Tennessee Valley Authority, Post Office Box 2000, Soddy-Daisy, Tennessee 37379-2000

Robert A. Fenech
Vice President, Sequoyah Nuclear Plant

February 2, 1994

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

In the Matter of	)	Docket No. 50-328
Tennessee Valley Authority	)	

SEQUOYAH NUCLEAR PLANT (SQN) - UNIT 2 CENTRIFUGAL CHARGING PUMP (CCP) 2B-B POSTMAINTENANCE TESTING SUITABILITY

On January 7, 1994, the 2B-B CCP shaft broke as a result of an event initiated by a high-cycle fatigue failure. A matched spare element was utilized to repair the 2B-B pump; and a subsequent American Society of Mechanical Engineers, Section XI, pump test was performed to validate the pump head and establish a baseline. As requested by NRC during a January 10, 1994, telecon, Enclosure 1 provides the basis for TVA's position that a modification to the emergency core cooling system (ECCS) subsystem flow characteristics has not occurred. Based on Enclosure 1, the ECCS flow tests specified by Technical Specification (TS) Surveillance Requirement (SR) 4.5.2.h will not be required. However, a flow verification test will be performed as scheduled during the upcoming Unit 2 Cycle 6 refueling outage.

It should be pointed out that performance of a system flow test, as specified by TS SR 4.5.2.h, is normally performed each refueling outage with the reactor vessel head removed and the reactor coolant pumps jacked up. Performance of the system flow test in other than this configuration unnecessarily challenges the cold overpressure protection system and has been a suspected source of seal degradation if seal injection is being maintained during the test. In addition, performance of the full flow test in the current plant configuration is estimated to delay plant restart two to three days.

D030 /1

Enclosure 2 contains the commitment provided in this submittal.

Please direct questions concerning this issue to J. D. Smith at (615) 843-6672.

Sincerely,

Robert A. Fenech

Robert A. Fenech

Enclosures
cc (Enclosures):
Mr. D. E. LaBarge, Project Manager
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One White Flint, North
11555 Rockville Pike
Rockville, Maryland 20852-2739

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Regional Administrator
U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323-2711

ENCLOSURE 1

S57 940108 880

ACCEPTANCE OF INSTALLING THE SPARE ELEMENT S/N 36532C-SPARE II INTO THE CCP 2B-B PUMP LOCATION AND PMT REQUIREMENTS

ACCEPTANCE OF INSTALLING THE SPARE ELEMENT INTO THE 2B-B CCP LOCATION WITHOUT PERFORMING A FULL FLOW TEST.

Tech Specs section 3/4.5.2 surveillance requirements requires the sum of the injection flow rates, excluding the highest flow rate must be greater or equal to 309 gpm (commonly referred to as the N minus 1 criteria or number of loops minus one) and the total pump flow must be less than or equal to 555 gpm. AS described in Tech Specs this requirement applies when modifications are performed to the ECCS subsystems that alter the flow characteristics. Though not addressed in Tech Specs there is also a design requirement that the pumps not be allowed to degrade below a minimum ECCS performance curve. This minimum ECCS performance curve insures that the system resistance is not reduced to compensate for weak pumps. Not all design base accidents will result in RCS pressure stabilizing immediately at ambient conditions where the flow balance is performed. Having a lower resistance than assumed in the analysis would result in more flow being lost thru the assumed break (in the lowest resistance branch line) when the RCS pressure is higher than those during the actual balance. From graph 1 it can be seen both the original and spare elements are well above the Min ECCS performance curve and add margin to the analysis.

From graph 1 and table I it can also be seen all 3 pump performance curves have very similar characteristics with the spare curve being between the 2A-A and 2B-B at the critical area or maximum flow. Near the low flow area of the curve the spare element has a slightly higher head which is a desirable characteristic yet insignificant.

From table I and graph II it can be seen the old 2B-B pump has shown negligible degradation since its original installation in 1983 with all flow balance points shown. Although field discharge pressure test data has not agreed with the vendor certified curve performed on an ideal test loop it is a known fact the specific plant piping layout includes a short run of discharge piping (3 ft) leaving a nonconcentric discharge nozzle with a ninety degree elbow immediately followed by the miniflow tee. In the middle of these components is the discharge pressure tap. It should be noted SNP has never been able to achieve test data as high as the vendor certified curve and the plant test data has always been in the conservative direction in relation to the Min ECCS performance curve. As seen on graph II a direct correlation does exist. The latest flow balances are seen on graphs IV and V.

