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U.S. Nuclear Regulatory Commission
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Subject: McGuire Nuclear Station - Units 1 & 2
Docket Nos. 50-369, 50-370
Inservice Testing Program
Relief Request MC-SRP-NS-01
Request for Additional Information (RAI)

Reference: (1) Letter from Mr. G.R. Peterson of Duke Power to NRC, dated August 12, 2004, (2) Letter from Mr. G.R. Peterson of Duke Power to NRC, dated November 18, 2004

After further review, Duke requests approval to use an alternative to Section XI of the ASME Boiler and Pressure Vessel Code in accordance with 10 CFR 50.55a(a)(3)(ii) instead of 10 CFR 50.55a(a)(3)(i). The applicable Code requirement imposes hardships without a compensating increase in level of quality or safety. However, the proposed alternative will provide an acceptable level of quality and safety.

Attached is the additional information that was requested by the NRC staff during a telephone conference conducted on February 2, 2005. The NRC staff's requests for information and Duke's responses are stated in the following attachment.

Questions with respect to this matter should be directed to Norman T. Simms of Regulatory Compliance at 704-875-4685.

Very truly yours,

G.R. Peterson

Attachment

A047

xc:

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ATTACHMENT

Response to RAIs for Relief Request MC-SRP-NS-01

Response to Nuclear Regulatory Commission Staff
Request for Additional Information
Relief Request MC-SRP-NS-01
Alternative to ASME OM Code
Duke Power Company
McGuire Nuclear Station, Units 1 and 2

Question 1

Have the Containment Spray (CS) Pumps ever been operated at design conditions? If so, provide copies of test data and test conditions.

Response to Question 1

All four CS pumps were run under full flow conditions during preoperational testing. These preoperational tests included testing the CS pumps in two configurations. The first configuration was a recirculation test to the refueling water storage tank (RWST). The second configuration allowed operation at full flow by taking suction from the RWST and discharging from the CS ring headers in containment through temporary piping to a yard drain. The spray header nozzles were plugged for this temporary configuration. These connections are no longer available and re-establishing this full flow test configuration for comprehensive pump testing is not practicable. Table 1 below provides a summary of pump parameters that were recorded during each preoperational test. Bearing temperatures were recorded for only the recirculation test, which included a four hour run time to allow for bearing temperature stabilization. Bearing temperatures were not recorded for the full flow test, since the duration of the full flow test was limited by the use of the 350,000 gallon RWST.

Table 1 – Containment Spray Pump Preoperational Test Data

Date	CS Pump	Flow-rate (gpm)	Diff. Press. (psi)	Calc. Head (feet)	Pump Shaft Vib (mils)	Upper Bearing Temp (°F)	Lower Bearing Temp (°F)
7/8/78	1A	999	178	411.5	1.8	95.4	136.8
8/8/78	1A	3400	167	392.0	7.0	-	-
7/24/78	1B	1000	180.5	417.2	1.3	124.2	172.5
8/8/78	1B	3400	167	392.0	4.0	-	-
1/18/82	2A	678	191	442.3	1.6	98.3	154.2
1/21/82	2A	3353	167	388.6	0.3	-	-
1/19/82	2B	672	187.5	434.8	1.7	108.8	Bad Sensor
1/21/82	2B	3450	165	384.7	0.18	-	-
3/3/82	2B	Note 1	Note 1	Note 1	-	113.6	153.3

Note 1: This test was a rerun of the "initial 4 hr pump run" for pump 2B that was performed on 1/19/82. Test procedure TP/2/A/1200/04 documented a log entry that the "suction pressure, discharge pressure, flowrate consistent with the initial 4 hr pump run."

Question 2

How many hours have the pumps been run since full flow testing: Include test data for all tests performed since the last time the CS pumps were operated at design conditions.

Response to Question 2

The Operator Aid Computer contains data for run times and starts for the four CS pumps from 1993 to present. Based on these 12 years of data the pump run times are as follows: 1A - 162 hrs; 1B - 99 hrs; 2A - 81 hrs; 2B - 72 hrs. Based on this data a conservative estimate of the total run hours on each pump since preoperational testing is less than 400 hours.

The cumulative test data for all IST tests on the 1A, 1B, 2A and 2B CS pumps are contained in the attached Tables 3-6 respectively. Note that lower motor bearing vibration data taken prior to 1990 was measured in mils and thereafter in inches per second. Also bearing stabilization temperature measurement data was discontinued after 1989. A summary of the hydraulic data is contained in the response to question number 4 and the description of a modification performed to correct high vibration is described in the response to question number 3. No significant trends or issues have been identified from this data since the initial full flow testing of the pumps that affected pump hydraulic performance.

Question 3

Provide a maintenance and corrective action history for the CS pumps since the last time they were operated at design conditions and provide justification or reasons stating why maintenance and corrective actions have not affected pump performance.

Response to Question 3

Pump and motor preventative maintenance activities are performed. Pump hydraulic data, vibration measurements, and oil sampling are performed quarterly. Motor electrical testing is performed on a 3 year cycle along with lubrication. Stator hi-pot testing is performed every 6 years. Thermography of the motor and switchgear is performed yearly. The motor has a planned replacement every 20 years. As part of a motor refurbishment program, three out of four pumps and motors have been visually inspected in the last seven years, with the motors sent to the OEM for refurbishment. The original impellers stayed with the new replacement motor in the same pump position. The fourth motor is scheduled for refurbishment in October 2006.

A rigorous maintenance history review of the CS pumps and motors (1A, 1B, 2A, and 2B) was performed for the period 1/1/1981 to 2/15/2005. During this time period, the pump casings were opened a total of 8 times. A review of the CS pump and motor procedure MP/0/A/7150/011 was performed for each pump inspection and the wear ring dimension summarized in Table 2 below. The recorded impeller wear ring clearances vary between 0.006" and 0.003" on the 1A and 2A pumps over a 14 year span. The variations can be explained by measurement errors over the 12.87" internal diameters due to: 1) ambient temperature differences between each pump rebuild, 2) actual micrometer "feel" and errors, and 3) indicator placement differences due to the casings having been elliptically deformed during the original casing weld operation.

