APPENDIX 3.9B

DESCRIPTION OF SEISMIC ANALYSIS AND SUMMARY OF RESULTS
FOR NON-NSSS SUPPLIED ACTIVE PUMPS AND THEIR SUPPORTS

3.9B.1 CHILLED WATER PUMPS

Description

→
The Chilled Water Pumps are Ingersoll-Dresser Model 4x3x13 HOC and the Chilled Water Motors which operate the pumps are Buffalo Forge Company Mode 4013 CRE. The pumps are designed in accordance with ASME Code Section III, Code Class 3, 1986 Edition, No Addenda, Subsections ND and NF. The 1986 code Edition will meet or exceed the requirements of the 1974 Code Edition including the Summer 1975 Addenda. The Motors are designed to ASME Code, Section III, Class 3, 1974 Edition, including Summer 1975 Addenda. The Seismic Analysis Report TR-9233 dated September 15, 1993 and The Structural Integrity Design Report TR-9232 dated September 15, 1993 by Ingersoll Dresser Pumps and Seismic Stress Analysis of Buffalo Forge Pumps Report ME-370 dated January 6, 1977 by Mcdonald Engineering Analysis Co. show that the pumps and the motors are structurally adequate to withstand the specified loads and will perform their intended function during normal steady state loads, OBE loads plus maximum nozzle plus normal loads; and SSE loads plus maximum nozzle plus normal loads.
←

The following seismic loads were applied to the center of mass of each pump component:

	OBE	SSE
Horizontal	0.5g	1.0g
Vertical	0.34g	0.67g

→
←
→
Note: For latest summary of stresses, deflections and loads, refer to Seismic stress reports filed under SQ-HV-13.
←

3.9B.2 CONTAINMENT SPRAY PUMPS

Description

The Containment Spray Pumps are B&W Type 6 x 8 13 SMK pumps. The pumps are designed in accordance with the ASME Code Section III, Class 3, 1971 Edition through Winter 1972 Addenda. The seismic analysis (B&W Seismic Report No. 7131-2.3.8/1-0, dated October 10, 1974) shows that the pumps are structurally adequate to withstand the specified loads and will perform its intended function during normal operating loads plus OBE loads plus nozzle loads and SSE loads plus nozzle loads plus normal operating loads. Since the actual SSE stresses and deflections are lower than OBE's allowable, only SSE case is given.

The following seismic loads were applied to the center of mass of each pump component:

	OBE	SSE
Horizontal	0.5g	1.0g
Vertical	0.34g	0.67g

→
←

APPENDIX 3.9B

Summary of Results

A summary of the stresses, deflections and loads is given below. The calculated values are compared to the referenced Codes or manufacturer's allowables. The allowable stresses for pressure retaining materials are determined from Section III of the ASME Code for the pump design temperature of 250F.

Normal Operating Loads + Nozzle Loads + SSE Loads

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference for Allowable
Casing Stress, psi (inside surface)	SA351-CF8	5,314	14,200	ASME
*Foundation Bolt Stress, psi (pullout force)	A36	12,642	21,600	AISC
*Attachment Bolt Stress, psi (Axial)	SA193-B7	17,053	25,000	ASME
Shaft Deflection, in (at impeller)		.000077 .	014	Design Clearance
Shaft Coupling Deflection, in	Koppers Fast Type 2-1/2 BS	. 000323	.036	Mfgr's data
Shaft Stress, psi (impeller keyway) (coupling keyway)	A564-XM25	21,852 24,462	31,250 31,250	ASME ASME
Gland Plate Bolt Stress, psi (Axial)	SA193-B7	6,993	25,000	ASME
*Base Plate Pedestal Stress, psi	A36	6,833	12,600	AISC
Suction Nozzle Stress, psi (inside surface)	SA351-CF8	2,109	14,200	ASME
Discharge Nozzle Stress, psi (outside surface)	SA351-CF8	4,972	14,200	ASME
Pump Bearing Loads, lbs (inboard) (outboard)	SKF-NU-312 SKF-7311-BG	1,443 86.2	12,100 23,300	Mfgr's data

The natural frequency was calculated to be 153.3 Hz.
* Indicates structural support.

Motor

Containment spray pump motors are Allis Chalmers 500 PS 6 frame Type FD 300 hp. motors. Allis Chalmers have shown by calculations that the motors will withstand operating loads plus specified seismic conditions.