A review was also conducted on the ten years of Section XI test data. (Ref Table III and Graph III) This shows at miniflow conditions the average head loss for the 2B-B pump was 18 psig over a 10 year period. Using the conversion of 4.3 lbs of pressure increase yeilds an increase of 1 gpm and applied uniformly across the pump performance curve only a 4 gpm increase in flow would be expected at the max flow conditions. The 2B-B pump flow was left at 538.24 gpm during the 1992 flow balance or 16.8 gpm from runout. Thus enough margin is available to absorb the additional flow.

Westinghouse (see attached memo) has also reviewed and discussed the following areas with TVA which include:

NORMAL CHARGING
TESTING
FLOW BALANCING
PUMP RUNOUT
NPSH REQUIREMENTS
RPM
HORSEPOWER

CONCLUSION: THE SPARE ELEMENT 36532C-SPARE II CAN BE INSTALLED AND VERIFIED ACCEPTABLE WITHOUT A FULL FLOW TEST. A SECTION XI TEST IS REQUIRED TO BASELINE THE PUMP. A FULL FLOW TEST WILL BE PERFORMED NEXT REFUELING OUTAGE IN ACCORDANCE WITH SEQUOYAH'S NORMAL SCHEDULE.

D. R. Cooper 1/7/94
NSSS SYSTEM ENGINEER

Michael E. Fry 1/7/94
NSSS SUPERVISOR

c:\wp51\ccp2b

(GRAPH II)

