.2.2.1, to deliver and distribute the spray additive solution to the containment atmosphere. Initially, water from the refueling water storage tank (RWST) is used for containment spraying followed by water recirculated from the containment sump. Sodium hydroxide is educted from the spray additive tank into the water from the RWST and containment sump and pumped to the spray ring headers and nozzles.

Parts of the system in contact with borated water or the sodium hydroxide spray additive, or mixtures of the two, are stainless steel or an equivalent corrosion-resistant material.

The stainless steel spray additive tank contains sufficient 30 weight percent (nominal) sodium hydroxide spray additive solution to bring the containment sump fluid to a minimum pH of 8.5 upon mixing with the borated water from the refueling water storage tank, the boron injection tank, the accumulators, and reactor coolant. This assures continued iodine retention effectiveness of the containment sump water during the recirculation phase.

The two spray additive eductors are 3-inch mixing eductors. The units draw the 30 weight percent (nominal) sodium hydroxide spray additive solution into their suction by using borated water discharged by the containment spray pumps as their motive flow.

The spray header design, including the number of nozzles per header, nozzle spacing, and nozzle orientation, is provided in Section 6.2.2.1 and shown in Figures 6.2.2-2 and 6.2.2-4. Each spray header layout is oriented to provide more than 90-percent area coverage at the operating deck of the reactor building.

Total containment free volume, unsprayed containment free volume, specific unsprayed regions and volumes, and post-accident ventilation between sprayed and unsprayed volumes are provided in Table 6.5-2. Operability of dampers, ductwork, etc., for which credit is taken postaccident is discussed in Section 6.2.2.2.2.3.

6.5.2.2.2 Component Description

The mechanical components of the spray additive subsystem are described in this section. Other components in the containment spray system are described in Section 6.2.2.1. Spray additive subsystem component design parameters are given in Table 6.5-3.

The containment spray additive tank, located at El. 2,000 in the auxiliary building, is a stainless steel tank with a nitrogen gas blanket designed to contain 30 percent by weight (nominal) sodium hydroxide solution. The capacity of the tank is given in Table 6.5-3. A local sample connection allows periodic chemical analysis of the contents, and fill and drain connections provide for initial fill, concentration adjustments, and maintenance. A manway is also provided for tank internal inspection. Tank level, pressure indication, and alarm instrumentation are provided.

An interlock is provided from the tank level transmitters to preclude closure of the discharge valves before sufficient NaOH has been added to the spray solution to comply with the sump pH criterion. Heat tracing of the spray additive tank and associated piping containing 30 weight percent (nominal) NaOH is not required since the auxiliary building is heated to maintain temperatures greater than 60 F. The containment spray additive tank is provided with overpressure protection and vacuum relief. Setpoints of the relief devices are provided in Table 6.5-3.

Sodium hydroxide is added to the spray liquid by a liquid jet eductor, a device which uses kinetic energy of a pressurized liquid to entrain another liquid, mix the two, and discharge the mixture against a counter pressure. The pressurized liquid in this case is the spray pump discharge which is used to entrain the sodium hydroxide solution and discharge the mixture into the suction of the spray pumps. The eductors are designed to assure a minimum pH of 9.0 for the spray mixture.

Component descriptions of the nozzles are provided in Section 6.2.2.1. Special tests performed on the spray nozzle include capacity and droplet size distribution. Figures 6.5-1, 6.5-2, and 6.5-3 provide the test results for the spray nozzles (Ref. 1).

The spray nozzle was flow tested at a range of inlet pressures from 3 to 100 psig to determine that the actual flow at 40 psi differential across the nozzle was in accordance with the design value of 15.2 gpm, as depicted in Figure 6.5-1.

Droplet-size distribution measurements were performed at the design pressure of 40 psi and the design flowrate of 15.2 gpm. At these conditions, the spray distribution was obtained by measuring the spray volume distribution in two perpendicular planes over a timed interval (Ref. 1).

For the droplet size distribution measurement, a television camera and light source were mounted on a flat beam. A protective covering was constructed with a slot which allowed spray droplets to fall between the camera and light source. Measurements of drop count in each micron increment were recorded at 4-inch increments from the outer edge of the spray cone to the spray axis.

At the design pressure, the droplet size distribution was recorded by high speed photographic methods. The droplet images were measured, and droplets with a diameter in the micron increment being counted were registered. Figure 6.5-2 shows the relative frequency for each droplet size. The results of testing performed on the spray nozzle are provided in Table 6.5-2. The containment spray envelope reduction factor as a function of post-LOCA containment saturation temperature is provided in Figure 6.5-4. This envelope reduction factor was applied to the throw distance and elliptic coverage values presented in Table 6.5-2.

6.5.2.2.3 System Operation

Summary of the design basis LOCA chronology for the CSS is presented in Table 6.2.2-3.

The method of switchover of the WCGS ECCS systems and the containment spray system from injection to recirculation evolved from a totally manual design to one of limited and reasonable operator action during the PSAR stage. The current design provides for the automatic switchover to the recirculation mode for the RHR pumps followed by manual realignment of the containment spray pumps, the centrifugal charging pumps, and the high head safety injection pumps. The necessary indications and the sequence of events for the switchover of the containment spray system are described in Section 6.2.2.1.2.3. The sequence of events for the switchover of the ECCS systems is described in USAR Section 6.3.2.8.

Table 6.2.2-4 provides the minimum duration of containment spray flow in the injection mode for the various assumed flow conditions. These durations provide an adequate time frame for the necessary operator actions required for ECCS and containment spray system management.

The current design was found to be acceptable by the NRC at the PSAR stage and is the basis, in that regard, for the issuance of the WCGS Construction permit.

The thermal-hydraulic analyses provided in Section 6.2.1 and the radiological consequences of the accidents analyzed in Chapter 15.0 demonstrate the adequacy of the existing containment spray system.

The spray system is actuated either manually from the control room or on coincidence of two-out-of-four CSAS containment pressure signals. This signal starts the containment spray pumps, opens the discharge valves to the spray headers, and opens the valves associated with the spray additive tank.

On actuation, approximately 5 percent of each spray pump discharge flow is diverted through each spray additive eductor to draw sodium hydroxide from the spray additive tank. The sodium hydroxide solution mixes with the liquid entering the suction line of the pumps to give a solution suitable for the removal of iodine from the containment atmosphere.

When the refueling water storage tank has reached its specified low-low level limit, recirculation spray flow is manually initiated. The operator can remotely initiate recirculation flow by use of either or both of the spray pumps. Sections 6.2.2.1.5 and 6.5.2.5 address the instrumentation and information displays available to the operator, in order for manual switchover of the CSS to take place.

System flow rates and the duration of operational modes are presented in Section 6.2.2.1.2.3.

Design operation of the CSS and the containment spray additive subsystem is such that LOCA iodine removal requirements are fulfilled during the injection phase and the amount of NaOH added is sufficient to ensure long-term iodine retention. Operation of the containment spray additive subsystem can be remote-manually terminated following the eduction of the prescribed quantity of NaOH which assures a minimum long-term sump pH of at least 8.5. Automatic isolation of the containment spray additive subsystem occurs upon receipt of a low-low level signal from the spray additive tank level instruments. The containment iodine removal credit assumed in the calculations of offsite doses, following a LOCA, is provided in Chapter 15.0.

6.5.2.3 Safety Evaluation

The safety evaluations are numbered to correspond to the safety design bases.

SAFETY EVALUATION ONE - The system's capability to reduce the airborne fission product inventory is based on the pH of the spray solution for removal during injection and for retention during recirculation, and on the system's capability to provide spray for essentially all regions of the containment, considering postaccident conditions.

The design minimum spray water pH of 9.0 coupled with the dependent parameters identified in Safety Evaluation Two below, assure the minimum elemental iodine removal coefficient of 10.0 per hour during the spray injection phase. The design minimum sump pH of 8.5 assures long-term iodine retention in the recirculated spray liquid.

The maximum pH of the spray solution in the CSS during the spray injection phase is 11.0, based on the maximum allowable eductor sodium hydroxide flow rate and minimum boric acid concentration in the RWST.