The following seismic loads were applied to the center of mass of each motor component:

	OBE	SSE
Horizontal	0.5g	1.0g
Vertical	0.34g	0.67g

Summary of Results

A summary of actual stresses loads and deflections is given below. The actual values are compared to the referenced Codes or manufacturer's allowables.

Normal Operating Loads + Nozzle Loads + SSE Loads

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference for Allowable
*Motor hold down bolts stress-				
- Shear, psi	SA307	3,919	10,000	AISC
- Tensile, psi		6,105	20,000	AISC
Rotor deflection at Bearings, in.		0.00053	0.0027	Design clearance

3.9B.3 DIESEL OIL TRANSFER PUMP

Description

The Diesel Oil Transfer Pumps are a Goulds Pump, Inc. Model 3736 Size 1 x 1-1/2-8. The pump designed in accordance with ASME Code Section III, Class 3, 1971 Edition through Winter 1972 Addenda. The analysis (Goulds Pump Seismic Analysis Report No. ME-324 Order No. N232806 by McDonald Engineering Company, dated April 16, 1976) shows that the pump and motor set are structurally adequate to withstand the specified loads and will perform their intended function during normal plus OBE loads plus maximum nozzle loads and normal plus SSE seismic plus maximum nozzle loads. The pump casing stresses are not calculated. The casing is verified for normal operation by service experience.

*Indicates structural support.

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The following seismic loads were applied to the center of mass of each pump component:

	OBE	SSE
Horizontal	1.0g	2.0g
Vertical	l.0g	2.0g

Summary of Results

A summary of the actual stresses, loads and deflections is given below. The actual values are compared to the referenced Codes or manufacturer's allowables for each load case. The allowable stresses for pressure retaining materials are determined from Section III of the ASME Code for the pump design temperatures of 125° F.

OBE Loads + Normal Loads + Maximum Nozzle Loads

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference for Allowable
*Motor Hold Down Bolt Stress				
- Shear, psi	A307	1,183	10,000	AISC
- Tensile, psi		2,276	20,000	AISC
*Pump Hold Down Bolt Stress				
- Shear, psi	A307	2,969	10,000	AISC
- Tensile, psi		5,572	20,000	AISC
*Anchor Bolt Stress				
- Shear, psi	A307	4,734	10,000	AISC
- Tensile, psi (pullout force)		5,199	20,000	AISC
Shaft Stress, psi	A276	5,256	17,500	**
*Support Frame, psi	A36	1,865	21,750	AISC
Thrust Retainer Bolt Stress, psi	A307	1,356	20,000	AISC
*Pump Frame Bolt Stress				
- Shear, psi	A307	5,662	10,000	AISC
- Tensile, psi		137	18,940	AISC
Stuffing Box Cover Flange Stress, psi	SA216 WCB	4,981	26,250	ASME
Stuffing Box Bolt Stress, psi	SA193-B8	6,148	14,575	ASME

APPENDIX 3.9B

OBE Loads + Normal Loads + Maximum Nozzle Loads (Cont'd)

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference for Allowable
Maximum Nozzle Stress				
- Suction, psi	SA216 WCB	3,906	17,500	ASME
- Discharge, psi	3,480	17,500	ASME	
Discharge Flange Stress, psi	SA216 WCB	10,903	26,250	ASME
Suction Flange Stress, psi	SA216 WCB	11,963	26,250	ASME
*Frame to Cover Bolt Stress, psi	A307	13,633	20,000	AISC
Rotor To Stator Clearance, in.		.00067	.014	Design clearance
Motor Bearing Loads,				
- Inboard, lbs	MRC-206-S	45	3,573	Mfgr's
- Outboard, lbs	MRC-207-S	45	4,443	data
Pump Bearing Loads				
- Inboard, lbs	MRC-310-S	317	10,688	Mfgr's
- Outboard, lbs	MRC-5310-G	1,624	17,865	data
Flexible Coupling Misalignment, Radians	Koppers Fast Type B-1 1/2B	.0016	.017	Mfgr's data
Impeller Key Stress				
- Shear, psi	A276	549	9,000	**
Impeller To Casing Clearance				
- Deflection, in		.003	.008	Design clearance

SSE Loads + Normal Loads + Maximum Nozzle Loads

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference or Allowable
*Motor Hold Down Bolt Stress				
- Shear, psi	A307	2,598	15,000	AISC
- Tensile, psi		5,252	30,000	AISC