Table 2 - Containment Spray Pump Work History				
Significant Maintenance- Pump Removal and Seal Replacements				
CS Pump	**Date**	**W/O**	**Description of work**	**Impeller wear ring clearance:**
1A	6/8/1998	97090023	Motor replaced with the previously never operated spare motor. Existing pump internals reused.	0.029"
1A	5/1/1991	91118884	Seal leak: pulled motor and replaced seal only.	0.029"
1A	10/17/1988	86068311	Seal leak; pulled motor and replaced seal only.	0.023"
1B	3/15/2001	98070397	Motor replaced with a refurbished motor. Existing pump internals reused.	0.027"
2A	4/5/1999	97046124	Motor replaced with a refurbished motor. Existing pump internals reused.	0.026"
2A	6/19/1986	86075174	Seal leak: pulled motor and replaced seal only.	0.027"
2A	2/5/1985	85073349	Seal leak: pulled motor and replaced seal only.	0.024"
2B	2/4/1985	83058996	Seal leak: pulled motor and replaced seal only.	0.026"

The CS System has four Ingersoll-Rand 8x20WD pumps in a clean borated water system with stainless steel impellers and wear rings. No abrasive wear, impeller recirculation erosion, or cavitation damage has been noted or documented. These pumps are estimated to have operated less than 400 hours each. The Residual Heat Removal (RHR) System at McGuire has four similar pumps, also Ingersoll-Rand model 8x20WD pumps, that have operated over 21,000 hours each at normal and low flow test conditions (Reference McGuire Calculation MCC-1381.05-00-0204 Revision 2) without visible pump impeller or wear ring degradation.

The Ingersoll-Rand model 8x20WD pumps contain a diffuser with 9 diffuser vanes, reducing radial loads on the impeller and shaft to insignificant values. With the extremely low radial loads, large 2.875" shaft, and large wear ring clearances, no evidence of casing to impeller wear ring rubbing nor wear has been documented, nor is it expected on either the CS or RHR pumps.

In the late 1990's, 1A and 2A CS Pumps vibration levels exceeded the alert. When comparing vibration levels between the X and Y directions, a significant delta was noted indicating the operating frequency was at or near a resonance frequency of the structure/component. Modal analysis was performed and the evaluation concluded that each of the CS Pump/Motor assemblies had substantial resonant activity in the 0 - 30 Hz range. Modifications MGMM-8752 (1A Pump), and MGMM-8771 (2A Pump) were implemented to externally stiffen existing supports and CS pump/motor structures to shift the resonance frequency away from shaft rotating speed. Vibration levels at tested flow rate decreased significantly on CS Pumps 1A and 2A as a result of stiffening the pump structure and vibration levels for the four CS Pumps are within the acceptance criteria of ISTB. Vibration at full flow conditions is not expected to be adversely affected by the mods.

In summary, there have been no failures or significant corrective maintenance or modifications performed on the four CS pumps since preoperational testing. The CS pumps have not operated long enough, nor have they experienced any internal rubbing which would have altered the as-installed pump performance to any measurable extent.

Question 4

Provide technical justification that shows how operation at lower flow rates equates to the ability to operate at design flow rates. Also discuss how the limiting acceptance criteria at the proposed lower flow rates relate to operations at the higher flow rates.

Response to Question 4

Testing at design flow is important for pumps with characteristic head-flow curves that are flat or gently sloping in the low flow region. In the low flow region, increasing internal recirculation flows may degrade pump performance. Pumps with "flat" curves at low flows should be tested at near design conditions to determine if degraded pump performance has occurred. This situation does not apply to the CS pumps because the pump curve is well sloped at the point of testing and degradation can be detected. Refer to the four OEM pump head curves on Figures 1, 2, 3 & 4. In fact, a comparison of the slope of the head curve at 1000 gpm versus 3400 gpm indicates that degradation in pump performance would be more detectable at the 1000 gpm point.

All of the single point hydraulic data from each of the four CS pumps (attached Tables 3 through 6) falls within 10 percent of the head curve and is thus within the acceptable range for the Group A/B test (acceptable or alert range for the Comprehensive test) dP acceptance criteria. The average of the single point data for the four pumps is within 2 percent of the head curve (well within the acceptable range for both tests). The tighter hydraulic acceptance criteria of the Comprehensive test is expected to identify any hydraulic problems even at the lower flow condition primarily due to the slope of the curve between test flow and shutoff.

Vibration data is taken on the CS pumps during testing. Since the vertically mounted motor and pump share a common shaft without a coupling, both must be evaluated together. The motor/pump has three bearings, one radial bearing lubricated by grease, and two back to back thrust bearings lubricated by oil. The vibration results can provide predictions for both motor and pump problems. Bearing problems can be seen regardless of flow conditions; these results are solely based on operating speed of the motor. Like bearing problems, impeller looseness and rubbing can also be predicted regardless of flow. Forces at 1x operating frequency, such as imbalance, may increase or decrease at various flow conditions. Since all other motor and pump conditions that are verifiable through vibration testing can be predicted at low flow, impeller imbalance is not a concern.

Bearing temperatures are recorded continuously, and monitored during operation. During pump and motor testing, operation time is not long enough to allow the bearing temperatures to stabilize. In addition, as flow increases, thrust loading increases, therefore increasing the temperatures on the motor bearings. As a result, test results at low flow conditions may not be representative of bearing temperature at full flow. However, a comparison can be made to the Residual Heat Removal (RHR) pumps. The RHR pumps are similar to the CS pumps in that they are both the same model, Ingersoll-Rand 8x20WD. The motors are also similar except for bearing locations. The RHR pumps have the thrust bearings located at the top of the motor, with all bearings oil lubricated, while the CS motors have the thrust bearings located at the bottom of the motor. Even with this design difference, thrust loading of the bearings for both motors are essentially the same. A pump thrust curve from Information Notice 93-08 of RHR pumps at Seabrook (has the same pumps and motors as McGuire) shows that the curve is flat between approximately 1200 gpm and 2600 gpm, and then trails off as flow continues to increase. This shape indicates that as flow increases past 1200 gpm, the thrust loading is essentially the same, which in turn would not have an effect on the thrust bearing temperatures. Based on this information, an assumption can be made that the bearing temperatures on the CS pumps would not be much higher at full flow conditions than at current test conditions.

An oil sample from the CS thrust bearings is taken on a quarterly frequency and is screened for particulate, dielectric constant, viscosity, and water. Based on the results, the oil is either sent to another lab for additional testing, or an oil change is performed on the motor. Since these pumps do not operate very much, a quarterly oil sample is a proactive approach to ensuring thrust bearing life.