The system is designed to provide a spray solution in the CSS during the spray recirculation phase with a maximum spray pH of less than 11.0 based on a sump pH of at least 8.5 (due to prior addition of NaOH), design spray recirculation flow rate, as noted in Table 6.2.2-2, and maximum spray additive flow rate greater than 46 gpm. To preclude closure of the valve between the spray additive tank and the spray additive eductors before sufficient NaOH has been added to meet the sump pH criterion, an interlock is provided on the motor-operated valves from the spray additive tank to prohibit closure of the valves before the prescribed amount of NaOH has been added to the sump. The total volume of sodium hydroxide added to the containment following a LOCA results in a minimum pH of 8.5 in the sump, and the rate of addition maintains the spray solution pH in the CSS between 9.0 and 11.0 for all single failures within the system. Single failure analysis for the spray additive subsystem is given in Table 6.5-4. The sump pH, as a function of time, is provided in Figure 6.5-5.

SAFETY EVALUATION TWO - The spray iodine removal analysis is based on the assumptions that:

a. Only one out of two spray pumps is operating

b. The ECCS is operating at its maximum capacity

The spray system is assumed to spray approximately 85 percent of the total containment net free volume. This volume consists of those areas directly sprayed plus those volumes which have good communication with the directly sprayed volumes. The remaining 15 percent of the containment free volume has restricted communication with the sprayed volumes and is assumed to be unsprayed. A description of the unsprayed volumes is presented in Table 6.5-2.

The containment spray additive subsystem is used to maintain the spray solution at a minimum pH of 9.0 during NaOH injection to ensure efficient and rapid removal of the iodine from the containment atmosphere.

The performance of the spray system was evaluated at the containment post-LOCA calculated saturation temperature corresponding to the calculated peak pressures provided in Table 6.2.1-8 and the containment design pressure provided in Table 6.2.1-2. The spray design flow rate of 2,995 gpm per train was used in the calculations provided in Appendix 6.5A.

Based on Regulatory Guide 1.4, three species of airborne iodine are postulated to exist in the containment atmosphere following a LOCA. These are elemental, particulate, and organic species.

It has been assumed in these evaluations of spray removal effectiveness that organic iodine forms are not removed by the sodium hydroxide spray. A limited credit for the removal of airborne particulates containing iodine has been taken, assuming that the spray removal rate is 0.45 hr^{-1} until a DF of 100 is attained. Credit for removal of elemental iodine is based on a spray removal rate of 10 hr^{-1} until a df of 100 is attained. These assumptions underestimate the actual amounts of iodine removed and thus result in calculated accident doses higher than could realistically be expected.

Utilizing the dose analysis input parameters indicated above and in Table 6.5-2, the dose analysis of Chapter 15.0 demonstrates that offsite radiation exposures resulting from a design basis LOCA are within the plant siting dose guidelines of 10 CFR 100.

Appendix 6.5A provides the model used to calculate the iodine removal coefficients provided in Table 6.5-2.

6.5.2.4 Tests and Inspections

All active components in the spray additive subsystem are tested both by performance tests in the manufacturer's shop and by inplace testing after installation.

Preoperational testing is described in Chapter 14.0. During the initial preoperational tests of the system, the performance of the eductor was checked by running the containment spray pumps with the spray additive tank filled with water. Calibration curves, which correlate water flow with 30-weight-percent NaOH flow, were provided by the manufacturer, based on shop tests. In addition, during the initial preoperational tests, calibration curves were generated for water flow, under the conditions of periodic plant tests when the spray pump will be operating at shutoff head (miniflow only).

Routine periodic testing of the spray additive system components and the necessary support systems at power is planned. Included is a periodic sampling of the NaOH in the spray additive tank through the local sampling connection.

The spray eductors are tested singly by opening the valves in the spray pump miniflow lines to the RWST and the valve in the eductor suction line from the RWST and running the respective pump. The operator observes the eductor suction flow and suction pressure.

The spray additive tank isolation valves can be opened periodically for testing. The contents of the tank are periodically sampled to determine that the required solution is maintained.

The CSS tests and inspections are discussed in Section 6.2.2.1.4, including spray nozzle tests and inspections.

6.5.2.5 Instrumentation Requirements

Instrumentation and associated analog and logic channels employed for the initiation of spray additive system operation are discussed in Section 7.3.

The following describes the instrumentation which is employed for monitoring the spray additive subsystem during normal plant operation and during post-accident operation. All alarms are annunciated in the control room.

a. Spray Additive Tank Pressure

   A locally mounted indicator on the spray additive tank provides means to monitor the tank pressure while adding nitrogen and during periodic inspections.

b. Spray Additive Flow

A flow element is located in each discharge line from the spray additive tank to the eductors. Readout is local and on the main control board to provide flow indication during flow testing.

c. Spray Additive Tank Level

1. Redundant level instruments are provided to alarm the imminent depletion of the spray additive tank and to provide automatic closure of the spray additive tank discharge line valves.

2. Redundant level instruments are also provided to annunciate at the time that sufficient additive has been educted from the tank to meet the pH criteria of the system. These level instruments are interlocked with the spray additive tank discharge line valves to preclude premature closure of those valves.

d. Spray Additive Eductor Suction Pressure

A locally mounted indicator on the eductor suction line provides eductor suction pressure during flow testing.

e. Containment spray instrumentation is given in Section 6.2.2.1.5.

6.5.2.6 Materials

The containment spray additive subsystem is constructed primarily of corrosion-resistant austenitic stainless steel. The spray additive tank, in which the NaOH is stored, is constructed of austenitic stainless steel. Construction materials for the spray additive subsystem are provided in Table 6.5-3.

The chemical compositions of the NaOH stored in the spray additive tank, the containment spray fluid entering the spray header during the injection phase of containment spray, and the containment spray fluid in the system during the recirculation phase of containment spray (containment sump solution) are provided in Table 6.5-5.

None of the materials used is subject to decomposition by the radiation or thermal environment. All specifications require that the materials be unaffected when exposed to the equipment design temperature and total integrated radiation dose.

The corrosion of materials in the NSSS and the containment building, resulting from the spray solution used for iodine absorption, has been tested by the Reactor Division at ORNL (Ref. 2). The spray solutions provided in Table 6.5-5 result in negligible corrosion, based on these studies.

Sodium hydroxide does not undergo radiolytic decomposition in the post-LOCA environment. Sodium has a low neutron absorption cross section and will not undergo significant activation.

With respect to the potential for pyrolytic decomposition, NaOH is stable to at least its melting point temperature of 604°F. It may convert to sodium oxide (Na2O) upon removal of the water.

6.5.3 FISSION PRODUCT CONTROL SYSTEMS

6.5.3.1 Primary Containment

The containment consists of a prestressed post-tensioned, reinforced concrete structure with cylindrical walls, hemispherical dome, and base slab lined with welded quarter-inch carbon steel liner plate, which forms a continuous, leaktight membrane. Details of the containment structural design are discussed in Section 3.8. Layout drawings of the containment structure and the related items are given in the general arrangement drawings of Section 1.2.

The containment walls, liner plate, penetrations, and isolation valves function to limit the release of radioactive materials, subsequent to postulated accidents, such that the resulting offsite doses are less than the guideline values of 10 CFR 100. Containment parameters affecting fission product release accident analyses are given in Appendix 15A.

Long-term containment pressure response to the design basis accident is shown in Figure 6.2.1-1. Relative to this time period, the CSS is operated to reduce iodine concentrations and containment atmospheric temperature and pressure commencing with system initiation, at approximately 60 seconds, as shown in Table 6.2.2-3 and ending when containment pressure has returned to normal. For the purpose of post-LOCA dose calculations discussed in Chapter 15.0, two dose models have been assumed, the 0-2 hour case and the 0-30 day case, as shown in Appendix 15A.

The containment minipurge system may be operated for personnel access to the containment when the reactor is at power, as discussed in Section 9.4.6.