UNIT 2 CCP PERFORMANCE

CURVES

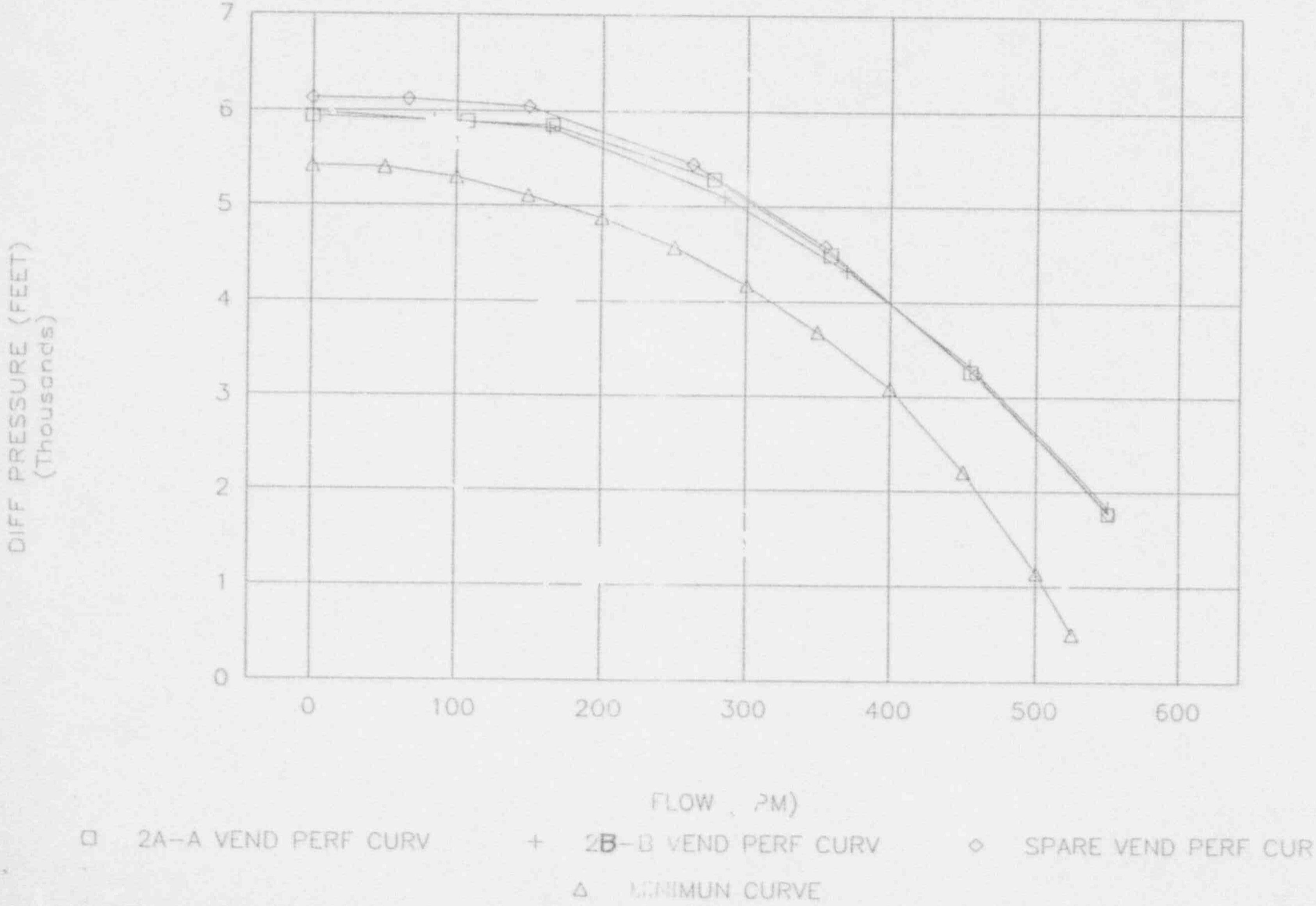


TABLE I

PUMP VENDOR DATA

2A-A HD	FLOW	2B-B HD	TEST DATA	SPARE HD	MINIMUM ECCS CURVE	
1769	550					
3250	455					
4499	359					
5281	277					
5855	166					
5892	107					
5944	0	5988				
	84	5907				
	164	5826				
	284	5098				
	370	4331				
	454	3326				
	550	1836				
	551			1774		
	458			3232		
	355			4581		
	262			5440		
	150			6047		
	66			6124		
	0			6129	5410	
	50				5400	
	100				5300	
	150				5110	
	200				4875	
	250				4575	
	300				4175	
	350				3675	
	400				3085	
	450				2200	
	500				1140	
	525				500	
	549		1235			1990
	548		1237			1986
	538		1320			1992
	536		1327			1983
	533		1261			1989
						YEAR