In summary, testing of the subject pumps utilizing the recirculation flow path provides for substantial flow testing in a stable, well sloped region of the pump curve well above the minimum continuous flowrate specified by the pump manufacturer. From all available information including oil analysis, vibration analysis, visual internal inspections, and bearing temperatures, low flow testing conditions provide adequate information to predict any problems on the CS pumps and motors that could occur at design flow conditions. Testing of the pumps at reference values established in this region of the pump curve will not cause damage to the pumps and will provide meaningful data to assess pump operational readiness.

Question 5

Provide a basis for relief in accordance with 10 CFR 50.55a(a)(3) (ii) to show that compliance with the American Society of Mechanical Engineers Operating and Maintenance Code required testing would result in hardship or unusual difficulty with out a compensating increase in the level of quality and safety specifically in regards to installing temporary or permanent modifications needed to perform the comprehensive pump test.

Response to Question 5

Duke is requesting that relief be granted from ISTB-3300 (e)(1) of the 1998 Edition of the American Society of Mechanical Engineers Operating and Maintenance (ASME OM) Code. This Code requirement to test at 80% of design flow poses a hardship in that the CS System and supporting Refueling Water System will require modifications to provide such capability. Duke considered potential modification options and has concluded that permanent modifications would be necessary to comply with this Code requirement. Temporary modifications were determined to not be practical, because the necessary size of connections needed to accomplish the needed flow capacity. A flow area of sufficient size to achieve the specified flow rates would require cutting and welding of new tees into both the CS System and the Refueling Water System. There were no existing flanged or other type connections allowing temporary connection to achieve these flow rates.

A study was completed to determine the most efficient permanent modification option that would allow the Code requirements to be met. Approximately 100 feet of new 8 inch stainless steel piping would be added. The connections would be downstream of the heat exchangers (upstream of valves NS-140 & 141) in the CS System, in a branch line near the RWST supply header (near valve FW-1) in the Refueling Water System. This piping would require about 44 elbows/tees. Four 8 inch manual globe valves would be added for isolation and throttling. New pipe supports would be required and stress analysis models updated for the new piping/valves. The total estimated cost to do both units is $1.5 million. In addition, this modification would increase congestion in areas of the auxiliary building that are already congested. This increased congestion would result in additional maintenance cost over the life of the plant.

Duke proposes that compliance with ISTB-3300 (e)(1) of the 1998 Edition of the ASME OM Code would result in a hardship as a result of these costs. Duke proposes that since the alternative testing described in this relief request will provide an acceptable and adequate indication of pump performance, this hardship is without a compensating increase in the level of quality and safety.

Table 3
1A CS Pump Test Data

Date	Flow Rate (gpm)	Delta P (psid)	Vibration Radial (in/sec)	Vibration Radial +90 (in/sec)	Vibration Axial (in/sec)	Disp. (mils)	Upper Brg Temp (deg F)	Lower Brg Temp (deg F)
12/16/2004	1000	180	0.0894	0.0921	0.07615			
9/23/2004	995	179	0.0894	0.0825	0.07615			
7/1/2004	980	181	0.0938	0.1119	0.09851			
4/8/2004	990	180.5	0.1091	0.0979	0.10100			
1/15/2004	1000	181	0.0880	0.0840	0.08432			
10/23/2003	1000	182	0.0861	0.0901	0.08611			
7/31/2003	1000	179.5	0.0854	0.0795	0.08119			
5/8/2003	985	181	0.0872	0.0832	0.07832			
2/13/2003	1000	181.5	0.0877	0.0872	0.07615			
11/21/2002	1000	180.4	0.0845	0.0830	0.07694			
8/29/2002	1005	180.5	0.1022	0.0868	0.08717			
6/6/2002	1000	179.1	0.0898	0.1028	0.07793			
3/18/2002	1000	181.4	0.0836	0.1057	0.08359			
12/19/2001	1000	181.5	0.0840	0.0843	0.07391			
9/24/2001	1010	182.1	0.0866	0.0966	0.08414			
7/5/2001	992.5	180.5	0.0894	0.0925	0.08689			
4/1/2001	1000	181	0.0887	0.0901	0.08100			
1/19/2001	990	181	0.0880	0.1205	0.08005			
10/28/2000	999.5	180.65	0.0847	0.0938	0.08119			
8/3/2000	1000	180.1	0.0879	0.0914	0.07615			
5/12/2000	1003	179.5	0.0918	0.1185	0.07203			
2/15/2000	1000	178.65	0.8941	0.1004	0.07773			
11/26/1999	1003	179.45	0.0924	0.0904	0.07181			
10/17/1999	1000	180	n/a	n/a	n/a	partial stroke for check valve		
9/3/1999	1000	179	0.1063	0.0904	0.08378			
6/11/1999	984	179.5	0.1102	0.1129	0.07773			
3/18/1999	990	179.3	0.0852	0.0868	0.07634			
2/15/1999	1000	178.65	0.0894	0.1004	0.07773			
12/30/1998	994	179	0.0914	0.1019	0.07773			
10/1/1998	1011	180	0.1033	0.0861	0.08976			
7/9/1998	1003	174.1	0.0973	0.1110	0.08941			
6/19/1998	995	178	0.0840	0.0931	0.09244			
4/24/1998	995	176.5	0.1535	0.1353	0.08769			
4/16/1998	1007	176.6	0.1428	0.1862	0.11920			
1/19/1998	991.5	176.75	0.1367	0.1729	0.11400			
12/4/1997	1013	175.9	0.1527	0.1920	0.11510			
10/28/1997	1006	176.8	0.1419	0.2548	0.13300			
9/10/1997	995	176.5	0.1135	0.3508	0.14450			
8/5/1997	995	179.5	0.0929	0.3387	0.14230			
7/7/1997	1010	177.5	0.0950	0.3522	0.12500			
5/24/1997	1003	178.5	0.0997	0.3473	0.14570			
4/10/1997	997	176.7	0.0934	0.3658	0.14950			
1/3/1997	1004	178.5	0.0950	0.3789	0.13120			
12/3/1996	1017	177	0.1004	0.3711	0.13670			
10/28/1996	1015	177.75	0.1065	0.3452	0.13580			
9/11/1996	998	178.15	0.0938	0.3394	0.15780			
8/16/1996	1010	178	0.0963	0.3394	0.13120			
7/15/1996	1002	178.1	0.1042	0.3336	0.13120			
6/18/1996	1050	177.1	0.0988	0.3373	0.14150			