Redundant, safety-related hydrogen recombiners are provided in the containment as the primary means of controlling post-accident hydrogen concentrations. A hydrogen purge system is provided for backup hydrogen control. Although use of the hydrogen purge system is not expected for post-accident hydrogen control, offsite dose analyses assuming the operation of the hydrogen purge system have been performed to determine its incremental contribution on the radiological doses. This analysis is provided in Chapter 15.0.

Containment combustible gas control systems are discussed in detail in Section 6.2.5.

6.5.3.2 Secondary Containment

This section is not applicable to WCGS.

6.5.4 ICE CONDENSER AS A FISSION PRODUCT CLEANUP SYSTEM

This section is not applicable to WCGS.

6.5.5 REFERENCES

1. Spraying Systems Company Topical Report No. SSCO-15215-lC-304SS-6.3-NP, April 1977, "Containment Spray Nozzles for Nuclear Power Plants"

2. "Design Considerations of Reactor Containment Spray Systems, The Corrosion of Materials in Spray Solutions," ORNL-TM-2412 Part III, December 1969

TABLE 6.5-1

ESF FILTRATION SYSTEMS INPUT PARAMETERS TO CHAPTER 15.0 ACCIDENT ANALYSIS

Emergency exhaust filter adsorber unit efficiencies (percent)	90
Control room filter adsorber unit efficiency (percent)	95
Control room air conditioning system flowrate (SCFM) per train	
Filtered intake from control building	$\leq$550
Filtered recirculation from control room	$\geq$1250

TABLE 6.5-2 (Sheet 1)

INPUT PARAMETERS AND RESULTS OF SPRAY IODINE REMOVAL ANALYSIS

Ultimate core power rating	3,565 MWt
Total containment free volume	2.50 x 10^6 ft^3
Unsprayed containment free volume	<15.0 percent
Area coverage at the operating deck	
design	>90 percent
Calculated	>93 percent
Mixing rate between sprayed and unsprayed volumes	85,000 cfm ***
Dose model	One region
Minimum vertical distance to operating deck from lowest spray header	118 feet - 2 in.
Net spray flow rate per train, injection phase	3,131 gpm
Design NaOH flow rate per eductor	44.0 ±2 gpm
Number of spray pumps operating	1
Spray solution pH	9.0 to 11.0
Elemental iodine absorption coefficient, s, used in accident calculations	10 hr^{-1} *
Expected s	25.7 hr-1 **
Particulate iodine absorption coefficient, p, used in accident calculations	0.45 hr^{-1} *
Calculated p	0.73 hr^{-1} **
Spray drop size, design	See Figure 6.5-2

TABLE 6.5-2 (Sheet 2)

Schmidt number	11.58
Gas diffusivity	0.064
Partition coefficient	5,000

---

* Used DFs of up to 100.

** As calculated from Appendix 6.5A.

*** Adequate mixing of the containment atmosphere following a LOCA is ensured by effects of the initial blowdown, containment sprays, natural convection and forced air ventilation provided by the containment coolers without reliance on the hydrogen mixing fans. Refer to Section 6.2.5 for additional information.

TABLE 6.5-2 (Sheet 3)

SPRAY NOZZLE TEST RESULTS

Nozzle droplet spectrum	Figure 6.5-2
Nozzle capacity curve	Figure 6.5-1
Nozzle mass median diameter versus pressure drop	Figure 6.5-3
Number mean diameter	526 micron @ 40 psi
Volume mean diameter	831 micron @ 40 psi
Number median diameter	325 micron @ 40 psi

Nozzle Orientation	Throw Distance*	Elliptic Coverage*
Vertical-down	0 ft	10 ft-0 in. x 10 ft-0 in.
7.5° off vertical-down	2.5 ft	10 ft-0 in. x 10 ft-0 in.
15° off vertical-down	3.75 ft	10 ft-0 in. x 10 ft-0 in.
30° off vertical-down	5.0 ft	10 ft-0 in. x 10 ft-0 in.
40° off vertical-down	7.3 ft	10 ft-6 in. x 11 ft-0 in.
Horizontal	10.6 ft	12 ft-6 in. x 12 ft-0 in.
30° off horizontal-up	10.8 ft	13 ft-0 in. x 12 ft-6 in.

*Based on 100-foot drop and post-LOCA saturation temperature.

TABLE 6.5-2 (Sheet 4)

UNSPRAYED CONTAINMENT FREE VOLUME

Unsprayed Region	Volume (ft^3)
Pressurizer enclosure and overhang	26,511
Region below the four RC pump hatches	44,245
Pressurizer safety valve enclosure	14,392
Region below the four containment coolers and two filter adsorber units	63,852
Pressurizer spray valve enclosure	8,920
Region under CRDM PLENUM/SEISMIC SUPPORT PLATE	3,189
Elevator machine room and elevator shaft	16,596
Region under concrete flooring used for structural strength and shielding	182,821
Total unsprayed free volume	360,526
Percentage of free volume unsprayed	~14.4%

TABLE 6.5-3

SPRAY ADDITIVE SUBSYSTEM-DESIGN PARAMETERS

Eductors

Quantity	2
Eductor inlet (motive)	
Operating fluid	Borated water
Operating temperature	Ambient
Eductor Suction Fluid	
NaOH concentration, wt percent	30 (nominal)
Specific gravity	~1.3
Viscosity (design), cp	~10
Operating temperature	Ambient
Material	Stainless steel

Spray Additive Tank

Number	1
Total volume, usable gallons	4,700
NaOH concentration, wt percent	30
Design temperature, F	200
External design pressure, psig	3
Internal design pressure, psig	10
Operating temperature, F	Ambient
Operating pressure, psig	~1*
Material	Stainless steel
High pressure relief valve set point, psig	10
Vacuum relief valves setpoint, in. Hg	2

Spray Additive System Piping

Material	Stainless steel

* During normal conditions, there is a 1 to 2 psig nitrogen gas blanket. During accident injection, the tank pressure falls below atmospheric pressure; redundant vacuum breakers are provided in order to assure that tank external design pressure is not exceeded relative to the tank internal vacuum.

TABLE 6.5-4

SPRAY ADDITIVE SUBSYSTEM - SINGLE FAILURE ANALYSIS

Component	Malfunction	Comments and Consequences
Automatically operated spray additive tank outlet isolation valve	Fails to open	Two provided in parallel. Operation of one required.
	Fails to close	Potential exists for losing one train. Operation of only one train required.
Spray additive tank vacuum breaker	Fails to open	Two provided. Operation of one required.

TABLE 6.5-5

CONTAINMENT SPRAY SYSTEM FLUID CHEMISTRY

1.	Containment Spray Additive	
	Sodium hydroxide, weight percent	30 (nominal)
	Temperature range, F	60-104
II.	Sprayed Fluid - Injection Phase	
	Aqueous solution, pH	4.0-11.0
	Chloride, ppm, max	0.15
	Fluoride, ppm, max	0.15
	Boric acid, ppm boron, max/min	2,500/2,400
	Sodium hydroxide, ppm	0-3,000
	Temperature range, F	37-120
III.	Sprayed Fluid - Recirculation Phase	
	Aqueous solution, pH	8.5-11.0
	Boric acid, ppm boron, max/min	2,500/2,400
	Sodium hydroxide, ppm, max	3,000
	Temperature range, F	120-255
IV.	Final Sump Fluid	
	Aqueous solution, pH	8.5-9.0
	Boric acid, ppm boron, max/min	2,500/2,400
	Sodium hydroxide, ppm, max	3,000
	Temperature range, F	120-255

