15

REPAIR PROGRAM

- INTRODUCTION

Areas chosen for repair are based upon UT and VT examination.

Reinforcement pads or sleeves are welded to the pipe to assure system integrity.

- REPAIR DESIGN

Design of the pads or sleeves is similar to reinforcement required on reinforced fabricated branch connections - ANSI B31.1

Other Design Considerations:

- Installation is not difficult
- Design concept is simple

Physical Description of Sleeves

- CODES AND STANDARDS

- Repair meets original construction codes
- Repair performed to ASME Section XI requirements

- TESTING

- The piping is hydro tested to 1.5 times design pressure
- Hydro pressure is 10 times operating/accident pressure

- SUMMARY

- All areas of UT or VT are reinforced
- 19 of 79 possible joints are reinforced

C/10

REPAIR PROGRAM

Repair of Cracks on Safety Injection (Pump Suction) Piping System

Prairie Island
Nuclear Generating Plant

Unit 1

Revision 0, February 1, 1983

INTRODUCTION

This repair program addresses the temporary repair of welds, adjacent piping, and fittings in Safety Injection piping from the boric acid storage tank.

The welds repaired have indications of cracks. The cracks are detected by visual, ultrasonic, and/or radiographic inspection. The weld locations, indications, inspection methods, and repairs are listed in Appendix A.

The repairs consist of reinforcement sleeves and pads on or around the pipe which cover the cracked areas and are fillet welded to the pipe. In addition, sections of pipe removed for analysis are replaced. See Appendix B

REFERENCES

1. Fluor letter FN-4940, dated February 2, 1983

2. Fluor report entitled "Justification for Temporary Repair of Cracks Using Reinforcement Pads on the Safety Injection (Pump Suction) System"

REPAIR DESIGN

The Safety Injection System is a safety related system and must be operable during and after an accident. Therefore, the reinforcing must be reviewed with respect to the Final Safety Analysis Report to ensure that repair by the addition of the plates will not affect the operability of the system. The following discussion shows that reinforcing the piping as detailed in Appendix B, at locations where cracks have appeared, will not compromise the structural integrity of the Safety Injection System.

From a design point of view, reinforcing the piping as detailed (see Reference 2) is basically similar to the reinforcement required on reinforced fabricated branch connections. Section 104.3.1D of ANSI B31.1 Power Piping, discusses the concerns and design requirements for the reinforcement of fabricated branch connections. In general, the Power Piping Code requirements ensure that the pressure retaining metal area removed from the run piping when designing a fabricated branch connection is replaced by providing plates and/or saddles within the calculated "reinforcement" areas of the fabricated branch design. The amount of reinforcement is dependent on two parameters: The amount of pressure retaining pipe wall removed; and, the design pressure of the system.

In the case of repairing and reinforcing areas of the system where cracks have been discovered, pressure retaining metal has not been removed and the design pressure is low. Therefore, from a design point of view, the repair of cracks as detailed in Appendix B is an acceptable technique and is justified in accordance with ANSI B31.1 Power Piping.

CODE OF CONSTRUCTION

This portion of the Safety Injection System was designed in accordance with USAS B31.1.0-1967 and design specification for stainless piping SS-M380-69(NSP).

JURISDICTIONAL REQUIREMENTS

The ANI is notified prior to the repair. This program is available for ANI and NRC review.

CODE OF REPAIR

The repairs are conducted in accordance with ASME Code Section XI 1980 Edition with Addenda thru Summer 1982. The design of sleeves are in accordance with ANSI/ASME B31.1 1973 Edition with Addenda thru Summer 1973.

REPAIR DETAILS

The line is ASTM A312 TP304 pipe and ASTM A403 TP 304 fittings.

The temporary repairs are accomplished by welding reinforcement sleeves to the piping over and extending to both sides of each weld. The reinforcement pads, or sleeves, extend beyond the maximum extent at the crack indications as shown in Appendix A. The sleeves are ASTM A240 Type 304 stainless steel. The welds are made with Type 308 filler metal. The dimensions of the sleeve are shown in Appendix B. One section of the pipe will be replaced with ASTM A312 TP 304 stainless steel.

Welding is performed in accordance with ANSI/ASME Code B31.1 1973 Edition with Addenda thru Summer 1973. Welding procedures and welders are qualified to the Summer 1973 or later addenda of B31.1 and Section IX.

After completion of welding, the welds and the base metal within one inch on both ends of each sleeve are liquid penetrant inspected. All butt welds are radiographic and liquid penetrant inspected. Methods and acceptance criteria are in accordance with Section XI, 1974 Edition with Addenda thru Summer 1976.

All work is performed in accordance with Northern States Power Company Quality Assurance Program.

HYDROSTATIC TESTING

Following repair, the piping is hydrostatically tested to 1.5 times design pressure.

TABLE 1

Design Pressure	210 PSIG
Design Temperature	300°F
Maximum Operating Pressure	30 PSIG
Operating Temperature	190°F
Hydrostatic Pressure	315 PSIG

DOCUMENTATION

The temporary repairs are documented on Form NIS-2, "Owner's Report of Repair or Replacement," or Hartford Steam Boiler Form HSB-2033.

The following records are maintained at the Prairie Island Nuclear Generating Plant for the life of the plant.

1. Certified Material Test reports for the sleeve mateial, replacement piping, and filler metal
2. Welding procedure specifications and qualification records
3. Certification of records of welder qualifications
4. Nondestructive examination procedures and personnel qualifications
5. Welding Control Records
6. Certified Design Report(s) for Repairs
7. Work Packages
8. NDE Records

REPAIR PROCESS AND CONTROLS

- ASME Section XI Repair Program
- NSP Approved Quality Assurance Program
- Authorized Nuclear In-service Inspector review and inspection
- Welding procedures qualified and written per ANSI/ASME-B31.1 and ASME Section IX
    - techniques verified in all positions on mock-ups of reinforcements with and without water backing
    - 308 filler metal (low carbon chemistry)
    - interpass temperature control
- 304 reinforcing material
- Welders qualified per ASME Section IX
- Welder practice on mock-ups
- Monitoring by welding inspectors of adherence to welding procedure requirements
- Liquid penetrant inspection per ASME Section IX

APPENDIX A

Summary of Repairs

Location Weld # Side of Weld	Ultrasonic Indication Extent	Visual Indications Extent	Repair	Minimum Distance Between Sleeve * OT Indication
51 Pipe Side	360° < 7/16"	NONE	Sleeve 1.43	.278 Note 2
53 Pipe Side	360° < 7/16"	NONE	Sleeve 2.10	.612 Note 2
57	360° < 3/4"	NONE	Sleeve 2.10	.30 Note 2
58/56	360° < 3/4"	NONE	Sleeve 2.10	.30 Note 2
60	180° < 3/4"	Single Leak at 180° Position	Sleeve 2.10	.30
61	90° < 3/4"	Single Leak at 180° Position	Sleeve 2.10	.30
62	360°	Multiple @ 0°	Replaced	--------
63	360°	Multiple @ 0°	Replaced	--------
64	360° < 7/8"	Single Leak at 0°	Sleeve 2.50	.375
67 Elbow Side	360° < 7/16"	NONE	Sleeve 2.10	.612 Note 1 & 2
71 Pipe Side	360° < 7/16"	NONE	Sleeve 2.10	.612 Note 2
72 Pipe Side	360° < 7/16"	NONE	Sleeve 2.10	.612 Note 2
76	3 Spot Locations	Single Leak	Pad	.875
80	1 Spot Location	Single Leak	Pad	.875
85	1 Spot Location	Single Leak	Pad	.875
87	360° < 3/8"	Single Leak at 0°	Sleeve 2.10	.675
277	360° < 7/16"	NONE	Sleeve 2.10	.612 Note 2
278	360° < 7/16"	NONE	Sleeve 2.10	.612 Note 2
279	360° < 7/16"	NONE	Sleeve 2.10	.612 Note 2

NOTE 1 : Circumferential weld on the sleeve limited by access to 2700.

NOTE 2 : Weld of band on to the horizontal joint done only on the welds with leak indication.