Table 3
1A CS Pump Test Data

Date	Flow Rate (gpm)	Delta P (psid)	Vibration Radial (in/sec)	Vibration Radial +90 (in/sec)	Vibration Axial (in/sec)	Disp. (mils)	Upper Brg Temp (deg F)	Lower Brg Temp (deg F)
3/25/1996	1023	179	0.1274	0.2889	0.11740			
2/1/1996	1010	178.65	0.1697	0.2873	0.09820			
10/12/1995	1042	181.45	0.1060	0.2997	0.12200			
9/11/1995	1023	181.1	0.1057	0.2441	0.11160			
7/19/1995	1044	181	0.0938	0.2706	0.12480			
6/21/1995	1025	181.05	0.1036	0.3322	0.11850			
5/25/1995	1020.5	181	0.1019	0.2956	0.11870			
4/27/1995	1000	180.4	0.1215	0.2838	0.16500			
3/29/1995	1000	181.25	0.1230	0.2548	0.12980			
2/28/1995	1012.5	181.5	0.1200	0.2204	0.12740			
1/3/1995	1042.5	181	0.1362	0.2724	0.12150			
11/9/1994	1041	181.65	0.1380	0.2679	0.12480			
9/29/1994	1040	179.5	0.1148	0.3358	0.11350			
7/28/1994	1035	180	0.0908	0.3430	0.10970			
6/13/1994	1011	178.1	0.0911	0.3262	0.12000			
3/9/1994	1003	175	0.1317	0.2465	0.10540			
12/8/1993	1033	181.4	0.1110	0.3022	0.11130			
9/7/1993	1030.5	176.9	0.0934	0.3171	0.10990			
5/23/1993	1029.5	177.8	0.0947	0.3038	0.18810			
2/3/1993	1000	177	0.1085	0.2470	0.12050			
11/12/1992	1050	175	0.1289	0.2085	0.13260			
8/27/1992	1010	175	0.0751	0.2715	0.10650			
6/25/1992	1020	177.5	0.0941	0.2720	0.10680			
3/10/1992	1000	179.45	0.0887	0.2770	0.10130			
11/28/1991	1000	179.17	0.0957	0.2137	0.11130			
9/4/1991	1006.7	178.43	0.0937	0.3093	0.09820			
8/2/1991	1000	180.63	0.0911	0.3550	0.10800			
6/19/1991	1000	176.49	0.1031	0.3507	0.09570			
5/7/1991	1000	177.77	0.0960	0.2715	0.09310			
3/21/1991	1000	174.61	0.0743	0.2425	0.08820			
12/20/1990	1000	175.3	0.0787	0.2359	0.10540			
9/26/1990	1025	175	0.0771	0.2560	0.10620			
6/21/1990	1000	176.33	0.0714	0.2461	0.09450			
4/25/1990	1000	177.33	0.0751	0.2520	0.10900			
11/17/1989	1000	177	0.2079	0.1110	0.09250	2.3		
8/24/1989	1000	177.5				1.75	122.6	150.6
7/5/1989	1000	182				2		
4/12/1989	1000	181.5				2.8		
2/17/1989	1000	181.5				2.5		
11/23/1988	1000	182				1.85	123.3	153
10/5/1988	1000	182				3.5	124	157.2
7/13/1988	1000	170.9				3.2		
4/22/1988	1000	171				1.8		
2/8/1988	1000	180				2.25	112.4	145.4
11/6/1987	1000	178.67				2.5		
8/12/1987	1000	179.3				2.4		
5/22/1987	1000	180				1.6		
2/19/1987	1000	181				2.75	110	153.8
11/20/1986	1000	181				3.25		

Table 3
1A CS Pump Test Data

Date	Flow Rate (gpm)	Delta P (psid)	Vibration Radial (in/sec)	Vibration Radial +90 (in/sec)	Vibration Axial (in/sec)	Disp. (mils)	Upper Brg Temp (deg F)	Lower Brg Temp (deg F)
8/23/1986	1000	178.3				2.5		
3/18/1986	1000	181				2.5	127.6	156.46
12/27/1985	1000	180				0.02	(suspect 2 mils not .02)	
9/27/1985	1000	176				2.5		
7/12/1985	1000	181				2		
4/12/1985	1000	179				2	118.4	147.5
1/25/1985	1000	180				3		
12/7/1984	1000	181				1		
9/20/1984	1000	180				2.6		
6/29/1984	1000	180				2		
4/6/1984	1000	180				3	118.13	143.93
12/20/1983	1000	180				1.5		
10/4/1983	1000	179				1.6		
7/14/1983	1000	181				2.1		
4/13/1983	1000	181				3.2	137.1	160.9
12/7/1982	1000	177				1.5		
9/3/1982	1000	179				0.03	(suspect 3 mils not .03)	
8/3/1982	1000	178				3.2		
7/4/1982	1000	179				3.1		
5/28/1982	1000	179				2.6		
4/27/1982	1000	179				3.8		
4/2/1982	1000	178.3				2.5		
3/11/1982	1000	177.3				2.8		
2/8/1982	1000	178				0.8	117.3	138.4
1/12/1982	1000	176				0.8		
12/15/1981	1000	179				0.95		
11/12/1981	1000	178				0.75		
10/15/1981	1000	179				0.8		
9/14/1981	1000	178				0.86		
8/14/1981	1000	176				2.2		
7/16/1981	1000	178				2.5		
6/19/1981	1000	171				0.85		
5/21/1981	1000	170				0.8		
4/22/1981	1000	174				0.8		
3/25/1981	1000	175				0.5		
2/16/1981	1000	177				2.6	108.4	140.93