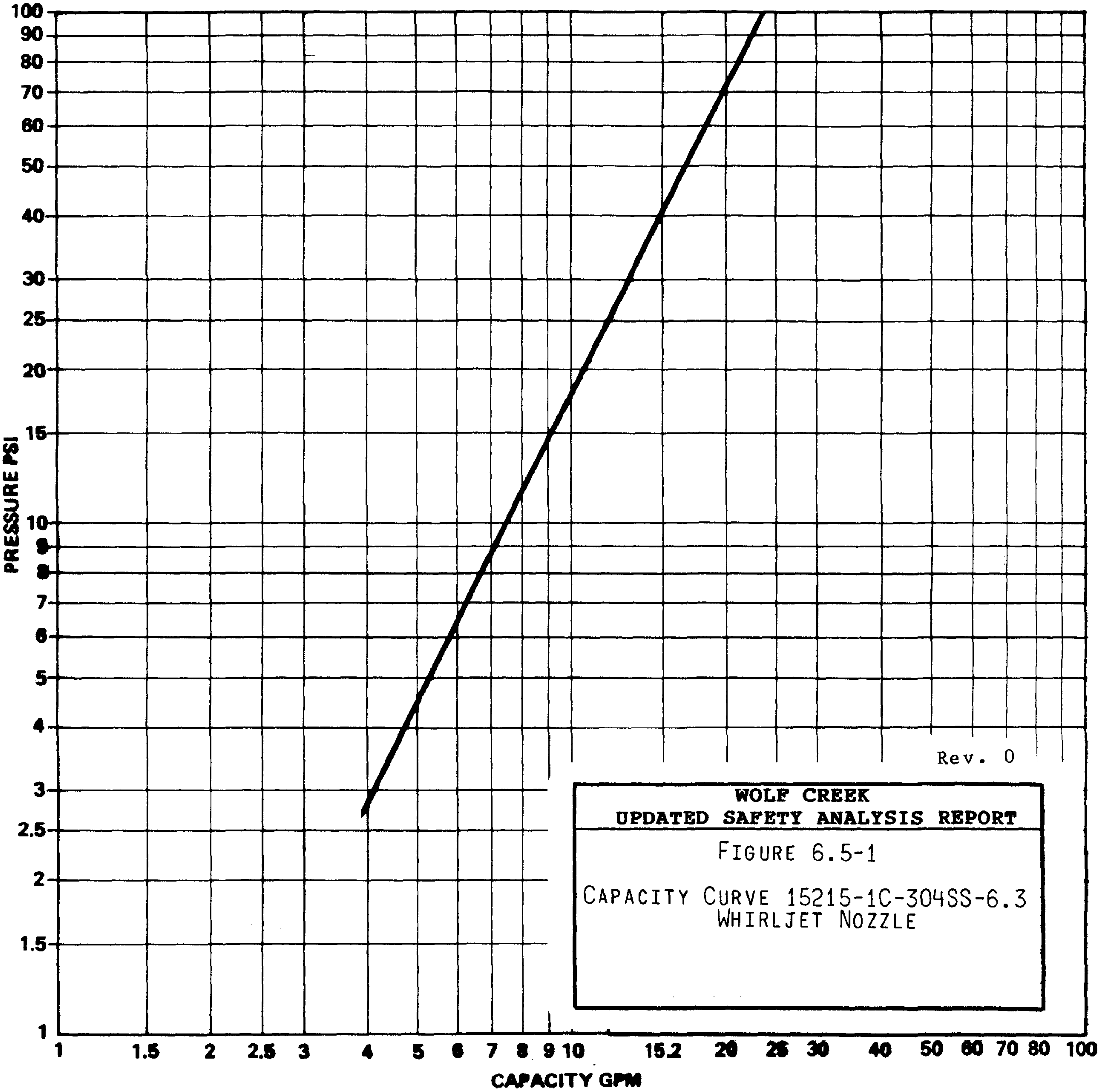

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FIGURE 6.5-1

CAPACITY CURVE 15215-1C-304SS-6.3
WHIRLJET NOZZLE

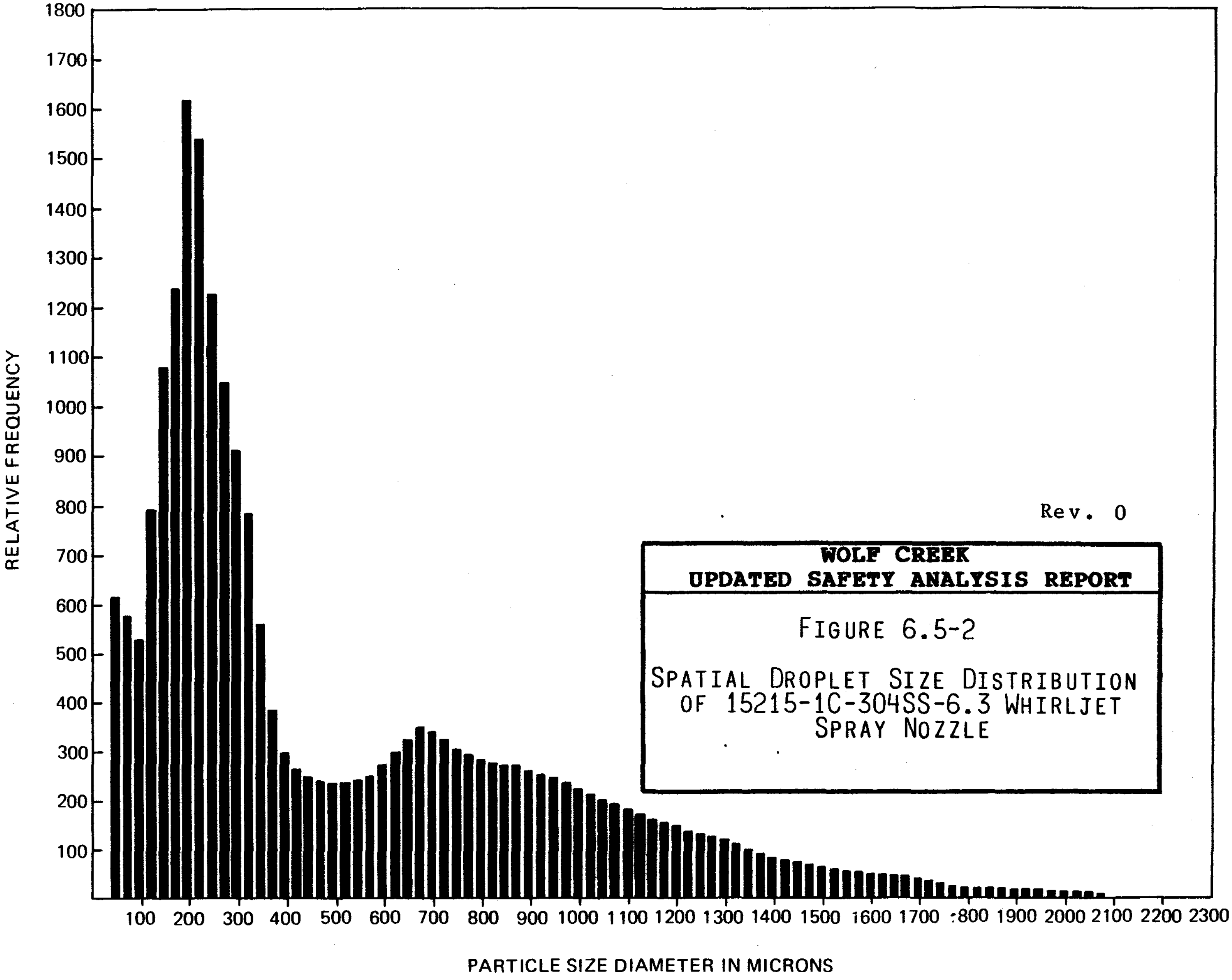

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FIGURE 6.5-2

SPATIAL DROPLET SIZE DISTRIBUTION
OF 15215-1C-304SS-6.3 WHIRLJET
SPRAY NOZZLE

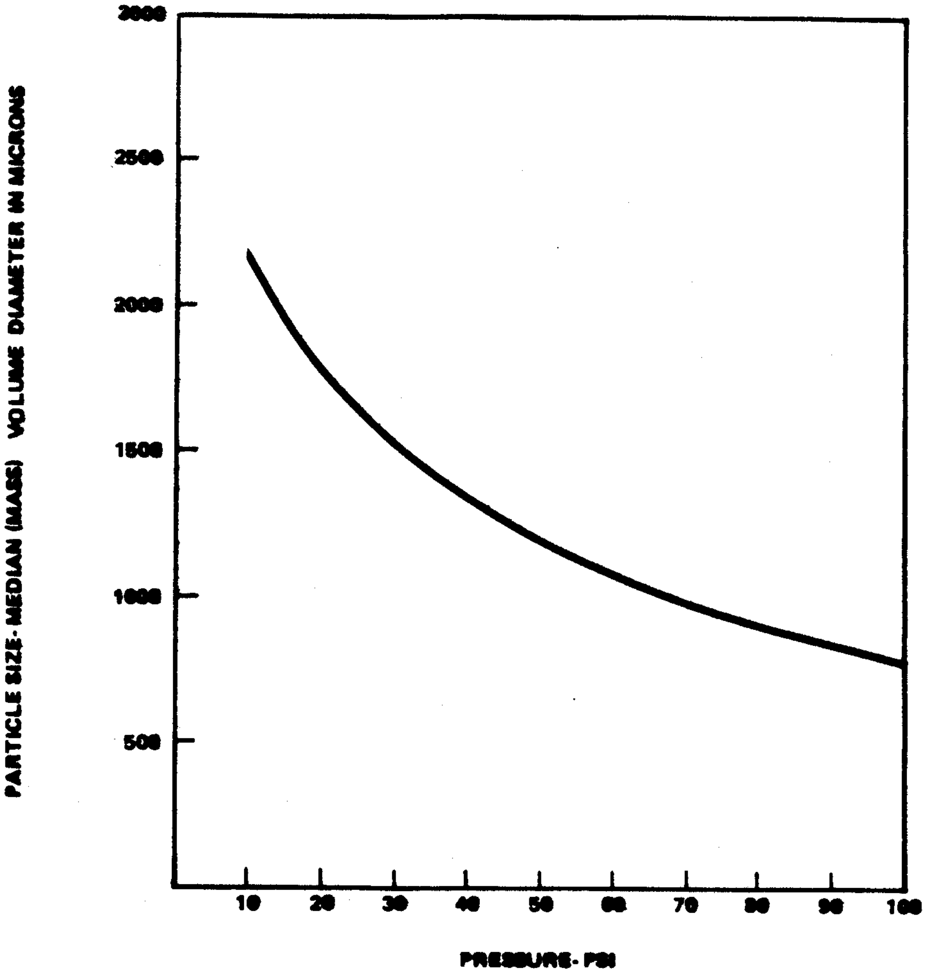

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FIGURE 6.5-3

PARTICLE SIZE VS. PRESSURE 15215
1C-304-S-6.3 WHIRLJET SPRAY NOZZLE

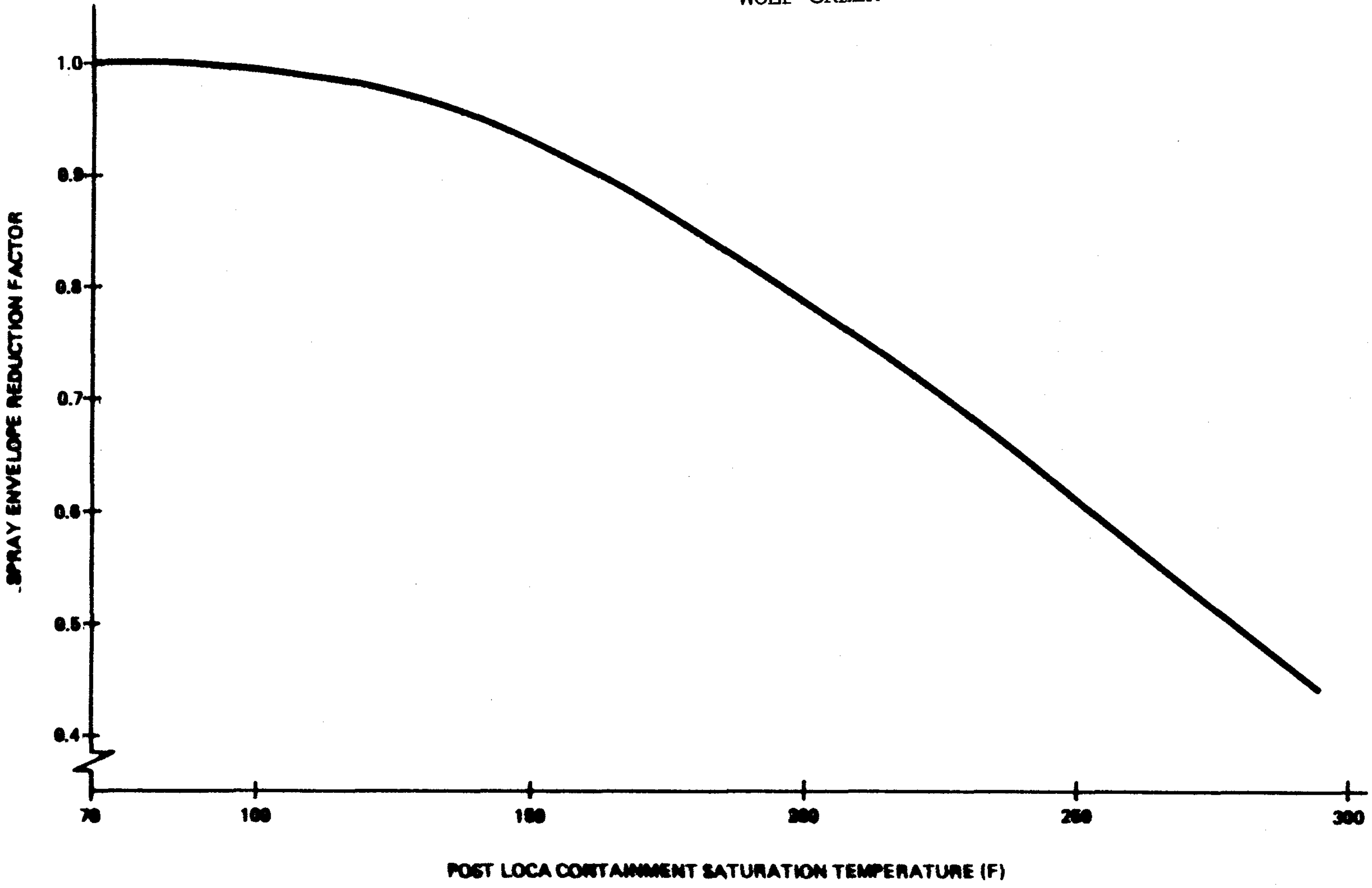