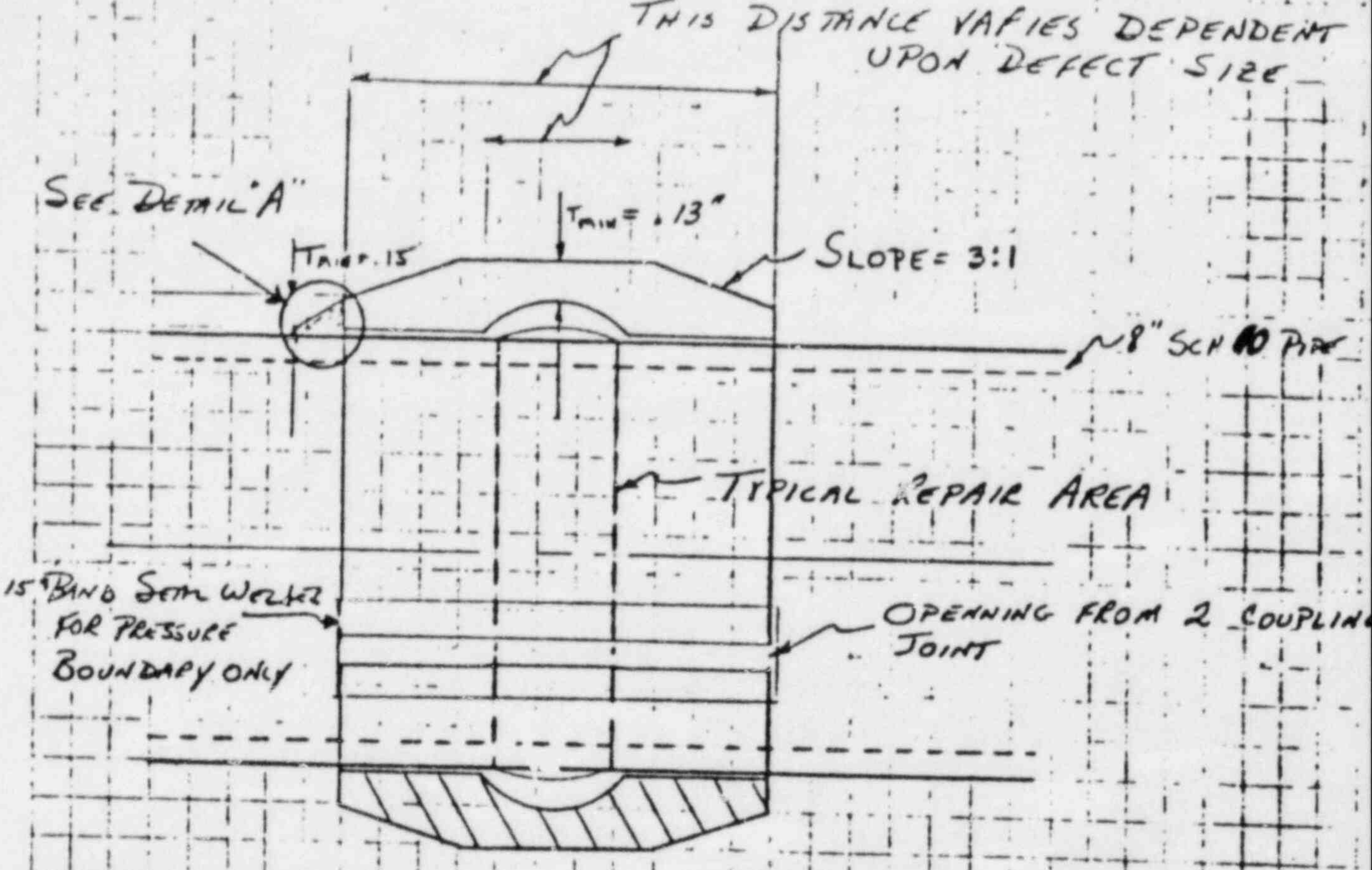
GENERAL COMPUTATION SHEET
FORM 17-4103

ATTACHMENT 1

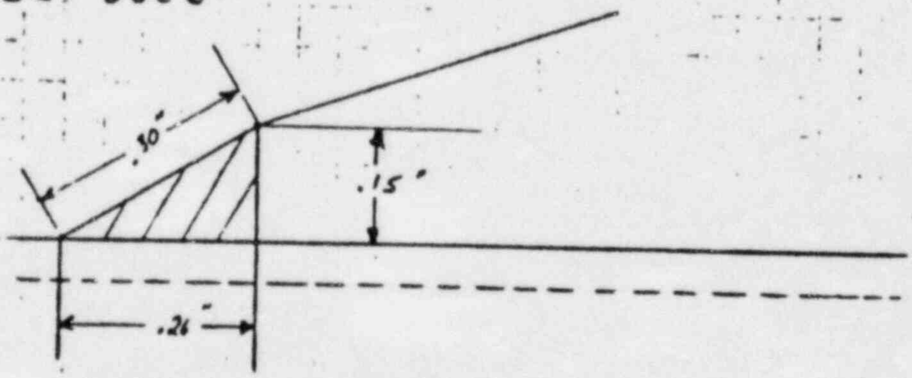
NSP Northern States Power Company

PROJECT Typical SI Line Repair Sketch
SUBJECT Using Coupling

E NO. 836743
SHEET NO. ____ OF ____
DATE ____
COMP. BY ____ CK'D BY ____



REQUIRED MINIMUM WELD DIMENSIONS FOR COUPLING THICKNESS OF .15". A WELD OF UNEQUAL LEGS SHALL BE USED

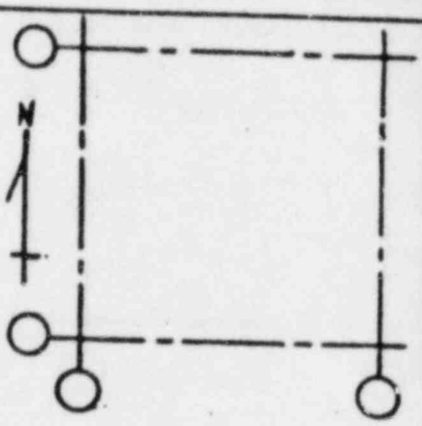


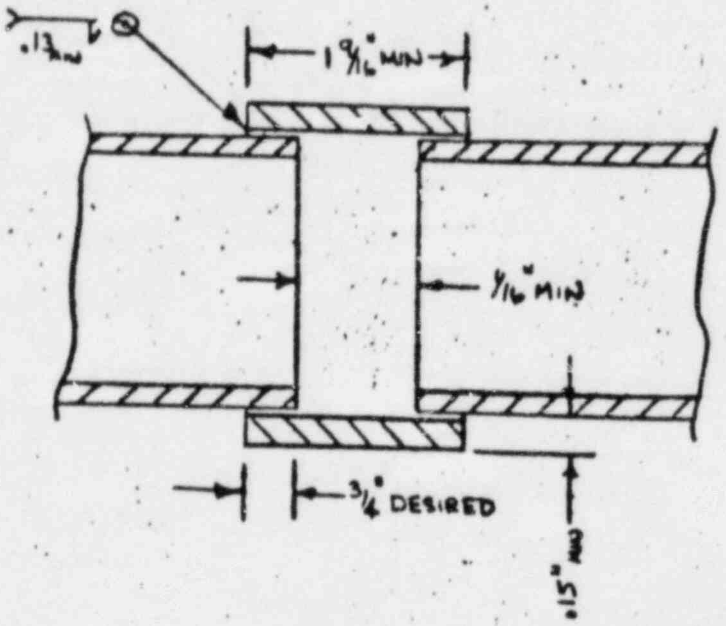
DETAIL "A"

[illegible] VI

G	1	2	3	4	5	6

SERVICE: SAFETY INJECTION





REVISIONS

8" PIPE COUPLING A240 TP 304 OR A312 TP 304

Appendix B2

REF. DWGS:

NSP CO. PRAIRIE ISLAND NUC. GEN. PLT. UNIT: ONE AND TWO

NSP NO.: REV:

TITLE SUCTION LINE FROM BAST TO SI PUMPS

VENDOR NO.:

16

SYSTEM DESCRIPTION

1. One 5000 gallon 3/8" thick 304 SS for each unit with one spare tank located on the 735' level.

2. One 8" schedule 10 304 SS pipe connecting tank to S.I. pump suction at 695' level.

3. Tanks heated with 2 electric immersion heaters and the line heated with electric heat tracing.

4. 10 gate valves, 304 SS castings, 6 have motor operators.