Table 4
1B CS Pump Test Data

Date	Flow Rate (gpm)	Delta P (psid)	Vibration Radial (in/sec)	Vibration Radial +90 (in/sec)	Vibration Axial (in/sec)	Disp. (mils)	Upper Brg Temp (deg F)	Lower Brg Temp (deg F)
11/30/2004	990	187	0.1349	0.1124	0.09600			
8/12/2004	995	187.5	0.0894	0.1119	0.08786			
5/20/2004	989	185.3	0.0963	0.1119	0.09309			
3/4/2004	1000	186.7	n/a	n/a	n/a			
2/26/2004	1000	186.7	0.1200	0.1121	0.09010			
12/4/2003	1000	187	0.1048	0.1074	0.09211			
9/17/2003	994	187	0.0960	0.1190	0.09342			
6/19/2003	1005	186.5	0.0849	0.1033	0.09010			
3/27/2003	990	186.6	0.0825	0.1057	0.09504			
1/2/2003	1000	187.5	0.1151	0.1349	0.10000			
10/11/2002	1012	187.5	0.1063	0.1080	0.09144			
7/18/2002	1000	186.5	0.0773	0.1083	0.09663			
4/25/2002	1000	187	0.0941	0.1225	0.09789			
1/31/2002	990	187	0.0957	0.1240	0.09407			
11/8/2001	1015	186.6	0.1233	0.1543	0.10360			
8/16/2001	990	186.5	0.1016	0.1198	0.10190			
5/24/2001	1010	187.6	0.1127	0.1482	0.09726			
4/2/2001	1000	187.5	0.0979	0.0991	0.07493			
3/2/2001	990	186	0.1330	0.1235	0.09758			
12/8/2000	992	184.9	0.1362	0.1132	0.08873			
9/14/2000	995	186	0.1030	0.0947	0.10510			
6/23/2000	995	183.3	0.0710	0.0737	0.07349			
3/30/2000	991	182.6	0.0994	0.1083	0.09600			
1/7/2000	1010	183	0.1088	0.1016	0.09851			
10/18/1999	1010	181.5	0.1105	0.1097	0.07615			
7/22/1999	1016	183.6	0.1116	0.1223	0.09913			
4/29/1999	995	186	0.1515	0.1161	0.09178			
2/4/1999	1004	185	0.1284	0.1151	0.10040			
11/12/1998	1014.5	186	0.1445	0.1083	0.10710			
8/20/1998	1017.5	184.8	0.1274	0.1121	0.08699			
6/19/1998	1009.5	190	0.1415	0.1108	0.08062			
5/28/1998	990	185.5	0.1250	0.1080	0.08769			
3/5/1998	1013	187	0.1445	0.1013	0.09944			
12/8/1997	997	186.4	0.1635	0.1279	0.10830			
9/17/1997	995	185.9	0.1307	0.1145	0.09726			
6/24/1997	1014	184.8	0.1402	0.1279	0.08664			
4/18/1997	997	186.8	0.1562	0.1113	0.09277			
1/10/1997	1000	186.5	0.1462	0.1265	0.09440			
10/22/1996	1015	186.1	0.1423	0.1161	0.10280			
7/31/1996	1005	186.3	0.1293	0.1119	0.08646			
5/6/1996	1037	185.5	0.1119	0.1140	0.09407			
2/15/1996	1010.5	186.75	0.1393	0.1085	0.08450			
11/21/1995	1045	187.4	0.1397	0.1255	0.09663			
8/30/1995	1036	184.4	0.1307	0.1349	0.09568			
6/7/1995	1000	185.2	0.1335	0.1419	0.05504			
3/13/1995	1036	185	0.1340	0.1116	0.09244			
11/23/1994	1020	185	0.1349	0.1274	0.08396			
8/9/1994	1024	183.4	0.1419	0.1255	0.09536			
5/18/1994	1050	184.34	0.1428	0.1288	0.09111			

Table 4
1B CS Pump Test Data

Date	Flow Rate (gpm)	Delta P (psid)	Vibration Radial (in/sec)	Vibration Radial +90 (in/sec)	Vibration Axial (in/sec)	Disp. (mils)	Upper Brg Temp (deg F)	Lower Brg Temp (deg F)
2/16/1994	1019.4	185.4	0.1650	0.1255	0.10130			
11/16/1993	1018	185.65	0.1353	0.1243	0.10360			
8/17/1993	1035.5	182	0.1127	0.1094	0.08175			
5/24/1993	1043	186	0.1255	0.1060	0.07948			
1/7/1993	1022.5	185.75	0.1344	0.1274	0.09144			
10/8/1992	1025	184.5	0.1367	0.1298	0.10360			
7/9/1992	1028	184.67	0.1245	0.1367	0.08769			
4/10/1992	1000	184.8	0.1406	0.1105	0.09310			
2/14/1992	1015	185	0.1230	0.1360	0.10040			
11/30/1991	1000	185	0.1398	0.2715	0.14330			
8/5/1991	1000	184.5	0.0937	0.1159	0.07970			
5/21/1991	1000	184.33	0.1264	0.1223	0.09820			
2/14/1991	1000	184	0.1437	0.1225	0.09110			
11/19/1990	1029	183.83	0.1445	0.1228	0.09600			
8/14/1990	1000	174.33	0.1353	0.1966	0.12020			
5/5/1990	1014	184	0.1410	0.1460	0.08600			
1/4/1990	1000	186				2.2		
10/4/1989	1000	181.5				2	109.5	168.4
7/5/1989	1000	182				2.5		
4/18/1989	1000	182.8				2.5		
1/4/1989	1000	183				2.3		
10/6/1988	1000	186				2.5	109.5	165.3
7/13/1988	1000	181.5	test gauge dP was 178.6			2.4		
4/20/1988	1020	180.5	test gauge dP was 183			2.5		
1/13/1988	990	187.3				2.4		
11/12/1987	1040	185	test gauge dP was 182.57			2.4	111.7	174.8
7/24/1987	1000	186.3				2.5		
4/23/1987	1000	187				1.5		
1/21/1987	1000	187.5				2	107.7	153.6
10/27/1986	1000	186				3.2		
8/23/1986	1000	183.3				2.3		
3/18/1986	1000	186				2	102.03	153.56
12/27/1985	1000	179.5				0.02	(suspect 2 mils not 0.02)	
9/27/1985	1000	178				2		
7/12/1985	1000	186				1.9		
4/12/1985	1000	184.3				2.5	108.4	156.16
1/25/1985	1000	185				3		
12/7/1984	1000	184				2		
9/20/1984	1000	185.6				2.1		
7/3/1984	1000	183.3				2.3		
4/6/1984	1000	184				1.7	108.8	151.03
1/12/1984	1020	184				1.8		
10/5/1983	1000	185				1.8		
7/12/1983	1000	184				1.9		
4/13/1983	1000	184				1.5	108.97	159.37
10/28/1982	1000	185				1.6		
8/4/1982	1000	185				2.2		
7/14/1982	1000	185				1.5		
6/7/1982	1000	185				2.7		