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SSE Loads + Normal Loads + Maximum Nozzle Loads (Cont'd)

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference for Allowable
*Pump Hold Down Bolts Stress				
- Shear, psi	A307	4,449	15,000	AISC
- Tensile, psi		7,501	30,000	AISC
*Anchor Bolt Stress				
- Shear, psi	A307	6,791	15,000	AISC
- Tensile, psi (pullout force)		8,277	25,702	AISC
Shaft Stress, psi	A276	6,874	26,250	**
*Support Frame, psi	A36	2,576	32,625	AISC
Thrust Retainer Bolt Stress, psi	A307	1,472	30,000	AISC
*Pump Frame Bolt Stress				
- Shear, psi	A307	7,447	15,000	AISC
- Tensile, psi		178	24,127	AISC
Stuffing Box Cover Flange Stress, psi	SA216 WCB	5,349	39,375	ASME
Stuffing Box Bolt Stress, psi	SA193-B8	6,645	21,862	ASME
Maximum Nozzle Stress				
- Suction, psi	SA216 WCB	3,906	26,250	ASME
- Discharge, psi	SA216 WCB	3,480	26,250	ASME
Discharge Flange Stress, psi	SA216 WCB	10,903	39,375	ASME
Suction Flange Stress, psi	SA216 WCB	11,963	39,375	ASME
*Frame to Cover Bolt Stress, psi	A307	16,655	30,000	AISC
Rotor to Stator Clearance, in.		.00108	.014	Design clearance
Motor Bearing Loads				
- Inboard, lbs	MCR-206-S	72	3,573	Mfgr's
- Outboard, lbs	MCR-207-S	72	4,443	data
Pump Bearing Loads				
- Inboard, lbs	MCR-310-S	397	10,688	Mfgr's
- Outboard, lbs	MCR-531OG	2,077	17,865	data

APPENDIX 3.9B

SSE Loads + Normal Loads + Maximum Nozzle Loads (Cont'd)

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference for Allowable
Flexible Coupling Misalignment, Radians	Koppers Fast Type B-1 1/2B	.0022	.017	Mfgr's data
Impeller Key Stress - Shear, psi	A276	549	13,500	**
Impeller To Casing Clearance - Deflection, in		.004	.008	Design clearance

A computer analysis for the frequencies was performed using computer code ICES-STRUDL. The lowest frequency is determined to be 82 Hz-

3.9B.4 COMPONENT COOLING WATER PUMPS

Description

The Component Cooling Water Pumps are Babcock and Wilcox Canada Model 12 x 14 x 16 DE pumps. The pumps are designed in accordance with the ASME Code Section III, Class 3, 1971 Edition through Winter 1973 Addenda. Component cooling water pump motors are Allis Chalmers type GS, 300 hp motors. The analysis (B&W Seismic Report No. 7272-11-2.3.8/1-0 Rev 0 dated November 28, 1977) shows that the pumps and motors are structurally adequate to withstand the specified loads and will perform their intended function during normal operating loads plus nozzle loads plus OBE loads and normal operating loads plus nozzle loads plus SSE loads. Since the actual SSE stresses and deflections are lower than the OBE's allowable, only SSE case is given.

The following seismic loads were applied to the center of mass of each pump component:

	OBE	SSE
Horizontal	0.50g	1.00g
Vertical	0.34g	0.67g

*Indicates structural support.
**Conservative estimate based on yield stress of ASTM A276 material.

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Summary of Results

A summary of the operating plus SSE actual and allowable stresses is given below. The actual values are compared to the referenced Codes or manufacturer's allowables. The allowable stresses for pressure retaining materials are determined from Section III of the ASME Code for the pump design temperature of 175°F. The allowables for the attachment bolting, foundation bolting and support steel are taken as 40%, 60%, 60% respectively of the yield strength of their material