5. Temperature maintained at 180°F in tank and line.

6. The line sees ~ 5 psig near tank and ~ 25 psig near pumps. Pressure decreases rapidly during accident condition.

FLAW EVALUATION

- MATERIAL
  - 304 S.S.
  - 8" SCH 10 (8.625 OD X 0.158 WALL)

- LOADS
  - TEMPERATURE ≤ 250°F
  - PRESSURE APPX 10 PSI
  - PIPE LOADS APPX 1/3 OF ALLOWABLE (MOST LOCATIONS)

- NET SECTION COLLAPSE
  - PROPOSED ASME SECTION XI PROCEDURE LIMITS CRACK DEPTH TO:
    - o 75% OF WALL, OR
    - o FACTOR OF SAFETY OF 3.0
  - USED
    - o THRU WALL CIRCUMFERENTIAL CRACKS
    - o FACTOR OF SAFETY OF 3.0
    - o WORST CASE MEMBRANE OR BENDING

nutech

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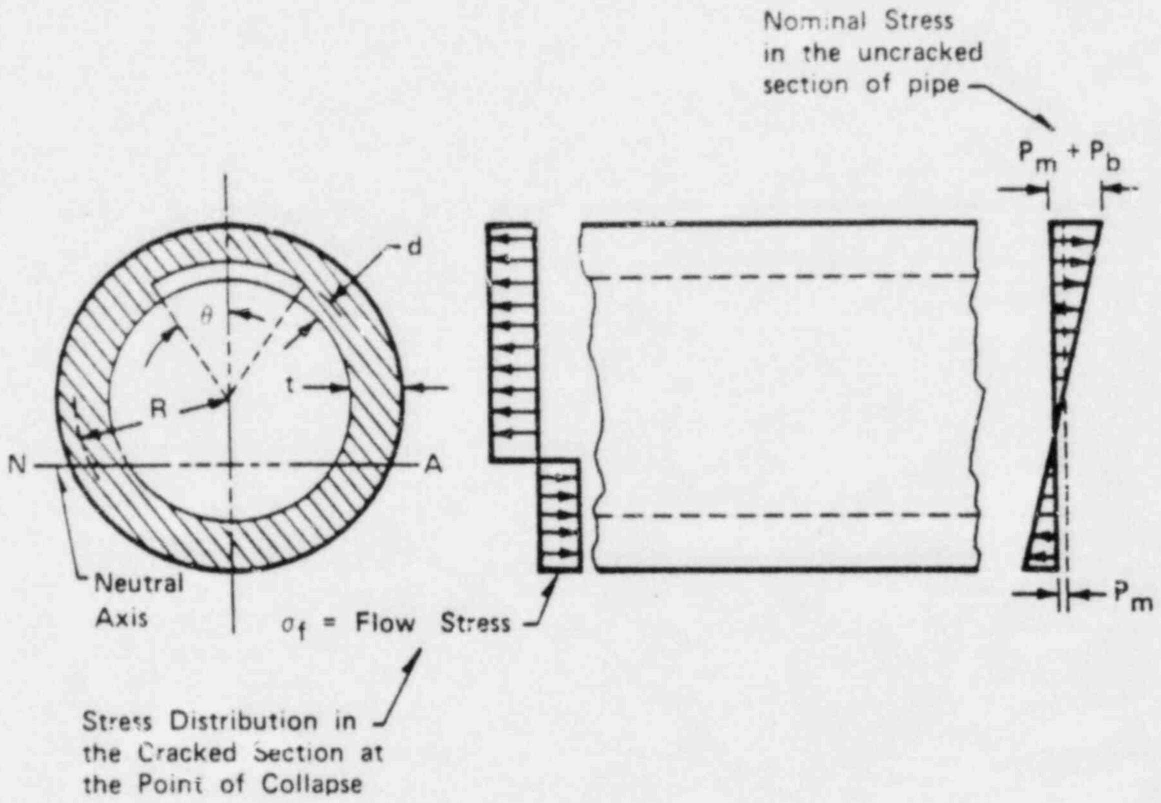


SCHEMATIC ILLUSTRATION OF NET SECTION COLLAPSE APPROACH

nutech
ENGINEERS

PROPOSED TABLE IWB-3641-1

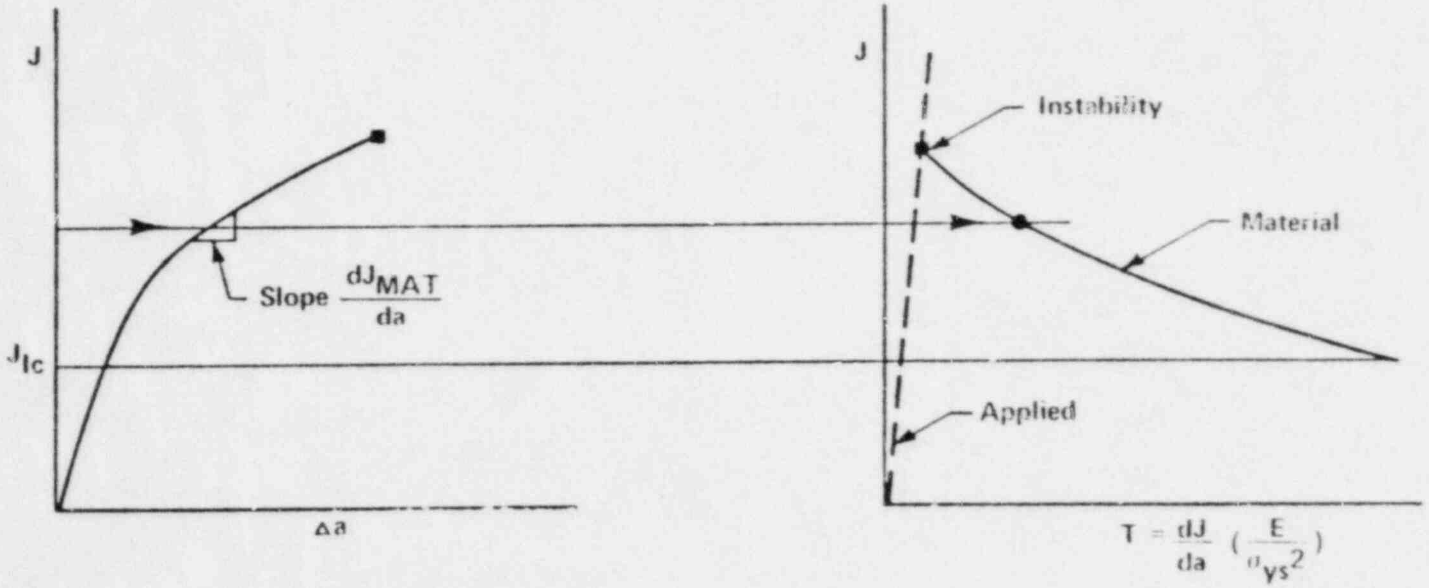
ALLOWABLE END-OF-INSPECTION PERIOD SIZE FOR CIRCUMFERENTIAL FLAWS NORMAL CONDITIONS

$\frac{P_m + P_b}{S_m}$ (1)	Ratio of Length to Circumference				
	0.1	0.2	0.3	0.4	0.5 or more
	Ratio of Flaw Depth to Thickness (2)				
1.5	(3)	(3)	(3)	(3)	(3)
1.4	0.30	0.20	(3)	(3)	(3)
1.3	0.48	0.38	0.28	0.18	0.18
1.2	0.66	0.56	0.46	0.36	0.26
1.1	0.73	0.63	0.53	0.43	0.33
1.0	0.75	0.70	0.60	0.50	0.40
0.9	0.75	0.75	0.66	0.56	0.46
0.8	0.75	0.75	0.72	0.62	0.52
0.7	0.75	0.75	0.75	0.68	0.58
0.6	0.75	0.75	0.75	0.73	0.63

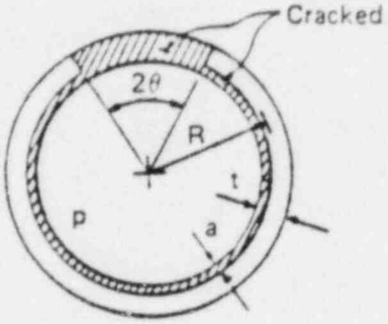
(1) P_m = Primary Membrane Stress
P_b = Primary Bending Stress
S_m = ASME Code Design Stress at Temperature

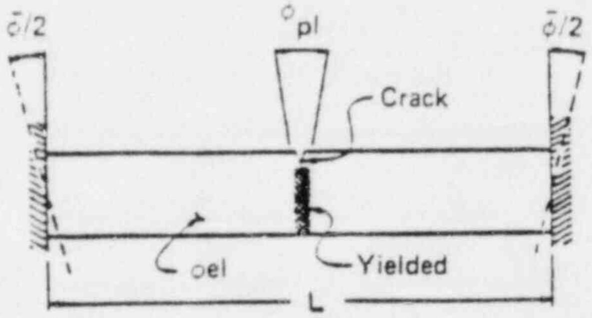
(2) Crack Depth = a for a Surface Flaw
2a for a Subsurface Flaw