************PAST TEST****************

9/24/83	1327	536
10/16/86	1237	549
2/07/89	1261	533
10/12/90	1235	549
3/24/92	1320	538
	HEAD FT	FLOW TOTAL

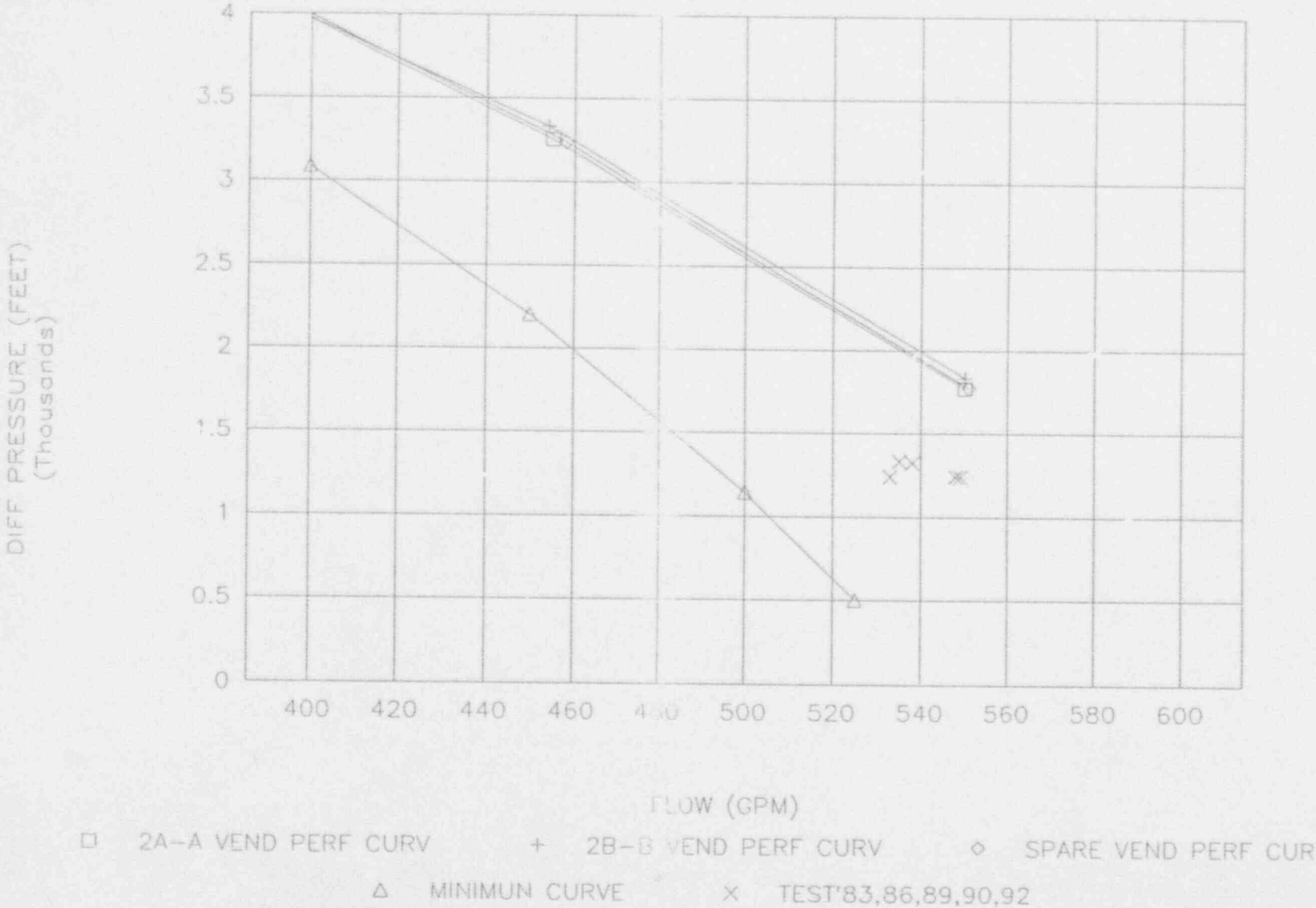
****

Flow test data

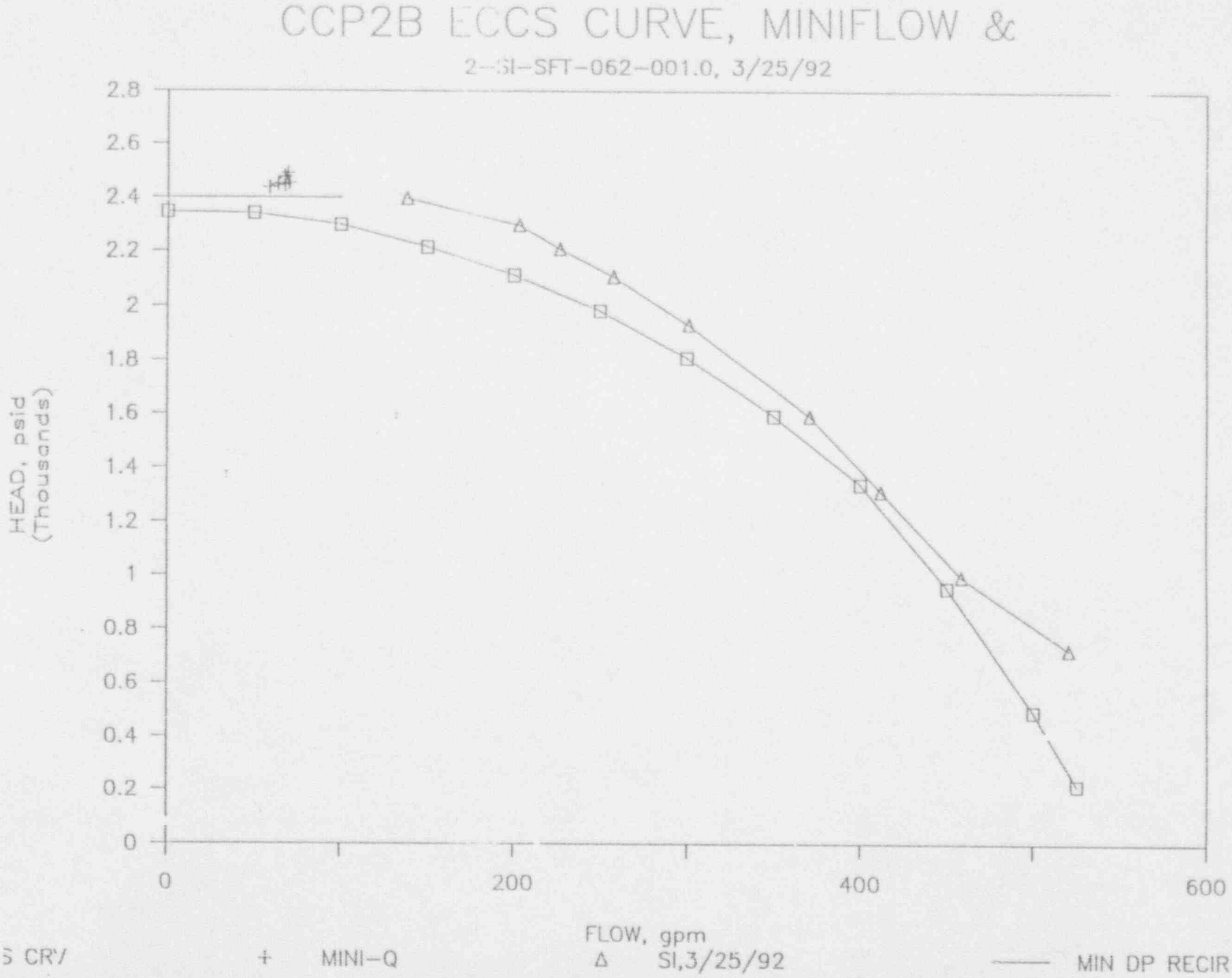
GRAPH

UNIT 2 CCP PERFORMANCE

CURVES



GRAPH III



CCP2B ECCS CURVE, MINIFLOW &
2-SI-SFT-062-001.0, 3/25/92
HEAD, psid (Thousands)
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
200
400
600
FLOW, gpm
S CR'/
+ MINI-Q
Δ SI,3/25/92
MIN DP RECIR