Table 4
1B CS Pump Test Data

Date	Flow Rate (gpm)	Delta P (psid)	Vibration Radial (in/sec)	Vibration Radial +90 (in/sec)	Vibration Axial (in/sec)	Disp. (mils)	Upper Brg Temp (deg F)	Lower Brg Temp (deg F)
5/4/1982	1000	185				2.2		
4/6/1982	1000	185				1.5		
3/10/1982	1000	185				2.5		
2/8/1982	1000	185				0.8	100.5	149.8
1/12/1982	1000	185				0.7		
12/14/1981	1000	185				0.5		
11/12/1981	1000	185				0.7		
10/15/1981	1000	186				0.6		
9/14/1981	1000	184				0.78		
8/17/1981	1000	185				0.68		
7/16/1981	1000	182				2.25		
6/19/1981	1000	186				0.75		
5/21/1981	1000	186				0.6		
4/22/1981	1000	178				0.7		
3/26/1981	1000	175				1.75		
2/16/1981	1000	186				3	93.57	155.8

Table 5
2A CS Pump Test Data

Date	Flow Rate (gpm)	Delta P (psid)	Vibration Radial (in/sec)	Vibration Radial +90 (in/sec)	Vibration Axial (in/sec)	Disp. (mils)	Upper Brg Temp (deg F)	Lower Brg Temp (deg F)
1/19/2005	990	186.0	0.0849	0.1113	0.07370			
10/27/2004	1000	180.0	0.0887	0.1274	0.07370			
8/4/2004	1000	180.5	0.0963	0.0944	0.07514			
5/12/2004	1000	180.0	0.0887	0.1274	0.07370			
2/18/2004	1000	182.1	0.0901	0.1225	0.07031			
11/24/2003	995	181.1	0.0963	0.1371	0.07031			
9/3/2003	1000	180.9	0.0894	0.1195	0.07287			
6/11/2003	1000	180.0	0.0814	0.1007	0.06944			
3/19/2003	1000	178.1	0.0928	0.1048	0.07160			
12/19/2002	990	182.3	0.0944	0.0982	0.07634			
10/2/2002	1000	182.0	0.0941	0.1097	0.07554			
7/10/2002	1010	181.0	0.0921	0.0991	0.07793			
4/17/2002	1000	182.5	0.0970	0.1113	0.07245			
1/23/2002	1001	182.0	0.0850	0.1102	0.07453			
10/31/2001	1004	180.1	0.0914	0.1102	0.06855			
8/9/2001	993	181.0	0.0872	0.1174	0.07574			
5/17/2001	1007	180.7	0.0819	0.1039	0.06944			
2/22/2001	1000	181.1	0.0741	0.1486	0.07329			
12/1/2000	999	179.5	0.0884	0.0988	0.06629			
9/26/2000	1002	179.7	0.0801	0.1108	0.07329			
6/16/2000	1007	182.2	0.0771	0.0745	0.05284			
3/25/2000	989	182.1	0.0911	0.0947	0.07634			
12/31/1999	995	182.9	0.0868	0.0823	0.06855			
10/8/1999	996	182.4	0.0816	0.1099	0.06536			
7/17/1999	996	182.0	0.1051	0.1330	0.07139			
5/18/1999	991	182.5	0.0931	0.1097	0.06766			
4/7/1999	1000	181.5	0.0982	0.1143	0.07224			
2/22/1999	1002	183.2	0.1788	0.5537	0.45390			
1/28/1999	1012	184.0	0.1788	0.5116	0.44410			
12/28/1998	990	184.5	0.1740	0.5077	0.42850			
12/1/1998	997	185.5	0.1620	0.4645	0.39650			
11/5/1998	989.5	185.1	0.1642	0.4729	0.39650			
10/8/1998	1008	185.0	0.1679	0.4851	0.49210			
9/10/1998	1012	184.9	0.1642	0.4901	0.42500			
8/13/1998	1008	184.6	0.1646	0.4729	0.43190			
7/16/1998	1009	183.0	0.1628	0.5019	0.42620			
6/16/1998	995	180.0	0.1639	0.4841	0.42040			
5/20/1998	986	185.0	0.1733	0.5135	0.42960			
4/21/1998	1001	180.7	0.1782	0.5537	0.45180			
3/26/1998	1009.5	185.0	0.1582	0.4666	0.39530			
2/26/1998	999	181.0	0.1559	0.5097	0.39530			
1/27/1998	992.5	183.1	0.1679	0.5116	0.41930			
12/29/1997	994	184.1	0.1582	0.4760	0.38780			
11/25/1997	1008	183.6	0.1722	0.4645	0.43750			
9/10/1997	1004	188.0	0.1768	0.4463	0.41810			
8/4/1997	1000	181.2	0.1559	0.4496	0.38270			
6/16/1997	1002	188.0	0.1722	0.5116	0.43190			
5/12/1997	1000	186.5	0.1661	0.5322	0.43190			
3/24/1997	998	181.3	0.1750	0.5210	0.44300			