Normal Operating Loads + Nozzle Loads + SSE Loads

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference for Allowable
PUMP				
Casing, inside surface, psi	SA351-CF8	3,213	12,320	ASME
Casing, outside surface, psi	SA351-CF8	2,963	12,320	ASME
*Attachment Bolts, psi	SA193-B7	12,197	42,000	ASME
*Foundation Bolts				
- Shear, psi	A36	5,239	21,600	AISC
- Axial, psi (pullout force)		5,189	21,000	AISC
*Pedestal Attachment Bolts, psi	SA193-B7	8,770	42,000	ASME
*Pedestal (axial stress), psi	A36	1,481	21,600	AISC
Pedestal Welds (base), psi	A36	3,471	18,000	**
Shaft Stress, psi	A237 CLA 400 BAR	6,413	20,000	ASTM
Discharge Nozzle Stress, psi (outside surface)	SA351-CF8	2,867	12,320	ASME
Suction Nozzle Stress, psi (outside surface)	SA351-CF8	1,352	12,320	ASME
Pump Bearing Loads				
- Inboard, lb	Kingsbury #C-5	839	1,010	Mfgr's data
- Outboard, lb	Kingsbury #CH-5	404	1,010	

APPENDIX 3.9B

Normal Operating Loads + Nozzle Loads + SSE Loads (Cont'd)

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference for Allowable
Pump				
Maximum Coupling Misalignment, in.	Kopper's Fast Type B-2-1/2B	0.0021	.036	Mfgr's data
Impeller To Casing Clearance - Deflection, in.		0.00470	0.00531	Design clearance
The lowest natural frequency was determined to be 321 Hz.				
Motor				
*Attachment Bolts	193-B7	2,788	42,000	ASME
*Foundation Bolts, - Shear, psi - Axial, psi (pullout force)	A36	2,381 4,194	21,600 21,600	AISC AISC
*Pedestal (axial stress), psi	A36	533.25	21,600	AISC
Pedestal Welds (base), psi	A36	2,130.3	18,000	**
Motor Hold Down Bolt - Shear, psi - Tensile, psi	A307	2,049 3,299	10,000 20,000	AISC AISC
Rotor Deflection at Bearings, in.	0.0074	0,042		Mfgr's data
The lowest natural frequency was determined to be 239 Hz.				

3.9B.5 AUXILIARY COMPONENT COOLING WATER PUMPS

Description

The Auxiliary Component Cooling Water Pumps are Babcock and Wilcox Canada Model 12 x 14 x 16 DE pumps. The pumps are designed in accordance with the

* Indicates structural support.
** Conservative estimate.

ASME Code Section III, Class 3, 1971 Edition through Winter 1973 Addenda. The Auxiliary Component Cooling Water Pump Motors are Allis Chalmers type GS, 300 hp motors. The analysis (B&W Seismic Report No. 7272-11-2.3.8/1-0 Rev 0 dated November 28, 1977) shows that the pumps and motors are structurally adequate to withstand the specified loads and will perform their intended function during normal operating loads plus nozzle loads plus OBE seismic and normal operating loads plus nozzle loads plus SSE loads. Since the actual SSE stresses and deflections are lower than OBE's allowable, only the SSE case is given.

The following seismic loads were applied to the center of mass of each pump component:

	OBE	SSE
Horizontal	0.50g	1.00g
Vertical	0.34g	0.67g

Summary of Results

A summary of the operating plus SSE actual and allowable stresses is given below. The actual values are compared to the referenced Codes or manufacturer's allowables. The allowable stresses for pressure retaining materials are determined from Section III of the ASME Code at the pump design temperature of 120F. The allowables for the attachment bolting, foundation bolting and support steel are taken as 40%, 60%, 60%, respectively of the yield strength of their materials.

Normal Operating Loads + Nozzle Loads + SSE Loads

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference for Allowable
Casing, inside surface, psi	SA351-CF8	3,213	12,320	ASME
Casing, outside surface, psi	SA351-CF8	2,963	12,320	ASME
*Attachment Bolts, psi	SA193-B7	12,197	42,000	ASME
*Foundation Bolts				
- Shear, psi	A36	7,582	21,600	AISC
- Axial, psi (pullout force)		6,230	21,000	AISC
*Pedestal Attachment Bolts, psi	SA193-B7	8,770	42,000	ASME
*Pedestal (axial stress), psi	A36	1,481	21,600	AISC

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Normal Operating Loads + Nozzle Loads + SSE Loads (Cont'd)

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference for Allowable
Pedestal Welds (base), psi	A36	3,471	18,000	**
Shaft Stress, psi	A237 CLA 400 BAR	6,413	20,000	ASTM
Pump Bearing Loads				
- Inboard, lb	Kingsbury #C-5	839	1,010	Mfgr's data
- Outboard, lb	Kingsbury #CH-5	404	1,010	
Maximum Coupling Misalignment, in.	Kopper's Fast Type B-2-1/2B	0.0021	0,036	Mfgr's data
Discharge nozzle stress, psi (outside surface)	SA351-CF8	2,867	12,320	ASME
Suction Nozzle Stress, psi (outside surface)	SA351-CF8	1,352	12,320	ASME
Impeller To Casing Clearance				
- Deflection, in.	0.00470	0.00531		Design clearance

The lowest natural frequency was determined to be 321 Hz.