(3) IWB-3514-3 Standards Govern



TEARING MODULUS CONCEPT FOR STABLE CRACK GROWTH



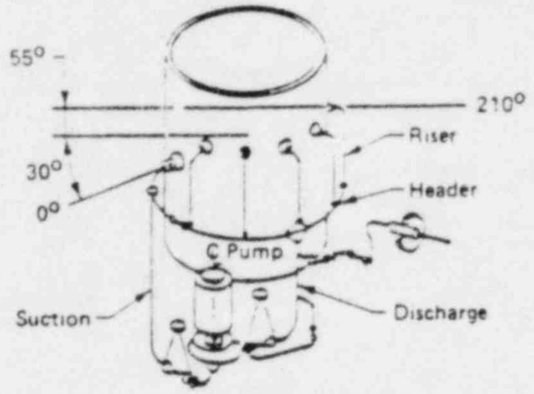


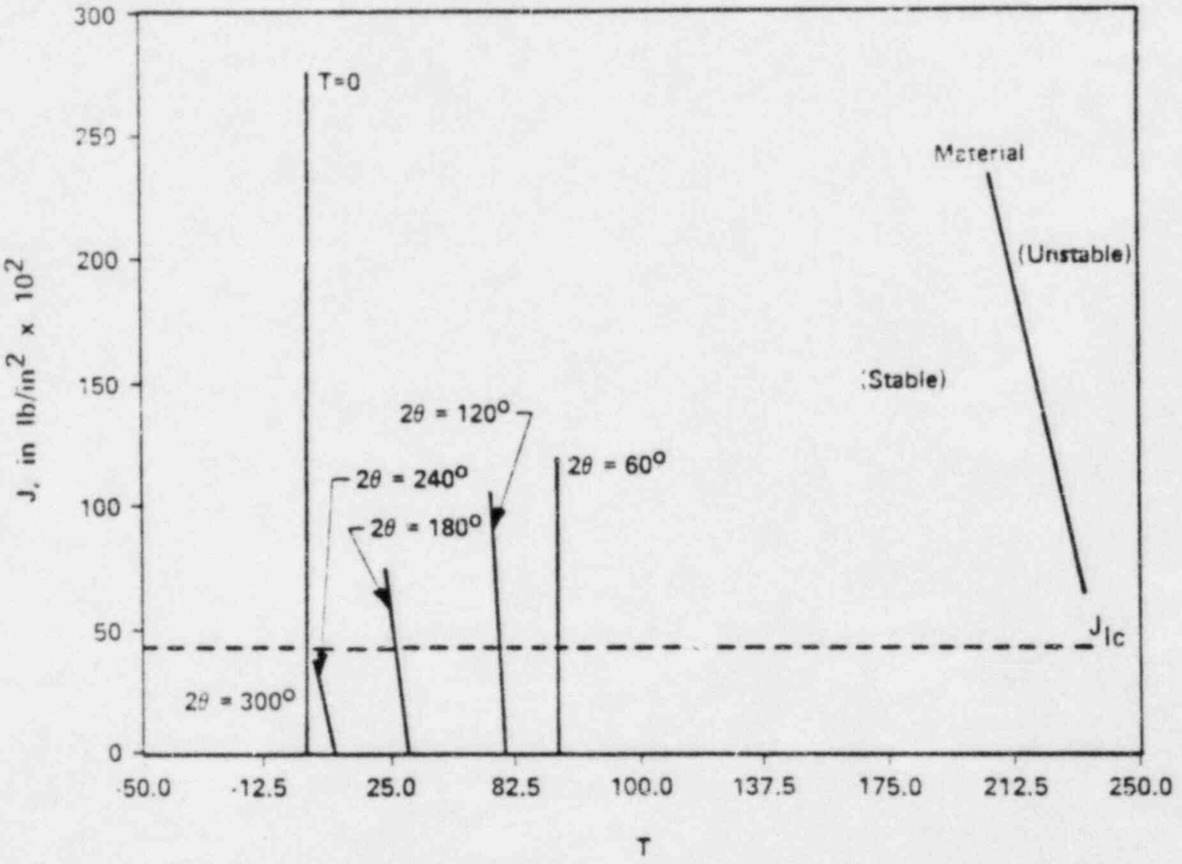
$$J = \sigma_o R \underbrace{F_j(\theta, a, P)}_{1.0 \sim 2.0} \phi$$

$$T = \frac{L}{R} \underbrace{F_1(\theta, a, P)}_{0.2 \sim 1.3} + \frac{JE}{\sigma_o{}^2 F} \underbrace{F_2(\theta, a, P)}_{\cdot 0.5 \sim 0.5}$$

APPROXIMATE ANALYSIS OF J AND T FOR A CIRCUMFERENTIALLY CRACKED PIPE UNDER FIXED END ROTATION

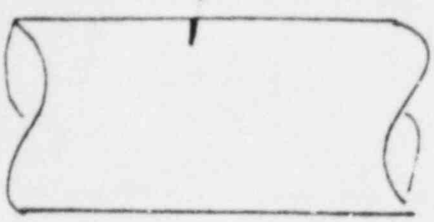
nutech ENGINEERS

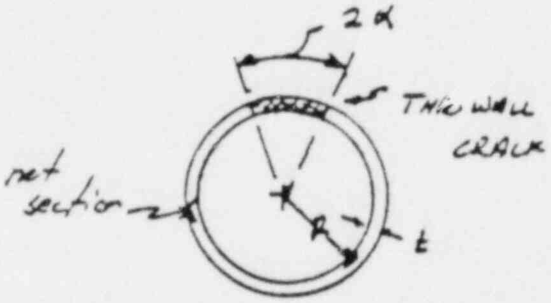




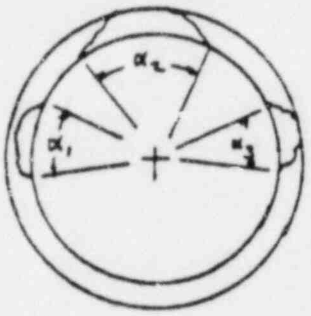
STABILITY ANALYSIS FOR BWR RECIRCULATION SYSTEM (STAINLESS STEEL)

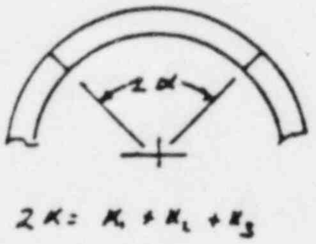
NET SECTION COLLAPSE





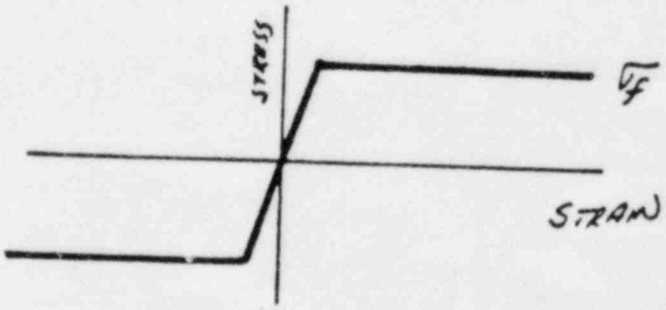
Assume the bounding crack geometry is through wall with an arc length of 2α. For evaluation, the cracks would be treated as follows:





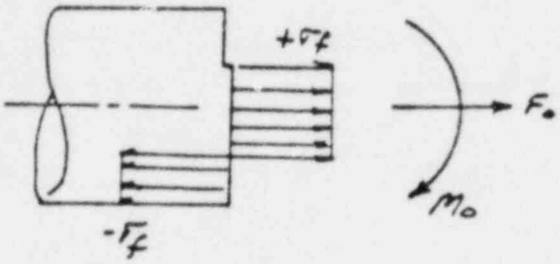
$2\alpha = \alpha_1 + \alpha_2 + \alpha_3$

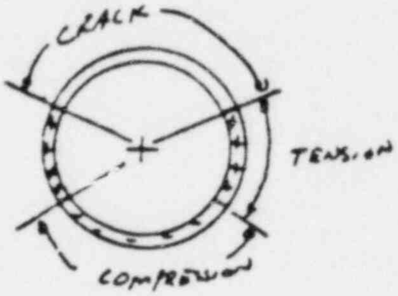
The net section collapse is calculated based on a non-strain-hardening material stress-strain curve:

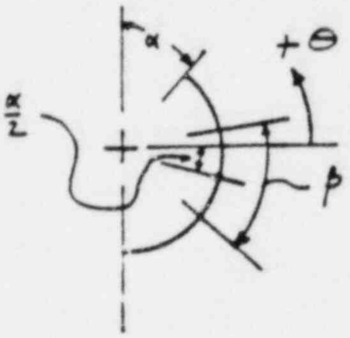


The flow stress (σ_f) is lower bounded by the material yield stress (S_y) and upper bounded by the ultimate stress (S_u).

The stress distribution at the net section is:







We will start with σ_f and Fo and calculate the resulting Mo.