Table 5
2A CS Pump Test Data

Date	Flow Rate (gpm)	Delta P (psid)	Vibration Radial (in/sec)	Vibration Radial +90 (in/sec)	Vibration Axial (in/sec)	Disp. (mils)	Upper Brg Temp (deg F)	Lower Brg Temp (deg F)
2/17/1997	993	184.1	0.1750	0.5322	0.45610			
12/27/1996	992	188.4	0.1665	0.4656	0.40020			
11/8/1996	996	188.3	0.1601	0.4528	0.40740			
10/2/1996	982	187.0	0.1690	0.4760	0.40500			
9/3/1996	1013	185.0	0.1547	0.4539	0.40980			
8/5/1996	1010	186.1	0.1507	0.4624	0.38650			
7/10/1996	1027.5	182.8	0.1539	0.4419	0.39030			
6/13/1996	1030	186.6	0.1590	0.4474	0.37110			
5/4/1996	1027	185.0	0.1555	0.4921	0.39280			
3/21/1996	1046	183.4	0.1495	0.4134	0.35220			
2/22/1996	1027.5	183.7	0.1570	0.4419	0.35900			
1/24/1996	1019	184.8	0.1474	0.4319	0.34940			
12/26/1995	1020	184.0	0.1668	0.4770	0.38530			
11/30/1995	1031	183.8	0.1466	0.4122	0.36040			
10/30/1995	1041	182.7	0.1415	0.4285	0.33290			
10/2/1995	1045	183.4	0.1478	0.4539	0.36440			
8/11/1995	1040	181.1	0.1605	0.4146	0.35220			
7/10/1995	1045	181.5	0.1562	0.3737	0.36170			
6/15/1995	1000	184.9	0.1523	0.3953	0.34520			
5/15/1995	1007	180.4	0.1478	0.4193	0.34800			
3/23/1995	1050	184.0	0.1519	0.4582	0.35630			
2/21/1995	1020	181.0	0.1499	0.4614	0.39280			
10/4/1994	1010	182.9	0.1701	0.4687	0.37890			
8/11/1994	1034	180.2	0.1704	0.4635	0.35900			
7/6/1994	1038	183.8	0.1683	0.4911	0.38690			
4/11/1994	1023	182.2	0.1672	0.4980	0.38530			
1/10/1994	1040	180.5	0.1601	0.4687	0.38010			
10/12/1993	1022	180.0	0.1624	0.5285	0.39530			
8/18/1993	1000	187.0	0.1665	0.5154	0.41340			
5/24/1993	1023	184.1	0.1453	0.3711	0.34090			
3/1/1993	1025	185.9	0.1362	0.3050	0.31870			
12/22/1992	1000	179.5	0.1293	0.3164	0.25960			
9/24/1992	1010	184.0	0.1108	0.2567	0.24560			
6/24/1992	1050	183.3	0.1164	0.2587	0.12100			
3/3/1992	1000	180.0	0.1612	0.4145	0.36890			
10/17/1991	1000	179.0	0.1467	0.3514	0.32920			
7/11/1991	1000	183.2	0.1293	0.2670	0.26050			
5/8/1991	1000	176.3	0.1151	0.2126	0.20549			
2/8/1991	1000	186.8	0.1110	0.1570	0.16830			
12/31/1990	1040	186.7	0.1040	0.1510	0.16200			
11/12/1990	1000	182.0	0.1580	0.3600	0.22800			
8/29/1990	1010	184.5	n/a	n/a	n/a	invalid vib data during shutdown		
5/30/1990	1000	187.3	0.1062	0.2701	0.23480			
3/20/1990	1000	183.3	0.2843	0.1570	0.29980	2.5	97.6	161.5
2/2/1990	1000	187.2	0.3182	0.1669	0.27720	2.6		
12/20/1989	1000	187.8	0.1335	0.3026	0.27010	2.4		
9/12/1989	1000	188.0				2.4		
8/8/1989	1000	186.0				1.7		
6/6/1989	1000	187.0				2.7	109.9	166.1

Table 5
2A CS Pump Test Data

Date	Flow Rate (gpm)	Delta P (psid)	Vibration Radial (in/sec)	Vibration Radial +90 (in/sec)	Vibration Axial (in/sec)	Disp. (mils)	Upper Brg Temp (deg F)	Lower Brg Temp (deg F)
3/9/1989	1000	183.0				2.7		
12/5/1988	1010	179.7				1.4		
9/9/1988	1000	180.0				2.5		
7/14/1988	1000	185.0				3	111.5	167.2
3/23/1988	1000	186.3				2.5	100	163.7
12/23/1987	1000	184.2				2		
9/21/1987	1000	184.0				2.3		
6/22/1987	1000	180.3				2		
3/24/1987	1000	186.0				2	99	162.9
12/23/1986	1000	187.0				2.1		
9/24/1986	1000	183.0				2.5		
6/24/1986	1000	185.6				1.5	116	173
6/18/1986	1000	172.5				12-20		
3/20/1986	1000	170.0				2.5		
12/20/1985	1000	172.0				2.5		
9/23/1985	672	177.0				1.6		
9/23/1985	1000	173.0				1.6		
8/20/1985	672	176.0				2	100.5	177.6
8/20/1985	1000	176.0				2		
8/9/1985	672	178.0				2.2		
8/9/1985	1000	174.0				2.2		
6/28/1985	672	174.0				2.3		
6/28/1985	1000	169.0				2.5		
5/14/1985	1000	172.0				2.5		
3/30/1985	670	177.3				3		
3/30/1985	1000	175.0				3.1	new flow orifice	
1/14/1985	1000	190.0				2.5		
10/26/1984	1000	192.0				3		
8/10/1984	1000	190.0				3		
5/22/1984	1000	183.0				2	100.3	160.3
2/17/1984	1000	183.0				2.5		
12/2/1983	1000	188.0				1		
7/9/1983	1000	189.8				2.9		
6/22/1983	1000	191.0				2		
3/17/1983	1000	191.0				1.5	92.1	156.6

Unit 2 flow data prior to 3/30/85 was non-conservatively high due to an undersized orifice bore.