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FIGURE 6.5-4

SPRAY ENVELOPE REDUCTION FACTOR

SUMP pH VERSUS TIME WITH NOMINAL FLOW OF 40 GPM PER EDUCTOR AND BOTH CONTAINMENT SPRAY TRAINS

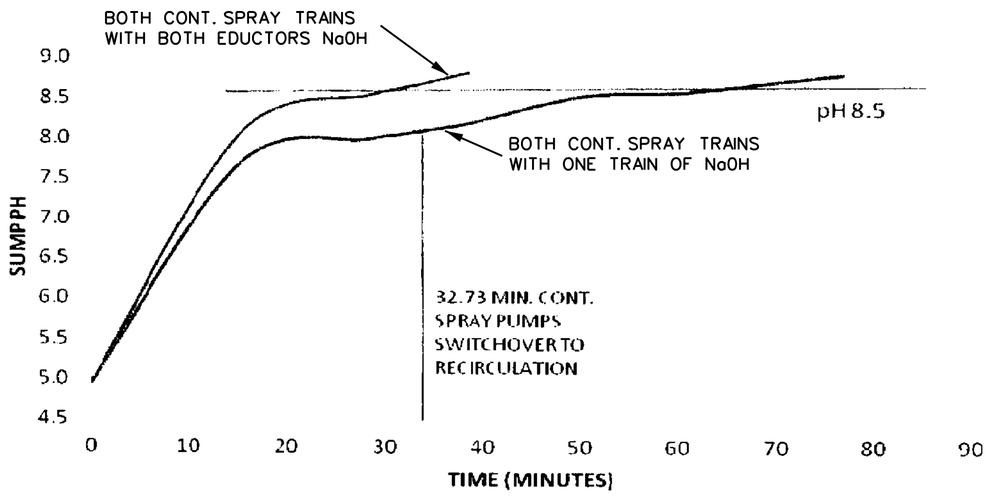

FIGURE 6.5-5:
CONTAINMENT SUMP PH WITH
NOMINAL EDUCATOR FLOW FOR ONE
AND TWO EDUCTOR OPERATION

APPENDIX 6.5A

IODINE REMOVAL MODELS
FOR THE
CONTAINMENT SPRAY SYSTEM

6.5A.1 PARTICULATE IODINE MODEL

The spray washout model for aerosol particles is represented in equation form as follows:

$$l_P = \frac{3hEF}{2dV} \qquad (6.5A\text{-}1)$$

Where:

l_P = spray removal constant for particles

h = fall height

E = total collection efficiency for a single drop

F = spray flow rate

d = mean drop diameter

V = volume of gas space

The capture of particles by falling drops results from Brownian diffusion, diffusiophoresis, interception, and impaction. Early in the injection phase, particles are removed mainly by impaction. Following injection, when the larger particles have already been removed, the removal rate is controlled by diffusiophoresis, which is the collection of particulates by steam condensing on the spray drops. The single drop collection efficiency, E, is taken as 0.0015, the minimum value observed in experimental tests (Ref. 1). The minimum collection efficiency, 0.0015, was only attained after the major fraction of airborne particles was removed. For early time periods, the removal rates were much higher than the minimum values ultimately reached.

The spray removal constant (l_P) for particulate iodine has been calculated to be 0.73 hr^{-1}, based on equation 6.5A-1.

A limited and conservative credit for spray removal of airborne particulates containing iodine has been taken, assuming the spray removal constant is 0.45 hr^{-1} for the 0 to 2-hour period following the postulated LOCA (see Table 6.5-2).

Particle spray removal constants considerably larger and of longer duration than those conservatively chosen above have been reported from the Battelle Northwest Containment Systems Experiment (Ref. 2) and by the Oak Ridge National Laboratories Nuclear Safety Pilot Plant (Ref. 4).

6.5A.2 ELEMENTAL IODINE MODEL

The spray system, by virtue of the large surface area provided between the droplets and the containment atmosphere, will afford an excellent means of absorbing elemental radioactive iodine released as a consequence of a LOCA. Sodium hydroxide is added to the spray fluid to increase the solubility of iodine in the spray to the point where the rate of absorption is largely dependent on the concentration of radioiodine in the air surrounding the drops.

The basic model of the containment atmosphere and spray system is given by Parsley (Ref. 4). The containment atmosphere is viewed as a "black box" having a sprayed volume, V, and containing iodine at some uniform concentration Cg. Liquid enters at a flow of F volumes per unit time, containing iodine at a concentration of CL1, and leaves at the same flow, at concentration CL2. A material balance for the containment vessel as a function of time is given by:

$$-VdCg = F(CL2 - CL1)dt \qquad (6.5A\text{-}2)$$

Where:

CL1 = the iodine concentration in the liquid entering the dispersed phase, gm/cm^3

CL2 = the iodine concentration in the liquid leaving the dispersed phase, gm/cm^3

V = sprayed volume of containment, cm^3

Cg = the iodine concentration in the containment atmosphere, gm/cm^3

F = the spray flow rate, cm^3/sec

t = spray time, sec

A drop absorption efficiency, E, which may be described as the fraction of saturation, is defined as:

$$E = (CL2 - CL1)/(CL^* - CL1) \qquad (6.5A\text{-}3)$$

In addition, the equilibrium distribution of iodine between the vapor and liquid phases is given by:

$$H = CL^*/Cg \qquad (6.5A\text{-}4)$$

Where:

H = The iodine partition coefficient (gm/liter of liquids)/(gm/liter of gas)

CL* = The equilibrium concentration in the liquid, gm/cm3

Substitution of equation 6.5A-4 into equation 6.5A-3 yields

$$E = (CL2 - CL1)/(HCg - CL1) \qquad (6.5A\text{-}5)$$

Solving equation 6.5A-5 for (CL2 - CL1) and inserting the result into equation 6.5A-2 gives

$$-(V)dCg = EF(HCg - CL1)dt \qquad (6.5A\text{-}6)$$

During the injection phase, CL1 = 0, so that

$$-(V)dCg = (EFHCg)dt \qquad (6.5A\text{-}7)$$

Equation 6.5A-7 can be integrated to solve for Cg. The concentration of iodine in the containment atmosphere during injection as a function of time is given by:

$$Cg = Cg_o \exp [-EHFt/V] \qquad (6.5A\text{-}8)$$

Where:

Cg_o = The initial iodine concentration in the containment atmosphere, gm/cm^3

Equation 6.5A-8 is applicable up to the time the spray solution is recirculated and is based on the following assumptions:

a. Cg is uniform throughout the containment

b. There are no iodine sources after the initial release

c. The concentration of iodine in the spray solution entering the containment is zero

From equation 6.5A-8, the spray removal constant, l, is given by

$$l = \frac{EHF}{V} \qquad (6.5A\text{-}9)$$

The above equation for is independent of the models on which the numerical evaluation of the drop absorption efficiency, E, and the iodine partition coefficient, H, may be based.

Absorption efficiency for elemental iodine may be calculated from the time-dependent diffusion equation for a rigid sphere with the gas film mass transfer resistance as a boundary condition. This mass transfer model was suggested by L. F. Parsley (Ref. 4), who gives the solution to the diffusion equation, with the above given boundary condition, as:

$$E = 1 - \sum_{n=1}^{\infty} \frac{6\ Sh^2 \exp\left(-a_n^2 Q_f\right)}{\left[a_n^2 + (Sh)\ (Sh - 1)\right] a_n^2} \qquad (6.5A\text{-}10)$$

Where:

Sh = the dimensionless group = kg a/HDL

a = the drop radius, cm

k_g = the gas film mass transfer coefficient, cm/sec

DL = the liquid diffusivity, cm2/sec

Qf = the dimensionless drop residence time

a_n = the eigenvalues of the solution

It should be noted that this solution, which applies to the rigid drop model, is based on the assumption that molecular diffusion is the only mechanism by which iodine is transported from the surface to the interior of the drop. Since a high degree of mixing is expected in the drops, particularly in the presence of sizable temperature and concentration gradients, it is apparent that this stagnant drop model presents a conservative approach to the calculation of iodine absorption by the drops.

The gas film mass transfer coefficient required for the above calculation is computed by the equation of Ranz and Marshall (Ref. 5).

$$k_g = \frac{D_g}{d} \left(2 \times 0.6\ Re^{0.5}\ Sc^{0.33}\right) \qquad (6.5A\text{-}11)$$

Where:

d = drop diameter, cm

D_g = diffusion coefficient in vapor, cm2/sec

Re = Reynold's number

Sc = Schmidt number

A more conservative numerical value of E is obtained from equation 6.5A-12 given below, which is quoted by Postma and Pasedag (Ref. 6):

$$E = 1 - \exp\left[-\frac{6\,k_g t_e}{d\left(\left(\frac{H + k_g}{k_L}\right)\right)}\right] \qquad (6.5A\text{-}12)$$

Where:

E = drop absorption efficiency

k_L = liquid phase mass transfer coefficient, cm/sec

t_e = drop exposure time, sec

d = drop diameter, cm

H = equilibrium partition coefficient

Equation 6.5A-12 is based on a model in which it is assumed that the drop consists of an outer stagnant film and a well-mixed interior. Though this model is basically nonconservative compared with the stagnant drop model represented by equation 6.5A-10, conservatism is introduced into equation 6.5A-12 when the following expression is used for kL:

$$kL = \frac{2p^2 \; D_L}{3d} \qquad (6.5A\text{-}13)$$

Where:

D^L = liquid diffusivity of iodine in water, cm^2/sec

d = drop diameter, cm

Equation 6.5A-13 results from a truncated approximation (Ref. 6) to the rigid drop diffusion equation due to Griffith (Ref. 7). Griffith's approximation is conservative in that it predicts lower absorption than would be predicted without such approximation for stagnant drop absorption.