Motor

*Attachment Bolts	SA193-B7	2,788	42,000	ASME
*Foundation Bolts,				
- Shear, psi	A36	2,528	21,600	AISC
- Axial, psi (pullout force)		4,194	21,600	AISC
*Pedestal (axial stress), psi	A36	533.25	21,600	AISC
Pedestal Welds (base), psi	A36	2,130.3	18,000	**
Motor Hold Down Bolts				
- Shear, psi	A307	2,049	10,000	AISC
- Tensile, psi		3,299	20,000	AISC

Normal Operating Loads + Nozzle Loads + SSE Loads (Cont'd)

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference for Allowable
Rotor Deflection at Bearings, in.		0.0074	0.042	Mfgr's data

The lowest natural frequency was determined to be 239 Hz.

3.9B.6 EMERGENCY FEEDWATER PUMPS

Description

→ (DRN 01-3697)
The Emergency Feedwater Pumps are Bingham-Willamette Ltd Models 3 x 4 x 9E MSD 7 stage and 3 x 6 x 9C MSD 6 stage pumps. The pumps are designed in accordance with the ASME Code Section III, Class 3, 1971 Edition through 1972 Winter Addenda, except for the pump case material, which met the 1974 Edition, Summer 1975 Addenda. The drivers for the above models are General Electric motor 5K811045C25 and Terry Turbine Company turbine model GS-2, respectively. The analyses (GE Seismic Analysis Report No. 34A842770 for motors Rev 0, dated November 3, 1977, Bingham Willamette Report No. 230223 for Motor Driven Pumps Rev 0, dated March 12, 1970, Bingham Willamette Report No. 230225 for Turbine Driven Pump Rev 2 dated March 3, 1977, and Seismic analysis by Keith Feibusch Engineering Company for the Turbine dated February 1973) shows that the pumps, motors and turbine are structurally adequate to withstand the specified seismic conditions without loss of function.
← (DRN 01-3697)

The following seismic loads specified were applied to the center of mass of each pump component:

	OBE	SSE
Horizontal	0.50g	1.00g
Vertical	0.34g	0.67g

Natural frequencies (Hz) for the motor driven pumps are as follows:

Item	X-direction	Y-direction	Z-direction
Pump	82.2	299.0	44.1
Driver	146.0	277.0	77.3

* Indicates structural support.

** Conservative estimate.

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Natural frequencies (Hz) for the turbine driven pump are as follows:

Item	X-direction	Y-direction	Z-direction
Pump	84.76	313.91	49.68
Driver	35.40	216.74	51.51

The directions for the above are; X-direction is horizontal, parallel to shaft, Y-direction is vertical, perpendicular to shaft, Z-direction is horizontal, perpendicular to shaft.

Summary of Results

A summary of the stresses caused by SSE loads is given below. The actual values are given and compared to the referenced Codes or manufacturer's allowables. The allowable stresses for pressure retaining materials are determined from Section III of the ASME Code at the pump design temperature of 115°F.

Normal Operating Loads + Nozzle Loads + SSE Loads

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference for Allowable
Motor Drive Pump				
*Pump Hold-Down Bolts-Tension,psi	A325	21,149	40,000	AISC
*Pump Foot Taper Pins - Shear, psi	AISI-1112	8,808	32,000	***
*Motor Foot Taper Pins - Shear, psi	AISI-1112	24,772	32,000	***
*Base Hold-Down Bolts - Tension, psi - Shear, psi (pullout force)	A36 A36	10,435 9,258	21,600 21,600	AISC AISC
Motor				
*Motor Hold Down Bolt Load - Tensile, psi - Shear, psi	A325	8,108 9,105	40,000 15,000	AISC AISC

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Normal Operating Loads + Nozzle Loads + SSE Loads (Cont'd)