From sum of forces:

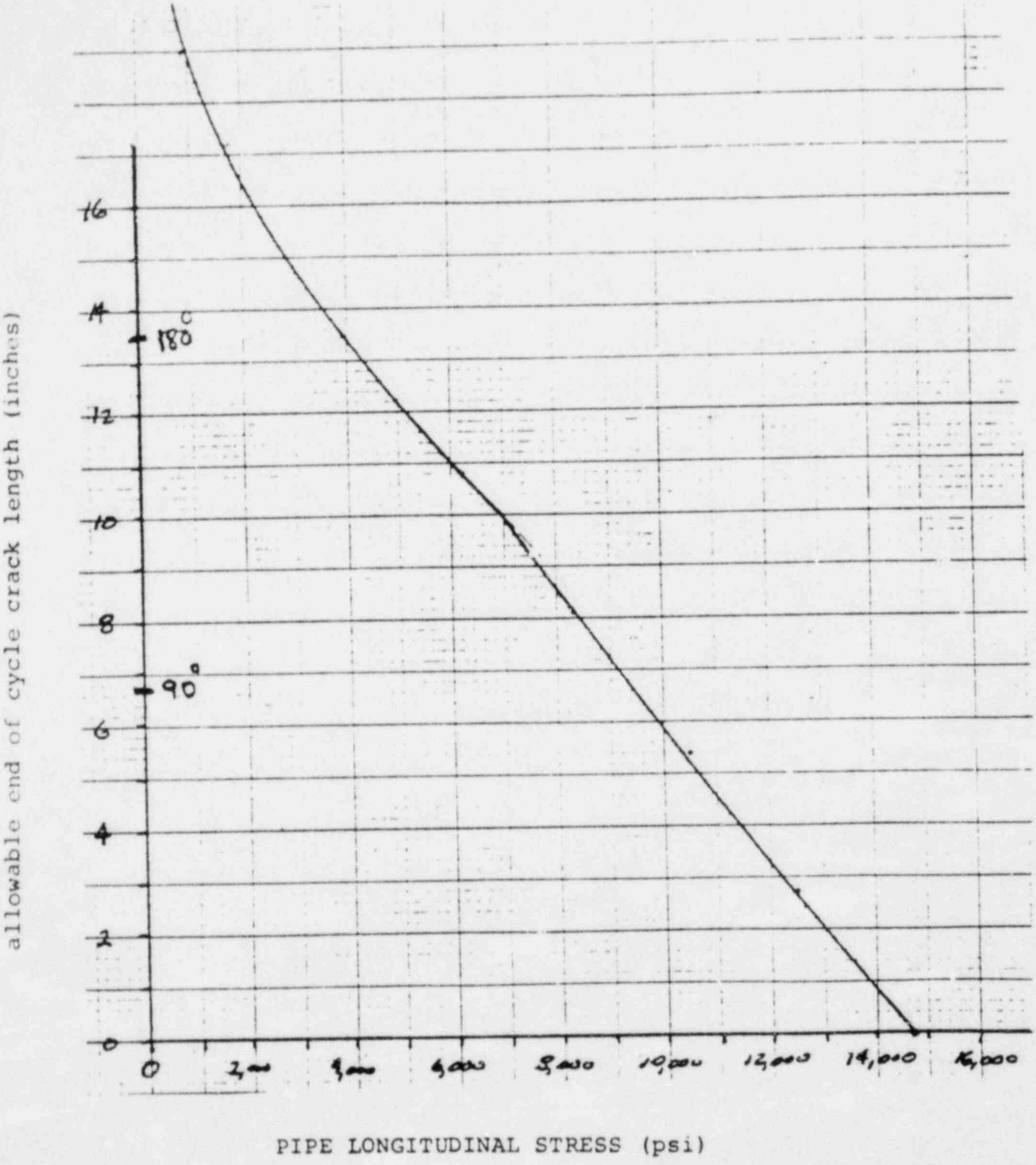
$$F_o = 2Rt\beta\sigma_f \qquad (1)$$

The neutral axis must be at $-\frac{\ }{2}$ so that the remaining tension and compression regions will balance.

$$M_o = -2t\sigma_f \int_{-\pi/2}^{-(\frac{\alpha}{2}+\frac{\beta}{2})} R\sin\theta \; Rd\theta + 2t\sigma_f \int_{-(\frac{\alpha}{2}+\frac{\beta}{2})}^{\pi/2-\alpha} R\sin\theta \; Rd\theta$$

$$= 2tR^2\sigma_f\left[2\cos\left(\frac{\alpha+\beta}{2}\right) - \sin\alpha\right] \qquad (2)$$

ALLOWABLE CRACK LENGTH RESULTS



FLAW EVALUATION CONCLUSIONS

- FOR FLAW LOCATIONS EVALUATED, ALLOWABLE THRU-WALL CRACKS WERE

WELD NO	STRESS	ALLOWABLE FLAW LENGTH
62	6900 PSI	10" (133^0 OF CIRC.)
63	5000 PSI	12" (159^0 OF CIRC.)

- THEREFORE, THE OBSERVED CRACKS IN THESE WELDS DO NOT REDUCE THE LOAD CARRING MARGINS OF SAFETY BELOW CODE ALLOWABLES.

- SIMILAR RESULTS EXPECTED GENERICALLY FOR ALL WELDS IN THIS RELATIVELY LOW-STRESS SYSTEM

(20

ULTRASONIC METHODOLOGY 8", .150" [illegible]

A basic pulse-echo procedure in accordance with Appendix III of ASME Section XI - 1974 Edition, through Summer 1976 addenda.

The calibration blocks were standard Section XI pipe segments containing 10% flat-bottomed notches.
+ U.T. [illegible] THRU WALL CRACK

Ultrasonic testing equipment - Nortec 131-D digital/analog UT instrument coupled to a two channel strip chart recorder.

Miniature (1/4" x 1/4") 5.0 Megahertz shear wave search units provided refracted angles of 45°, 52°, and 70° in the material tested.

[illegible]

Manual scanning was performed at a <u>minimum</u> of two times (+6dB) the primary reference sensitivity (DAC Level).

Ultrasonic teams consisted of inspection personnel certified in accordance with ASNT-TC-1A:

A) Level II performs the scan

B) Level I runs the recorder

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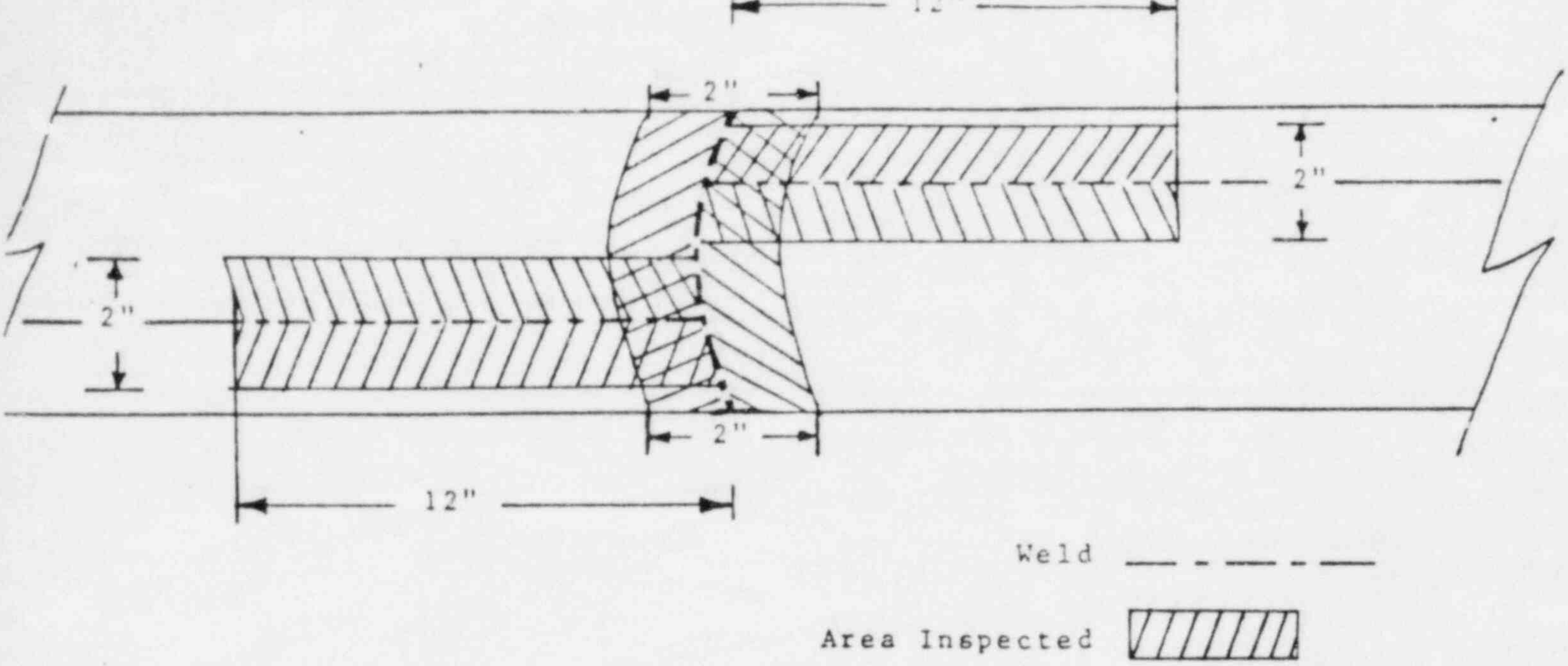
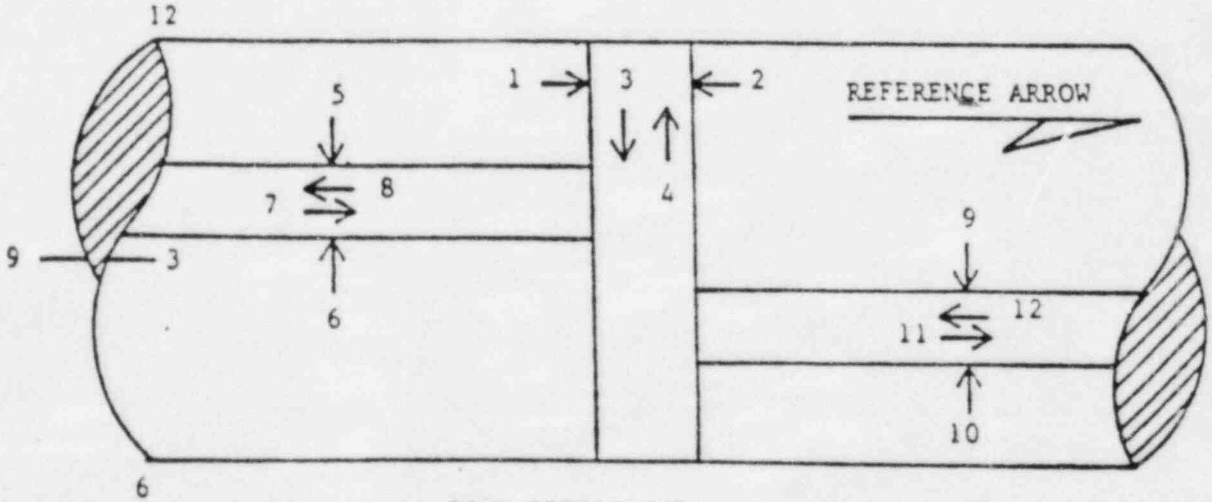
EXAMINATION COVERAGE