The numerical value of E obtained from equation 6.5A-12 is more conservative than the one obtained from equation 6.5A-10, as shown by Postma and Pasedag (Ref. 6) by comparing them with the numerical value of E based upon another model. The reference model chosen by Postma and Pasedag (Ref. 6) for comparison is the completely well mixed model in which the solution in the entire drop, including the interior as well as the gas-liquid interface, is in equilibrium with the iodine concentration in the gas phase outside the drop. The expression in this reference model is:

$$E = 1 - \exp\left(-\frac{6\ k_g t_e}{dh}\right) \qquad (6.5A\text{-}14)$$

The absorption efficiency is a function of the drop size, the gas phase mass transfer coefficient, diffusion in the liquid phase, the partition coefficient, and the drop fall time.

Eggleton's equation (Ref. 8) for the equilibrium elemental iodine decontamination factors, DF, is given by:

$$DF = 1 + H(VL)/(VG) \qquad (6\ 5A\text{-}15)$$

Where:

VG = Gaseous volume of the containment

VL = Liquid volume of the containment, which may be used for calculation of the partition coefficient, H, for a given value of the DF. However, equation 6.5A-15 was not used in the present analysis; instead, a numerical value of 5,000 for H, the minimum found from CSE tests (Refs. 9 and 10) for sodium hydroxide spray, was used in the evaluation of λ.

Since the spray does not consist of a uniform droplet size, a spectrum of drop sizes and their corresponding volume percentage (for the specific nozzle design) were used to determine the individual spray removal constant for each droplet size. The total spray removal constant is equal to the sum of the individual spray removal constants, i.e.:

$$l = \sum_{i=1}^{n} li = \sum_{i=1}^{n} \sum_{J=1}^{m} iJ \qquad (6.5A\text{-}16)$$

Since the fall time, t_e, is dependent on distance from the spray header to the operating deck, and each spray header consists of ring headers ( ) located at various levels, i was calculated for each spray ring header ( ), utilizing the appropriate drop distance for each header.

Therefore,

$$l_{i_J} = \frac{E_{iJ} \ H \ F_{iJ}}{V} \qquad (6.5A\text{-}17)$$

Where:

E_{i_J} = collection efficiency for a single drop of micron increment i for ring header

F_{i_J} = spray flow rate for micron increment i for header J

and,

$$F_{i_J} = (F_i/\text{nozzle}) \ . \ (N_J) \qquad (6\ 5A\text{-}18)$$

Where:

$$F_i/\text{nozzle} = \frac{15.2 \ (N_i) \cdot (V_i)}{\sum_{i=1}^{n} N_i \ \ V_i}$$

N_J = number of nozzles on ring header

N_i = number frequency for micron increment i (Figure 6.5-2)

V_i = volume of a drop in micron increment i

As the spray solution enters the high-temperature containment atmosphere, steam will condense on the spray drops. The amount of condensation is easily calculated by a mass balance of the drop:

$$mh + m_c \ h_g = m'h_f$$

where:

m and m' = the mass of the drop before and after condensation, lbs

m_c = the mass of condensate, lbs

h = the initial enthalpy of the drop, Btu/lb

h_g and h_f = The saturation enthalpy of water vapor and liquid, Btu/lb

The increase in each drop diameter in the distribution, therefore, is given by:

$$\left(\frac{d'}{d}\right)^3 = \left(\frac{v}{v_f}\right) \cdot \left(\frac{h_g - h}{h_{fg}}\right)$$

Where:

v_f = the specific volume of liquid at saturation, ft^3/lb

v = the specific volume of the drop before condensation, ft^3/lb

h_{fg} = the latent heat of evaporation, Btu/lb

h_g = the enthalpy of steam at saturation, Btu/lb

d and d' = the drop diameter before and after condensation, cm

Postma and Pasedag (Ref. 6) conclude that condensation will tend to increase the iodine washout rate due to the increased volume of the spray. Their effect has been conservatively ignored.

The drop exposure time calculated is based on the assumption that the drops were sprayed in such a manner that the initial downward velocity of the drops at the spray ring header elevation was zero. The drops fall under the effect of gravity from the spray ring header to the operating deck. The minimum height is given in Table 6.5-2. As the drop size increases, the average residence time decreases from about 20 to 5 seconds. Incorporating the above parameters into equation 6.5A-16 with the sprayed containment volume, V, and assuming a single spray header flow rate, the value of the spray removal coefficient calculated is presented in Table 6.5-2.

The resulting elemental iodine spray removal constant is greater than 10 hr^{-1}. Only this conservative removal constant of 10 hr^{-1} is assumed and used in the design basis LOCA evaluations presented in Section 15.4.

6.5A.3 REFERENCES

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10. Coleman, L. F., "Iodine Gas-Liquid Partition," Nuclear Safety Quarterly Report, February, March, April 1970, BNWL-1315-2, Battelle-Northwest, Richland, Washington, p. 2.12-2.19, 1970.

6.6 INSERVICE INSPECTION OF CLASS 2 AND 3 COMPONENTS

This section addresses the preservice inspections, inservice inspections, repairs and replacements of quality group B and C (ASME Boiler and Pressure Vessel Code, Section III, Class 2 and 3) components as required by the applicable edition of Section XI of the ASME Code, including addenda, per 10 CFR 50.55a(g), with certain exceptions and alternatives whenever specific written relief is granted by the NRC per 10 CFR 50.55a, or when Section XI Code Cases are used which either have been reviewed by the NRC and found acceptable as documented in Regulatory Guide 1.147 or approved for use by the granting of relief requests. The conditions for use of Regulatory Guide 1.147 approved Code Cases are discussed in Appendix 3A. The inservice testing of pumps and valves is discussed in Section 3.9(B). The limitations and modifications that the NRC places in the ASME Code in paragraph (b) of 10 CFR 50.55a are adhered to.

In addition, separate preservice/inservice inspection program documents, complying with the "NRC Staff Guidance for Complying with Certain Provisions of 10 CFR 50.55a(g) - Inservice Inspection Requirements" were submitted to the NRC. Subsequent inservice inspection program documents are prepared in accordance with the 10 year update requirements in 10 CFR 50.55a and submitted to the NRC for initial approval. The inspection program documents identify the applicable Section XI Edition and Addenda and provide the details of the areas subject to examination, method of examination, extent and frequency of examination, and applicable Code Cases. "Relief Requests" seeking relief from applicable code requirements are submitted to the NRC and become part of the inservice inspection program. The repair and replacement program identifies the applicable Section XI Edition and Addenda, applicable Code Cases and relief requests, and provides the administrative controls for performing repairs and replacements.

6.6.1 COMPONENTS SUBJECT TO INSPECTION

The ASME Section XI Class 2 and 3 components are classified in accordance with the definitions of the 1974 Edition of the ASME Boiler and Pressure Vessel Code, Section III, Paragraph NA-2140. Class 2 and 3 components subject to inspection and the extent of preservice and inservice inspections are described below.

6.6.1.1 Preservice Inspections

Class 2 components, other than those exempted by Paragraph IWC-1220, were inspected in accordance with the requirements of Subsection IWC of Section XI in the 1977 Edition of the ASME Boiler and Pressure Vessel Code up to and including Summer 1978 Addenda. However, the extent of selection of Class 2 piping welds was determined by the requirements of the 1974 Edition of Section XI with Addenda through Summer 1975, except the residual heat removal system, which contained at least a 25 percent representative sample of all pressure boundary welds at structural discontinuities distributed among the loops, and the high pressure coolant injection system, which contained a 7-1/2 percent sample of all pressure welds at structural discontinuities on the safety injection pump suction lines. Class 3 components were inspected in accordance with the technical requirements of Subsection IWD of the 1977 Edition of Section XI with Addenda through Summer 1978, insofar as practicable.