Table 6
2B CS Pump Test Data

Date	Flow Rate (gpm)	Delta P (psid)	Vibration Radial (in/sec)	Vibration Radial +90 (in/sec)	Vibration Axial (in/sec)	Disp. (mils)	Upper Brg Temp (deg F)	Lower Brg Temp (deg F)
12/9/2004	1000	183.9	0.1085	0.2049	0.08839			
9/16/2004	990	185.0	0.1582	0.1901	0.08646			
6/24/2004	992	183.6	0.1428	0.2187	0.08359			
4/1/2004	990	184.2	0.1457	0.1582	0.09077			
1/6/2004	1000	184.0	0.1094	0.1445	0.08839			
10/13/2003	995	183.7	0.1250	0.2096	0.08804			
7/23/2003	1000	184.0	0.1269	0.1809	0.08664			
5/2/2003	989	184.0	0.1200	0.1740	0.08119			
2/6/2003	1000	185.0	0.1436	0.1958	0.09504			
11/14/2002	1000	181.3	0.1159	0.1284	0.08593			
8/21/2002	998	185.0	0.1248	0.1551	0.08873			
5/30/2002	1000	185.5	0.1137	0.1402	0.08976			
4/2/2002	1000	183.1	0.1344	0.1547	0.08752			
12/13/2001	1010	185.0	0.1019	0.1628	0.08522			
9/17/2001	1000	184.0	0.1436	0.1726	0.08212			
6/28/2001	1000	180.0	0.1045	0.1620	0.08341			
4/5/2001	999	183.0	0.0997	0.1344	0.07890			
1/11/2001	1000	185.5	0.1091	0.1415	0.08286			
10/19/2000	1000	185.0	0.1317	0.1654	0.07948			
9/26/2000	1011	183.0	0.1441	0.2079	0.09277			
7/26/2000	996	181.9	0.1466	0.1597	0.08341			
5/4/2000	1000	183.5	0.1195	0.1668	0.08522			
2/10/2000	1000	182.5	0.1284	0.1868	0.08231			
11/16/1999	1010	187.0	0.1177	0.1441	0.09010			
8/26/1999	1002	185.3	0.1210	0.1624	0.08156			
6/3/1999	1000	186.2	0.1213	0.1822	0.08249			
3/8/1999	1009	184.3	0.1750	0.2280	0.07812			
12/16/1998	1004	185.5	0.1690	0.2210	0.08558			
9/23/1998	1017	185.8	0.2037	0.2119	0.08100			
7/1/1998	1003	186.0	0.1503	0.2148	0.08414			
4/8/1998	1006	185.4	0.1601	0.2431	0.08593			
3/9/1998	1002	186.0	0.1566	0.2237	0.08664			
2/13/1998	998	185.5	0.2323	0.1704	0.10190			
1/14/1998	998	186.5	0.1474	0.2043	0.10000			
11/20/1997	1004	185.9	0.2519	0.3270	0.11160			
7/28/1997	1000	185.2	0.1659	0.2055	0.08540			
5/5/1997	1000	185.0	0.1555	0.2237	0.08901			
2/10/1997	1008	186.5	0.1736	0.2333	0.09277			
11/14/1996	987	185.1	0.1624	0.2390	0.08231			
8/22/1996	999	186.4	0.1428	0.2652	0.08249			
5/29/1996	1045	184.0	0.2275	0.2981	0.11610			
5/4/1996	1007	185.0	0.2359	0.1631	0.08576			
3/5/1996	1038	185.2	0.1547	0.2067	0.08062			
12/14/1995	1025	187.9	0.1849	0.2253	0.09407			
9/21/1995	1021.5	185.0	0.1535	0.2328	0.08752			
6/27/1995	1026	186.0	0.1582	0.1815	0.09010			
4/4/1995	1015	185.0	0.1650	0.2148	0.09277			
12/29/1994	1020	187.9	0.1367	0.1764	0.08304			
11/16/1994	1032	184.1	0.1393	0.1586	0.09375			

Table 6
2B CS Pump Test Data

Date	Flow Rate (gpm)	Delta P (psid)	Vibration Radial (in/sec)	Vibration Radial +90 (in/sec)	Vibration Axial (in/sec)	Disp. (mils)	Upper Brg Temp (deg F)	Lower Brg Temp (deg F)
8/24/1994	1050	182.1	0.1457	0.1782	0.08717			
5/23/1994	1010	184.9	0.1335	0.1970	0.09144			
2/28/1994	1036	187.0	0.1288	0.1939	0.07554			
11/29/1993	1035	187.7	0.1397	0.1605	0.08432			
8/19/1993	1038	183.0	0.1657	0.2131	0.08839			
4/14/1993	1022	186.2	0.1389	0.1719	0.08175			
1/20/1993	1010	186.9	0.1135	0.1620	0.08341			
10/29/1992	1040	185.0	0.1375	0.1650	0.08414			
8/25/1992	1010	185.0	0.1185	0.1453	0.08300			
5/20/1992	1000	187.7	0.1371	0.1570	0.08120			
3/3/1992	1000	186.0	0.1192	0.1523	0.08300			
11/13/1991	1000	186.3	0.1639	0.2199	0.08520			
8/13/1991	1000	187.0	0.1030	0.1410	0.06700			
5/22/1991	1000	186.8	0.1168	0.2107	0.13440			
2/20/1991	1000	182.0	0.1260	0.2490	0.08062			
11/13/1990	1000	182.3	0.1402	0.2001	0.09001			
7/25/1990	1017	182.0	0.1344	0.2080	0.08810			
4/25/1990	1000	181.5	0.1170	0.2140	0.07700			
1/22/1990	1000	184.0	0.1280	0.0944	0.06510	2.75	111.6	164.6
11/8/1989	1000	184.0	0.1260	0.0931	0.05770	2.7		
8/16/1989	1000	184.0				2.7		
5/4/1989	1000	187.0				3.2		
2/7/1989	1000	182.3				3.2	115	164.3
11/3/1988	1000	184.0				3.2		
8/16/1988	1000	182.0				3.5		
5/25/1988	1000	183.0				3.2		
3/3/1988	1000	185.0				3.5	114.1	162.5
12/22/1987	1000	184.0				2.5		
9/24/1987	1000	184.2				3		
7/1/1987	1000	179.0				2.75		
3/25/1987	1000	182.5				3	112	157.03
12/22/1986	1000	186.0				3.2		
9/24/1986	1000	183.3				2.4		
7/1/1986	1000	181.0				2.6		
3/20/1986	1000	183.0				2.8	112.2	158
12/20/1985	1000	184.0				2.9		
9/23/1985	672	189.0				1.9		
9/23/1985	1000	186.0				1.8		
8/9/1985	672	188.0				2.8		
8/9/1995	1000	185.0				2.8		
7/1/1985	1000	184.0				2.5		
5/15/1985	1000	184.0				4.2	111.36	152.4
3/30/1985	1000	176.3				3.5	Suction PG Out Of Cal	
3/30/1985	670	172.0				3.8	Suction PG Out Of Cal	
1/14/1985	1000	177.0				3	Suction PG Out Of Cal	
10/26/1984	1000	185.0				3.2		
8/10/1984	1000	189.0				0.3	(suspect 3 mils not 0.3)	
5/23/1984	1000	184.0				2.5	105.17	153.13
2/17/1984	1000	188.0				3		

Table 6
2B CS Pump Test Data

Date	Flow Rate (gpm)	Delta P (psid)	Vibration Radial (in/sec)	Vibration Radial +90 (in/sec)	Vibration Axial (in/sec)	Disp. (mils)	Upper Brg Temp (deg F)	Lower Brg Temp (deg F)
12/2/1983	1000	183.0				2.8		
9/14/1983	1000	187.5				3		
6/22/1983	1010	188.0				2.2		
3/16/1983	1000	187.0				1.4	103.7	140.7

Unit 2 flow data prior to 3/30/85 was non-conservatively high due to an undersized orifice bore.