SCAN DIRECTIONS

22

PREVIOUS TESTING VS 1983 RESULTS

WELD ID NUMBER	YEAR INSPECTED	1983 INSPECTION RESULTS
58	1981	NAD
68-6[illegible] L.S	1981	NAD
74	1980	NAD
75	1980	NAD
80	1980	LEAK POINT NO. [illegible]
81	1980	NAD
98	1981	NAD
99	1980	NAD
235	1980	NAD
236	1980	NAD
238	1981	NAD
238-86W L.S.	1981	NAD
239	1980	NAD
243	1980	NAD
51-52-53 L.S.	1980	NAD

L.S. = LONG SEAM

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ULTRASONIC RESULTS

Welds Inspected = 77 Total

Welds with 360° intermittent circumferential indications = 16 Total (20.8%)

These are weld numbers:

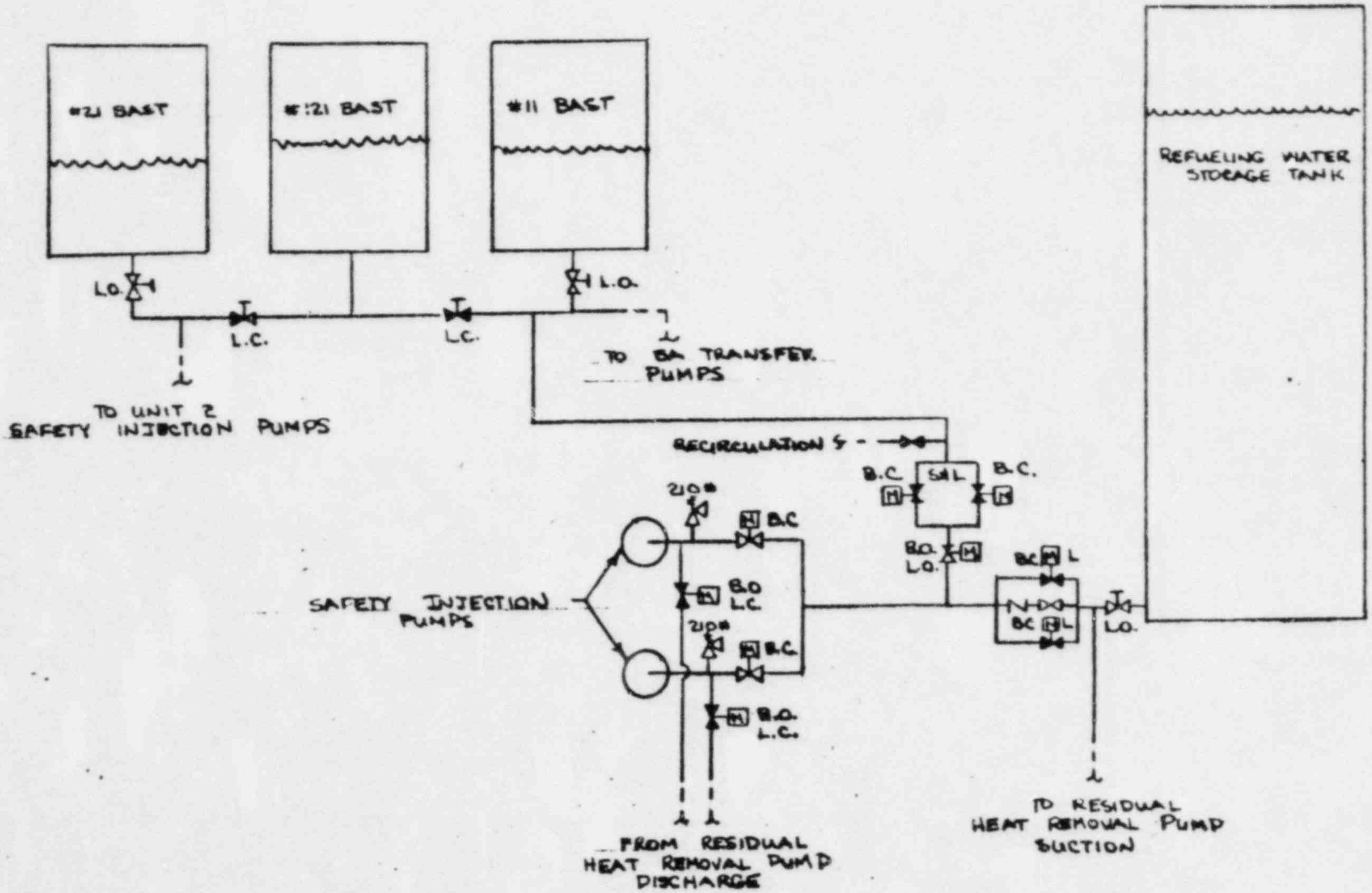
51
53
67
71
72
277
278
279
57
56
60
61
62
63
64
87