6.6.1.2 First 10-Year Interval Inservice Inspections

All Class 2 components other than those exempted by Paragraph IWC-1220 were inspected in accordance with the requirements of Subsection IWC of Section XI in the 1980 Edition of the ASME Boiler and Pressure Vessel Code up to and including Winter 1981 Addenda. However, the extent of selection of Class 2 piping welds was determined by the requirements of the 1974 Edition of Section XI with Addenda through Summer 1975 as allowed by 10CFR50.55a(b)(2), excepting the high pressure coolant injection system which contained a 7-1/2 percent sample of all pressure welds at structural discontinuities on the safety injection pump suction lines. All Class 3 components were inspected in accordance with the technical requirements of Subsection IWD of the 1980 Edition of Section XI with Addenda through Winter 1981 insofar as practicable.

6.6.1.3 Subsequent 10-Year Interval Inservice Inspections

All Class 2 and Class 3 components other than those exempted by Paragraph IWC-1220 and IWD-1220, respectively, will be inspected in accordance with the requirements of the applicable Edition and Addenda of Section XI, as described at the beginning of section 6.6 and documented in the inservice inspection program. Beginning in ISI interval 2, the selection of piping welds for examination is determined under a risk-informed ISI program as an NRC approved alternative to the Section XI requirements. This program is implemented under the ‘Relief Request’ process described at the beginning of 6.6.

6.6.2 ACCESSIBILITY

The physical arrangement of the components (such as piping, pumps, and valves) and supports is designed to allow personnel access to welds requiring inservice inspection to the maximum extent practical. Modifications to the initial plant design were incorporated where practical to provide proper inspection access. Removable insulation was provided on those piping systems initially requiring volumetric and surface inspection. In addition, the placement of pipe hangers and supports with respect to the welds requiring inspection was reviewed and modified, where necessary, to reduce the amount of plant support required in these areas during inspection.

Working platforms have been provided in many areas required to facilitate the servicing of pumps and valves. Temporary platforms, scaffolding, and ladders will be provided to gain access to the piping welds. The surface of the welds initially requiring ultrasonic or surface examination within the inspection boundary has been prepared to permit effective examination.

An inservice inspection design review was undertaken to evaluate access requirements of the ASME Boiler and Pressure Vessel Code with subsequent design modifications and/or inspection technique development to ensure Code compliance, as required, to the extent practical. The provisions for suitable access for inservice examinations minimizes the time required for these inspections to be performed and reduces the amount of radiation exposure to both plant and examination personnel.

Space is provided to handle and store insulation, structural members, shielding, and similar material related to the inspection. Suitable hoists and other handling equipment have also been provided. Lighting and sources of power for the inspection equipment are provided at appropriate locations.

6.6.3 EXAMINATION TECHNIQUES AND PROCEDURES

Prior to commercial operation, inspection locations, inspection techniques, inspection frequencies, and evaluation of examination data for Class 2 and 3 preservice examinations were in accordance with the technical requirements of the 1977 Edition of the ASME Boiler and Pressure Vessel Code, Section XI, with addenda through Summer 1978. The inspection locations, techniques, extent and frequency of inspections and the evaluation of examination data for Class 2 and 3 inservice examinations are in accordance with the technical requirements of the Edition and Addenda of ASME Section XI, as described at the beginning of USAR section 6.6 and documented in the inservice inspection program. Furthermore, the ultrasonic examination of ferritic, austenitic, and dissimilar metal piping welds will be performed in accordance with the same Edition and Addenda.

The visual, surface, and volumetric examination techniques and procedures are written in accordance with the requirements of Section XI, Subarticle IWA-2200.

The liquid penetrant or magnetic particle methods are used for surface examinations and radiography or ultrasonic (UT) methods (manual or remote) for volumetric examinations. Manual ultrasonic examination techniques are used for most volumetric examinations of Class 2 components. Reportable indications are mapped, and records are made of maximum signal amplitude, depth below the scanning surface, and length of the reflector. The data compilation format is such as to provide for comparison of data with subsequent examinations. Radiographic techniques may be used where ultrasonic techniques are not applicable. For areas where manual surface examinations or direct visual examinations are to be performed, reportable indications are mapped with respect to size and location in a manner to allow comparison of data to subsequent examinations.

6.6.4 INSPECTION INTERVALS

The inservice inspection schedule for Class 2 system components is developed in accordance with the requirements of Subarticles IWA-2400 and IWC-2400.

The schedule for the inspection of Class 3 system components is developed in accordance with the requirements of Subarticles IWA-2400 and IWD-2400.

The inspection interval, as defined in Subarticle IWA-2400 of Section XI, is a 10-year interval of service. These inspection intervals represent calendar years after the reactor facility has been placed into commercial service. The interval may be extended by as much as one year to permit inspections to be concurrent with plant outages. The examinations required by Subarticles IWC-2400 and IWD-2400 were performed completely, once, prior to initial plant startup. Inservice examinations are primarily performed during normal plant outages, such as refueling shutdowns or maintenance shutdowns occurring during the inspection interval. However, inservice examinations may be performed while the unit is on-line, if radiological and operational conditions permit access to the components.

6.6.5 EXAMINATION CATEGORIES AND REQUIREMENTS

Inservice inspection categories and requirements for Class 2 and 3 components and piping are in agreement with Tables IWC-2500-1 and IWD-2500-1, respectively except where an alternative is approved by the NRC as previously descried in 6.6.

Preservice examinations for Class 2 and 3 components following repair or replacement meet the requirements of Subarticles IWC-2200 and IWD-2200, respectively.

6.6.6 EVALUATION OF EXAMINATIONS

Prior to commercial operation, evaluation of examination results of Class 2 and 3 components for Preservice Inspection were in accordance with Article IWC-3000/IWD-3000 of the ASME Code, Section XI, 1977 Edition with Addenda through the Summer of 1978. Inservice Inspection examination results for Class 2 and 3 components are evaluated in accordance with the Edition and Addenda of ASME Section XI, as described at the beginning of USAR section 6.6 and documented in the inservice inspection program.

Repair and replacement of Class 2 and 3 components are performed in accordance with the requirements of ASME Section XI, as described in the opening paragraphs of USAR section 6.6 and documented in the repair and replacement program.

6.6.7 SYSTEM PRESSURE TEST

Class 2 systems subject to pressure tests are tested in accordance with Articles IWA-5000 and IWC-5000 and Table IWC-2500-1.

Class 3 systems subject to system pressure tests are tested in accordance with the requirements of Articles IWA-5000 and IWD-5000, and Table IWD-2500-1. Class 2 and 3 components are visually examined during the system pressure test in accordance with the requirements of Paragraph IWA-5240, once every 1/3 of each inspection interval. For systems, or portions of systems, required to be hydrostatically tested each inspection interval, the provisions of an applicable ASME Code Case as documented in the ISI program plan may be used to perform a system leakage test in lieu of the system hydrostatic test.

6.6.8 AUGMENTED INSERVICE INSPECTION TO PROTECT AGAINST POSTULATED PIPING FAILURE

An augmented inservice inspection program is conducted on high-energy piping between the required pipe break restraints located inside and outside the containment beyond the isolation valves. This program is conducted in accordance with the requirements set forth in Standard Review Plan 3.6.1, Branch Technical Position APCSB 3-1, B.2.d or as required per the risk-informed process for piping as outlined in EPRI report 1006937, Rev. 0.

If pipe break restraints are not provided, the area between the containment isolation valves and/or inside containment wall interface, of high-energy pipe, including valve/pipe circumferential welds, is subject to the augmented examinations, to the maximum extent practical.

The welds are examined using volumetric techniques for butt welds and surface examination techniques for socket welds once in each inspection interval.

High-energy fluid piping systems are defined as those fluid systems that, during normal plant conditions (i.e., reactor startup, operation at power, hot standby, and reactor cool-down to cold shutdown conditions), are in operation or maintained pressurized under either or both of the following conditions:

a. Maximum operating temperature exceeds 200°F.

b. Maximum operating pressure exceeds 275 psig.