① TABLE III 2B-B

IONFL XI PUMP DATA FOR CCP2B 2-SI-SYP-062-001.B
ARY LIST

	DISCH PRESS psig	INLET PRESS psig	DIFF PRESS psid	FLOW RATE gpm	INBD BEARING H.VIB mils	INBD BEARING V.VIB mils	OUTBD BEARING H.VIB mils	OUTBD BEARING V.VIB mils	AXIAL VIB mils	BAL DRM FL RATE gpm	OIL PRESS psig	BEARING TEMPS INBD (F)	DIFF (F)	OUTBD (F)	DIFF (F)	THRUST (F)	DIFF (F)	ERCW TEMP	SCHED BASELN yes/no	REMARKS
4/81	2580	36	2544		0.39	0.15					9.4		47		55		56		YES	Initial perf
3/81	2575	21.4	2553.6		0.35	0.25					10.5		38		50		47		YES	MRA97053, TC80-1081
3/81	2570	20	2550	90	0.4	0.24					10.8		0		0		0		NO	
7/81	2575	27	2548	110	0.41	0.3					11.5		0		0		0		NO	TC81-1081
1/81	2600	37	2563	90	0.41	0.19					11.9		0		0		0		NO	
3/81	2570	30	2540	85	0.71	0.61					11.1		0		0		0		NO	
7/81	2580	27	2553		0.69	0.76					11.3		0		0		0		YES	PMT
3/81	2620	39.5	2580.5	90	0.3	0.45					11.5		0		0		0		NO	
1/81	2620	30	2590	87	0.83	0.26					11.3		0		0		0		NO	
1/82	2620	30	2590	90	0.59	0.56					11.3		0		0		0		NO	
5/82	2560	31	2529	93	0.63	0.24					11.4	97	54	108	65	113	70	43	NO	
5/82	2540	32	2508	95	0.43	0.85					11.8		0		0		0		NO	
2/82	2580	44	2535	97	0.84	0.71					11.7		0		0		0		NO	
5/82	2590	56	2524		0.78	1.4					11.2	103	37	114	49	132	66	66	YES	New shaft & impeller
5/82	2500	45	2455	92	0.93	1.06					10.8		0		0		0		NO	
4/82	2580	45	2535	96	0.76	0.45					11.5		0		0		0		NO	
4/83	2500	40	2460	90	0.63	0.44					11.8	93	46	106	57	129	82	47	NO	
4/83	2520	37	2483	93	0.78	0.53					11.9		0		0		0		NO	
7/83	2550	40	2510	95	0.68	0.89					11		0		0		0		NO	
1/83	2550	40	2510	112	0.42	0.32					10.7	112	31	119	33	135	54	81	NO	PMT,seal repl
1/83	2550	33.5	2516.5	110	0.42	0.29					11.7		0		0		0		YES	PMT, high vibs bearing #8-18 mils, repl pmp
7/83	2550	31.5	2518.5		0.6	0.4					11.9	91	10	115	34	120	39	81	YES	PMT, MRA087530
5/83	2540	26.5	2513.5		0.55	0.23					11.5	129	53	144	68	109	33	76	YES	PMT after seal work
5/83	2560	52	2508	90	0.48	0.23					11.6	122	51	139	68	112	41	71	NO	
1/83	2520	39.5	2480.5	91	0.4	0.11					11.2	115	75	123	89	97	57	40	NO	
7/84	2520	35	2485	91	0.43	0.16					11.4	115	62	124	71	109	47	53	NO	MRA076092 ERCW oil cooler
1/84	2510	35	2475	91	0.44	0.12					11.3		0		0		0		NO	
7/84	2510	35	2475	95	0.5	0.18					11.6		0		0		0		NO	
1/84	2520	40	2490	90	0.48	0.15					11.8		0		0		0		NO	
/84	2550	48	2502	97	0.48	0.2					10.8	115	62	123	70	120	47	53	YES	MRA289305 oil cooler
/84	2540	34	2506	100	0.6	0.2					11		0		0		0		NO	PMT
/85	2550	46	2504	99	0.49	0.22					11	117	69	121	73	99	31	48	NO	
/85	2510	47	2463	87	0.58	0.21					9.2	120	69	121	70	85	34	51	YES	PMT, spd incr/oil clr,MR'sA302519,'524,'521,'508,'525
/85	2550	49	2501	100	0.6	0.26					10.5		0		0		0		NO	