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference for Allowable
Motor (Cont'd)				
Rotor To Stator Clearance, in.		.095	.100	Design clearance
Shaft Stress, psi	A276-410HT	7,587	20,000	**
Shaft Key Stresses, psi	AISI-1018	3,618	10,000	***
Conduit Box Bolting,				
- Tensile, psi	A490	528	54,000	AISC
- Shear, psi		168	27,000	AISC
Bearing Loads				
- Radial, psi	Sleeve Type	196	1,000	Mfgr's data
Top Cover Stress, psi	A7 steel	710	20,000	**
Top Cover Bolting				
- Tensile, psi	A490	392	54,000	AISC
End Shield Bolting				
- Tensile, psi	A490	763	54,000	AISC
Motor Frame Stress, psi				
- (local)	Cast Iron	5,288	10,000	Mfgr's data
Turbine Driven Pump →				
*Pump Hold-Down Bolts				
- Tension, psi ←	A325 or equal	31,094	40,000	AISC
*Pump Foot Taper Pins				
- Shear, psi	AISI-1112	11,581	32,000	***
*Base Hold-Down Bolts				
- Tension, psi	A36	11,283	21,600	AISC
- Shear, psi	A36	11,783	21,600	AISC

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Turbine****	Margin of Safety*****
*Hold-Down Bolt	3.3
*Taper Pin	0.3
*Sliding Foot Connection	0.5
*Turbine Pedestal (compressive stress)	11.0
*Turbine Pedestal (weld stress)	1.0
Baseplate Connection to Concrete (pullout force)	0.2
Baseplate Connection to Concrete (anchor bolt, shear)	0.6

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Maximum Nozzle Loads	Axis	Actual Piping(1) Loads Force (lb)		Actual Piping(1) Loads Moment (ft-lb)		Maximum Nozzle Loads Calculated By Pump Mfg'r Force (lb)	Maximum Nozzle Loads Calculated By Pump Mfg'r Moment ft-lb)
→(LBDCR 15-006, R309)							
Motor Driven Pumps (material: SA-487 CA6NM ref for max loads: Seismic Analysis Report No. 230225)		Pump A	Pump B	Pump A	Pump B		
Suction	X	108	79	301	134	1,100	1,250
	Y	219	139	294	56	1,200	1,250
	Z	92	54	256	124	1,100	1,350
Discharge	X	346	341	986	1,103	800	700
	Y	561	499	687	933	850	700
	Z	165	271	601	409	800	750
Turbine Driven Pump (material: SA-487 CA6NM ref for max loads: Seismic Analysis Report No. 230223)							
Suction	X	142		344		1,600	2,700
	Y	564		440		1,700	2,700
	Z	152		285		1,600	2,900
Discharge	X	209		594		800	700
	Y	666		275		850	700
	Z	727		210		800	750

(1) The actual piping loads are for information only and should not be used as a reference for the current loadings on the pumps. See the current pipe stress analysis calculations for the current loadings and qualifications.

←(LBDCR 15-006, R309)

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A computer analysis for the frequencies and stresses was performed using the SANDE Computer Program.

* Indicates structural support.

** Conservative estimate based on yield stress of ASTM 276, A-7 materials.

*** Machinery Handbook 21st Edition.

**** The seismic calculation for the emergency feedwater pump turbine uses the criteria of horizontal and vertical seismic forces of 3.0g and 1.0g, respectively.

***** Margin of Safety = $\frac{\text{allowable stress}}{\text{calculated stress}}$ - (1)

Small clearances between rotating and stationary parts in the pump will not present any operating difficulties during an earthquake. Small clearances exist at wear rings and bushings. These components behave as hydrodynamic bearings and are self-centering during operation - they support the rotating element against any seismic inertia loads. In addition experience with pumps having very flexible rotating elements shows that these pumps operate satisfactorily even though contact would occur at close clearances due to the weight and flexibility of the rotating element when the pumps are idle. Therefore, these small clearances are not controlling factors during an earthquake.

The pump bearings are considered adequate because the increase in bearing load due to the seismic inertia load of the rotating element is very small compared to the hydraulic loads already existing in a pump.

3.9B.7 COMPONENT COOLING WATER MAKE-UP PUMPS

Description

The Component Cooling Water Make-Up Pumps are Babcock and Wilcox Canada Model 3 x 4 x 14 DL Pumps. The pumps are designed in accordance with the ASME Code Section III, Class 3, 1971 Edition through Winter 1973 Addenda. The motors are Allis Chalmers Type RG 40 hp motors. The analysis (B&W Seismic Analysis Report No 7272-12-2.3.8/1-0 Rev A dated 3-29-78) shows that the pumps and motors are structurally adequate to withstand the specified loads and will perform its intended function during normal operating loads plus nozzle loads plus OBE loads and normal operating loads plus SSE loads. Since the actual SSE stresses are lower than the OBE's allowable, only the SSE case is given.