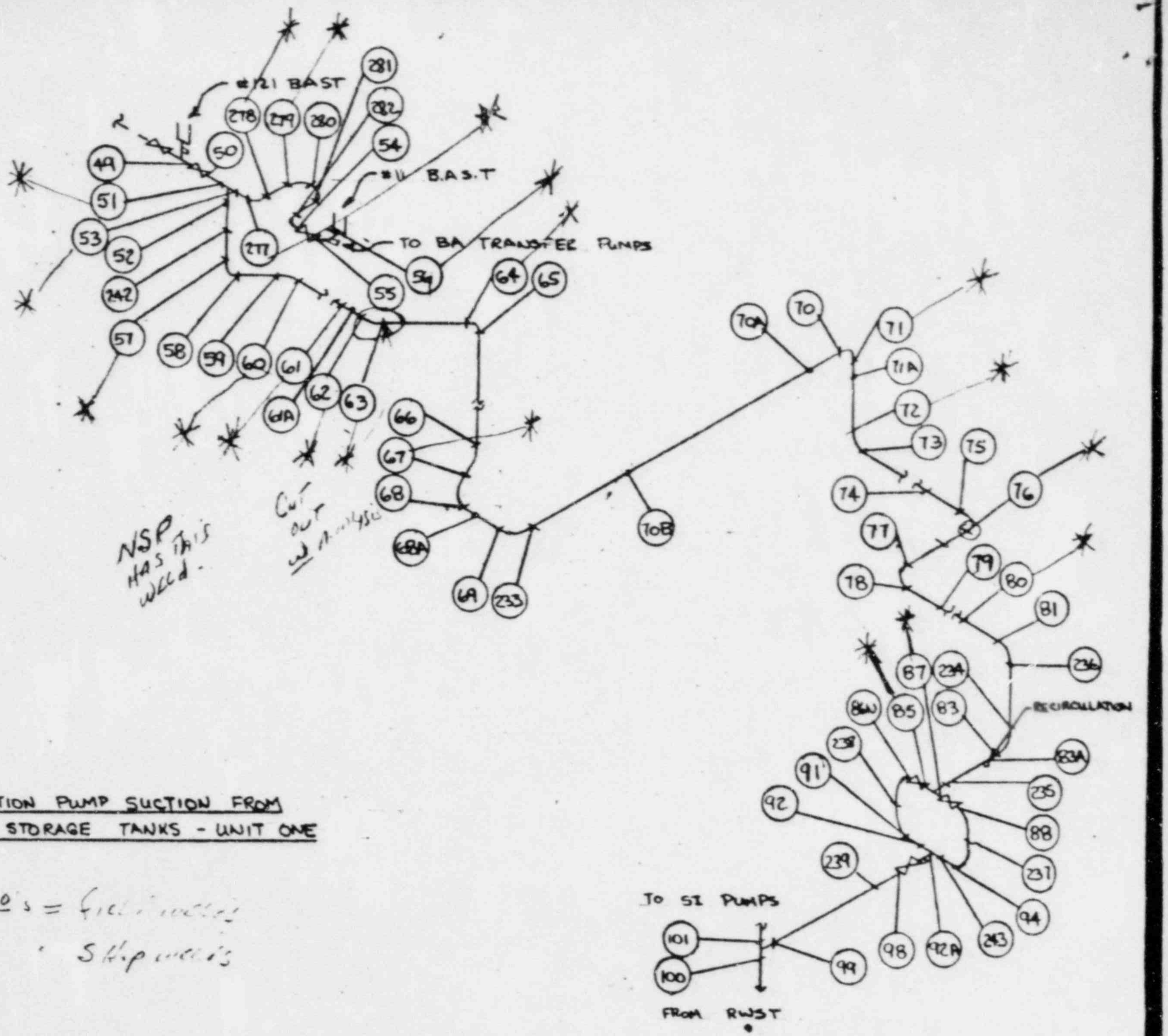
Welds with spot/axial indications = 3 Total (3.9%) · [illegible]

These are weld numbers:

76 80 85

Conclusion: The ultrasonic techniques employed provided conservative and adequate capabilities for the detection of stress corrosion cracks in this system.


#21 BAST
#121 BAST
#11 BAST
REFUELING WATER STORAGE TANK
L.O.
L.C.
L.C.
L.O.
TO BA TRANSFER PUMPS
TO UNIT 2 SAFETY INJECTION PUMPS
RECIRCULATION $
B.C.
SAL
B.C.
B.O.
L.O.
BC
L
BC
L
L.O.
210#
B.C.
B.O
L.C.
210#
B.C.
B.O.
L.C.
SAFETY INJECTION PUMPS
FROM RESIDUAL HEAT REMOVAL PUMP DISCHARGE
TO RESIDUAL HEAT REMOVAL PUMP SUCTION



SAFETY INJECTION PUMP SUCTION FROM
BORIC ACID STORAGE TANKS - UNIT ONE

3 digit No's = field welds
2 " " " Shop welds

TO [illegible]

FROM LEWIS

Reg folder

Henderson

㊲

The justification for permitting continued operation of ANO-1 subsequent to the identification of cracks in the 10-inch, schedule 10 piping of the reactor building spray system was based on the following:

1. The cracks occurred in the reactor building spray (RBS) piping, a low pressure low temperature system and is not connected to the reactor coolant system. The system normal operating pressure about 30 psig and 100 degrees of fahrenheit. The system design is 75 psig and 300°F.

2. The RBS system is redundant and only one of the two RBS systems is required to perform its intended safety function.

3. The cracks occurred in the weld heat affected zones of the 10-inch schedule 10 pipe and was identified as intergranular stress assisted corrosion cracking. All cracks occurred in an isolated section of pipe (crossover pipe) or in a section that was readily isolatable (RBS pump suction).

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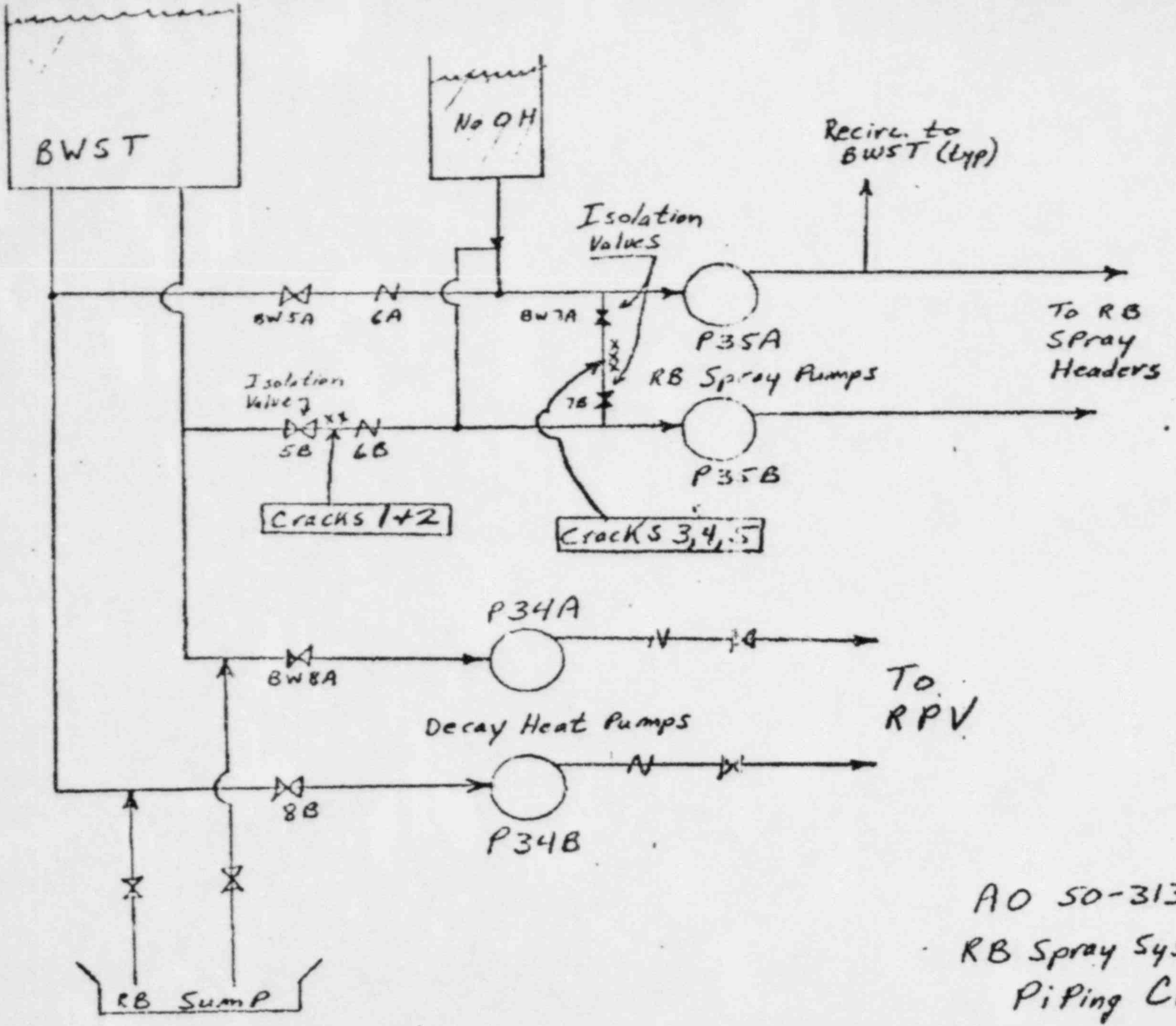
4. The RBS piping is located in an area that can be periodically inspected, both by visual and radiography. Increased surveillance was implemented. The cracks occurred in an area outside the containment that was readily accessible in any operating mode.

5. Cracks 1 and 2 occurred during a period of reactor shutdown and were repaired prior to startup. (See attached drawing) Crack 2 occurred in a weld that was made during the repair of Crack 1.

6. Cracks 3, 4, and 5 occurred in a normally isolated crossover section of pipe, whose failure would have no effect on system operation.