new pump
AVG ΔP 2516

(2) TABLE III

?/85	2520	37	2483	100	0.56	0.14				10.8		0		0		0		NO	
?/85	2540	49	2491	100	0.44	0.17				11.3		0		0		0		NO	
?/86	2550	30	2520	97	0.36	0.16				11	112	71	101	60	74	33	41	NO	
?/86	2560	33	2527	103	0.44	0.22				11		0		0		0		NO	WRB104366
?/86	2550	31	2519	115	0.55	0.14				11.2		0		0		0		NO	
?/86	2550	32	2518	87	0.53	0.2				11.5		0		0		0		NO	
?/86	2460	29.95	2430.0	84	0.6	0.25				11.9		0		0		0		NO	TC86-1158
?/87	2420	25	2395	85	0.5	0.23				11.?	105	60	119	73	77	31	46	NO	TC86-1466
?/87	2420	33.5	2386.5	87	0.38	0.3				10.4		0		0		0		NO	
?/87	2450	24.2	2425.8	90	0.5	0.22				10.9		0		0		0		NO	TC87-1073
?/87	2525	31.5	2493.5	53.3	0.51	0.27				11.6		0		0		0		YES	Baseln, 1s. test w/UT
?/88	2480	28.5	2451.5	58	0.47	0.26				10	99	50	103	55	109	61	48	NO	Gear box hi?. vibs,PRO 2-88-4
?/88	2500	54	2446	57	0.55	0.34				11.4		0		0		0		NO	
?/88	2510	38	2472	55.6	0.2	0.43						0		0		0		NO	
?/88	2500	28.5	2471.5	55	0.41	0.21						0		0		0		NO	
?/88	2490	33.7	2456.3	55	0.44	0.21						0		0		0		NO	O rngs expanded, ICF 88-1311
?/89	2550	40	2510	61	0.44	0.18					93		103		97			NO	
?/89	2520	35	2485	65	0.49	0.27						0		0		0		NO	
?/89	2500	35.4	2464.6	58	0.5	0.29						0		0		0		NO	
?/89	2500	50.8	2449.2	60.5	0.5	0.3						0		0		0		NO	WR B758967 on pmp outbd seal
?/90	2480	29.5	2450.5	54.8	0.25	0.45					72		113		97			NO	
?/90	2490	34.2	2455.8	63.9	0.2	0.23					112	62	144	94	146	96	50	NO	? on bearing temps
?/90	2525	33	2492	54	0.3	0.35						0		0		0		NO	
?/90	2490	34	2456	70	0.26	0.26						0		0		0		NO	
?/90	2500	30.8	2469.2	62.5	0.4	0.25						0		0		0		NO	
?/90	2480	27	2453	71.7	0.45	0.23						0		0		0		NO	
?/90	2460	16.5	2443.5	64.2	0.7	0.45						0		0		0		NO	
?/91	2490	30	2460	64	0.45	0.3					94		94		99			NO	Add'l M&TE 549622-vib
?/91	2500	30	2470	65.8	0.3	0.3	0.9	0.5	26.6		98		99		105			NO	1st perf new SI
?/91	2525	29	2496	62	0.25	0.3	0.85	0.4	51	11		0		0		0		NO	
?/91	2480	26	2454	74	0.2	0.2	0.7	0.3	41.5	8.6		0		0		0		NO	
?/91	2500	22	2478	67.3	0.24	0.22	0.72	0.8	44.1	11.3		0		0		0		NO	
?/92	2480	27.4	2452.6	70	0.3	0.22	1	0.9	41	11.2	103	48.6	111	56.6	111	56.6	54.4	NO	ERCW DT 57
?/92	2480	33	2447	63.5	0.32	0.24	0.52	0.38	51.6	10.6		0		0		0		NO	
?/92	2475	32.8	2442.2	67.4	0.26	0.18	0.86	0.74	45.2	10.7		0		0		0		NO	
?/92	2470	33.5	2436.5	58.6	0.34	0.18	0.5	0.16	41	11.4		0		0		0		NO	
?/93	2525	35.5	2489.5	69.3	0.42	0.32	1.2	0.9	41.9	11	91	34	96	39	92	35	57	NO	
?/93	2510	33.8	2476.2	56.4	0.26	0.28	0.82	0.9	25.7	10.8		0		0		0		NO	
?/93	2460	40	2420	56.6	0.23	0.18	0.92	0.26	36	11		0		0		0		NO	
?/93	2480	31	2449	62.4	0.38	0.16	1.2	0.36	48.4	11.8		0		0		0		NO	
			0									0		0		0			