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The following seismic loads were applied to the center of mass of each pump component:

	OBE	SSE
Horizontal	0.50g	1.00g
Vertical	0.34g	0.67g

Summary of Results

A summary of the operating plus SSE actual and allowable stresses is given below:

The actual values are compared to the referenced Codes or manufacturer's allowables.

The allowable stresses for pressure retaining materials are determined from Section III of the ASME Code at the pump design temperature of 175°F. The allowables for the attachment bolting, foundation bolting and support steel are taken as 40%, 60%, 60% respectively of the yield strength of their materials.

Normal Operating Loads + Nozzle Loads + SSE Loads

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference for Allowable
Pump				
Casing, inside surface, psi	SA351-CF8	1,318	12,320	ASME
Casing, outside surface, psi	SA351-CF8	1,168	12,320	ASME
*Attachment Bolts, psi	SA193-B7	5,472	42,000	ASME
*Foundation Bolts	A36	3,648	21,600	AISC
- Shear, psi		2,335	21,600	AISC
- Axial, psi (pullout force)				
*Pedestal Attachment Bolts, psi	SA193-B7	8,967	42,000	ASME
*Pedestal (axial stress), psi	A36	439	21,600	AISC
Pedestal Welds (base), psi	A36	782	18,000	**
Shaft Stress, psi	A276-410	6,711	25,000	***

APPENDIX 3.9B

Normal Operating Loads + Nozzle Loads + SSE Loads (Cont'd)

Components	Material or Mfgr's Model No.	Actual	Allowable	Reference for Allowable
Pump Bearing Loads - Inboard, lb - Outboard, lb	SKF-6307 SKF-3306 A/C3	114 56	5,750 7800	Mfgr's data
Maximum Coupling Misalignment, in.	Kopper's Fast Type B-2B	0.00134	0.029	Mfgr's data
Impeller Clearance - Deflection; in.		0.00227	0.00327	Mfgr's data
Discharge Nozzle Stress - Outside Surface, psi	SA 351-CF8	305	12.320	ASME
Suction Nozzle Stress , - Outside Surface, psi	SA 351-CF8	295	12,320	ASME

The lowest natural frequency was calculated to be 361 Hz.

Motor				
*Attachment Bolts, psi	SA193-B7	966	42,000	ASME
*Pedestal - Axial Stress, psi	A36	142.74	21,600	AISC
Pedestal Welds (base>, psi	A36	463	18,000	**
Motor Hold Down Bolts - Shear, psi - Tensile, psi	A307	633 1,031	10,000 20,000	AISC AISC
Rotor Deflection at Bearings, in		0.025	0.0005	Mfgr's data

The lowest natural frequency was calculated to be 477 Hz

*Indicates structural support.

**Conservative estimate.

***Conservative estimate based on yield stress of ASTM A276 material.

APPENDIX 3.9B

3.9B.8 DIESEL ENGINE DRIVEN LUBE OIL PUMP

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Description

The Lube Oil Pump is Roper Model 20040. The pump is flanged mounted to the Cooper Bessemer Engine with the inlet and discharge parts oriented horizontally. The pump is driven directly by the diesel engine crankshaft. The analysis (Seismic Analysis Report No. HC5-922-2 by Hissong Consultants dated September 22, 1975) shows that the pump is structurally -adequate to withstand the specified operating and seismic condition. The operability of this lube oil pump is contingent on the operation of the diesel generator. The operability of the pump is assured by the diesel generator qualification program described in Subsection 8.3.1.1.2.13.k.

3.9B.9 DIESEL ENGINE DRIVEN JACKET WATER PUMP

Description

The Jacket Water Pump is Allis Chalmers Model C16. The pump is flange mounted to Cooper Bessemer equipment with the impeller mounted on shaft. The pump is driven by the diesel engine crankshaft. The analysis (Seismic Analysis Report No. HC6-106 by Hissong Consultants dated January 6, 1976) shows that the pump is structurally adequate to withstand the specified operating and seismic condition. The operability of this pump is contingent on the operation of the diesel generator. The operability of the pump is assured by the diesel generator qualification program described in Subsection 8.3.1.1.2.13.k.

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