7. Region II inspectors, including a metallurgist inspected the failed pipe, the installed piping and reviewed the licensee's proposed investigation into the cause of the failure and the examination of insitu piping. In addition, NRC retained Battelle to conduct an independent examination of a section of the schedule 10 pipe.

8. The actions proposed and implemented by the licensee, were considered by Region II to be adequate to assure that the plant could be operated, without degradation of safety.



AO 50-313/74-11
RB Spray System
PiPing CracKS

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6.1.4 TESTS AND INSPECTIONS

All active components, listed in Table 6-[illegible], of the emergency injection system will be tested periodically to demonstrate system readiness. Performance of active systems can be tested by establishing flow and observing pressures and flows during scheduled shutdowns. The HPI system will be inspected periodically during normal operation for leaks from pump seals, valve packing, and flanged joints. During operational testing of the LPI pumps, the portion of the system subjected to pump pressure will be inspected for leaks. Items for inspection will be pump seals, valve packing, flange gaskets, heat exchangers, and safety valves for leaks to atmosphere.

6.2 REACTOR BUILDING SPRAY SYSTEM

6.2.1 DESIGN BASIS

The reactor building spray system is designed to furnish building atmosphere cooling to reduce the post-accident building pressure to nearly atmospheric pressure. In addition, alkaline sodium thiosulfate in the spray is provided in more than adequate quantities to remove the fission product iodine inventory from the containment atmosphere.

6.2.2 SYSTEM DESIGN

6.2.2.1 System Description

A schematic diagram of the system is shown in Figure 6-3. Corresponding interfaces are shown on the decay heat removal system schematic, Figure 9-12.

The reactor building spray system serves only as an engineered safeguard and performs no normal operating function. In the event of a major loss-of-coolant accident the system sprays a chemical spray solution into the reactor building atmosphere to reduce the post-accident energy and to remove fission product iodine. The system consists of two pumps, two reactor building spray headers, and the necessary piping, valves, instrumentation, and controls. In addition a tank containing sodium thiosulfate is supplied for iodine removal and a tank containing sodium hydroxide is included for pH adjustment of the borated water. The pumps and remotely operated valves may be operated from the control room. The reactor building spray system is sized to furnish 100% of the design cooling capacity and 200% of the design iodine removal capability with both of the spray paths in operation. Both paths operate independently, and the reactor building spray system also operates separately from the reactor building cooling units, which independently possess full post-accident cooling capability.

A high reactor building pressure signal from the engineered safeguards actuation system initiates reactor building spray operation. Table 6-12 shows the reactor building pressure actuation level. The two pumps start and take suction initially from the BWST through the low pressure injection system piping. The chemical spray solution is injected in the building atmosphere through the spray headers and nozzles. Upon receipt of the safeguards signal, the valves at the outlet of the sodium hydroxide tank and at the outlet of the sodium thiosulfate tank open, permitting gravity draining and mixing with water from the BWST. No pumping action is required to inject these chemicals into the lines of the suction side of the reactor building spray pumps.

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The sodium thiosulfate tank and the sodium hydroxide tank are designed and located to permit gravity draining into the system at a rate commensurate with the draining rate of the BWST. The contents of each tank are proportioned so that the correct amount of sodium thiosulfate is injected for iodine removal and the proper quantity of sodium hydroxide is injected for pH control. Sodium thiosulfate will react rapidly with the iodine released to the building atmosphere and convert it to a non-volatile iodide, which is retained in the spray solution. The sodium hydroxide raises the pH of the borated water into the alkaline range (approximately 9.5), where the sodium thiosulfate is most stable. Section 14 reviews the effectiveness of the alkaline sodium thiosulfate spray.

After the water in the BWST reaches a low level, with the emptying of the sodium thiosulfate and the sodium hydroxide tanks, the spray pump suction is transferred to the reactor building sump when the operator places the low pressure injection system in the recirculation mode. The reactor building sump water is cooled by the decay heat removal coolers.

6.2.2.2 Quality Control Codes and Standards

The equipment is designed to the applicable codes and standards given in Section 9 and Tables 6-2 and 6-7.

Components and piping in the reactor building spray system are designated as Class I equipment and are designed to maintain their functional integrity during an earthquake. Appendix 5A defines the acceptable stress limits for Class I equipment; Section 1.6 describes the quality program.

6.2.2.3 Material Compatibility

All wetted materials are compatible with the reactor coolant and the alkaline thiosulfate solution. The major components of the system are constructed of stainless steel. Minor parts such as pump seals utilize other corrosion resistant materials.

None of the active components of the reactor building spray system are located within the reactor building, so none are required to operate in the steam-air environment produced by the accident.

6.2.2.4 Component Design

Piping

Except for the section of lines requiring flanged connections for maintenance, the entire system is of welded construction. Table 6-3 lists the design conditions for this system. The piping shown on Figure 6-3 is designed to ANSI Code for Pressure Piping B31.1 and is fabricated and inspected in accordance with ANSI Nuclear Power Piping Code B31.7.

Pumps

The reactor building spray pumps are similar to those used in refinery service. These pumps are liquid-penetrant tested by methods described in the ASME Boiler and Pressure Vessel Code Section VIII and are hydrotested and qualified to be able to withstand pressures equal to or greater than 1.5 times the design pressure. The system is designed so that periodic testing of the pumps may be performed to assure operability.

Curves of total dynamic head and NPSH versus flow are shown in Figure 6-9.

Valves

The valves of the reactor building spray system are designed and inspected to the same code requirements as the valves in the emergency core cooling systems. Refer to Section 6.1.2.4.

Spray Headers and Nozzles

The reactor building spray nozzles are arranged on each of the two sets of concentric reactor building spray headers. The spray nozzles are spaced in the headers to give uniform spray coverage of the reactor building volume above the operating floor with one or both of the spray header systems in operation.

Instrumentation

The engineered safeguards actuation instrumentation for the reactor building spray system employs redundant channels and is described in Section 7.

Coolant Storage

This system shares BWST capacity with the HPI system and the LPI system. Sodium thiosulfate and sodium hydroxide tankage information is given in Table 6-7.

Motors

The reactor building spray pump motors are designed to the same requirements as the emergency core cooling system motors. Refer to Section 6.1.2.4.

6.2.2.5 Reliability Considerations

A failure analysis has been made on all active components of the system to show that the failure of any single active component will not prevent fulfilling the design function. This analysis is shown in Table 6-6.

6.2.2.6 Missile Protection

Protection against missile damage is provided by direct shielding or by physical separation of duplicate equipment. The spray headers are located outside and above the primary and secondary concrete shield.

6.2.2.7 Actuation

A description of the Engineered Safeguards Protective System is given in Section 7.1.3. Table 6-12 gives spray actuation setpoints.

6.2.3 DESIGN EVALUATION

The reactor building spray system, acting independently of the reactor building cooling system, can reduce the building pressure to near atmospheric level after a loss-of-coolant accident. In combination with the reactor building cooling units, it provides redundant alternative methods to maintain containment pressure at a level below design pressure. Any of the following combinations of equipment will provide sufficient heat removal capability to accomplish this:

a. The reactor building spray system.

b. Four reactor building cooling units.

c. Two reactor building cooling units and the reactor building spray system operating at one-half capacity.

6.2.4 TESTS AND INSPECTION

The components of the reactor building spray system can be tested as shown in Table 6-8.

During these tests, the equipment can be visually inspected for leaks. Valves and pumps will be operated and inspected following maintenance on the system to assure proper operation.

6.3 REACTOR BUILDING COOLING SYSTEM

6.3.1 DESIGN BASES

Reactor building cooling is provided to limit post-accident reactor building pressure to the design value. The cooling system consists of four 25 percent capacity units.

6.3.2 SYSTEM DESCRIPTION

The schematic flow diagram of the reactor building cooling system and associated instrumentation is shown in Figure 6-4.

Emergency and normal cooling are performed with the same basic units. Each unit contains normal and emergency cooling coils and a single speed fan. During normal plant operation, chilled water from the plant main water chillers is circulated through the normal cooling coils in 3 of the 4 units. For emergency cooling all units operate under post-accident conditions with the heat being rejected to the service water system. Each of these units can remove 60×10^6 Btu/h under peak reactor building temperature conditions. Figure 6-5 shows the cooling coil characteristics versus building ambient conditions for these units. The design data for the cooling units are shown in Table 6-9.

6.3.3 DESIGN EVALUATION

The reactor building cooling system provides the design heat removal capacity for the reactor building following a loss-of-coolant accident. The system

Table 6-3 (Cont'd)

		Temp, F	Pressure, psig
4.	**Reactor Building Spray System**		
	a. From the connection with the decay heat removal system at the isolation valve to the reactor building spray pumps.	300	75
	b. From the reactor building spray pumps to downstream of the reactor building spray actuation valves.	300	350
	c. From downstream of the inlet valves through the nozzles.	300	59