2B-B

LAST ECCS BAL

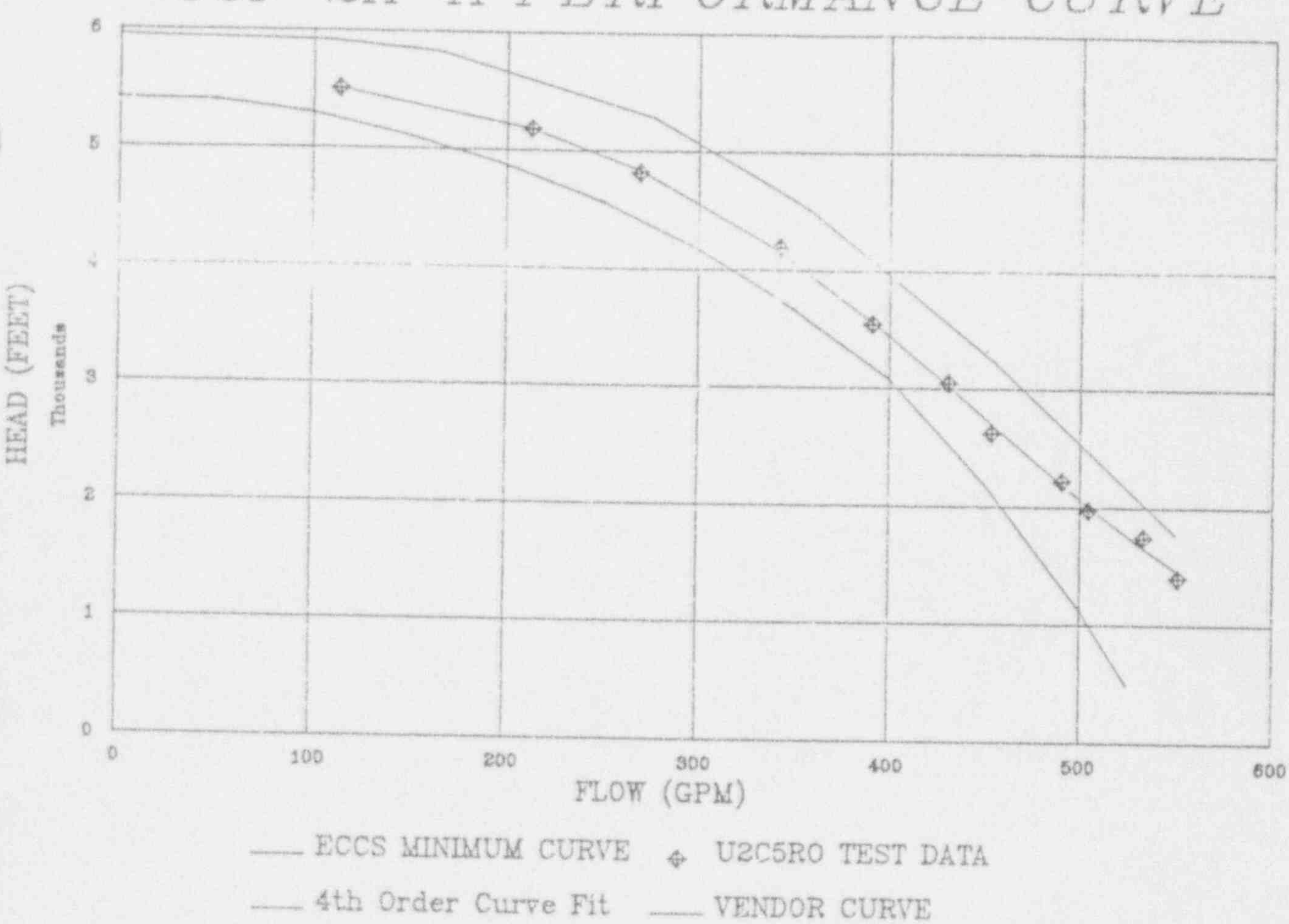
AVG = ~~2516~~ 2498

2516 - 2498 ⇒ 18 # degradation 10 yrs

GRAPH IV

ECCS MINIMUM PERFORMANCE		2A-A CCP TEST DATA U2C5RO DATA		VENDOR DATA		CURVE FIT COEFFICIENTS FOR TEST DATA	
HEAD (FEET)	FLOW (GPM)	HEAD (FEET)	FLOW (GPM)	HEAD (FEET)	FLOW (GPM)		
5410	0	1395.84	552.04	5944	0	C=	5991.037
5400	50	1741.34	534	5892	107	X=	-7.92882
5300	100	1972.29	505.5	5855	166	X^2=	0.050516
5110	150	2214.78	491.5	5281	277	X^3=	-0.00018
4875	200	2618.94	454.6	4499	359	X^4=	1.6E-07
4575	250	3046.19	431.7	3250	455		
4175	300	3541.57	392	1769	550		
3675	350	4188.22	343.4				
3085	400	4811.78	270.6				
2200	450	5181.29	214				
1140	500	5504.62	114.2				
500	525						

CCP 2A-A PERFORMANCE CURVE

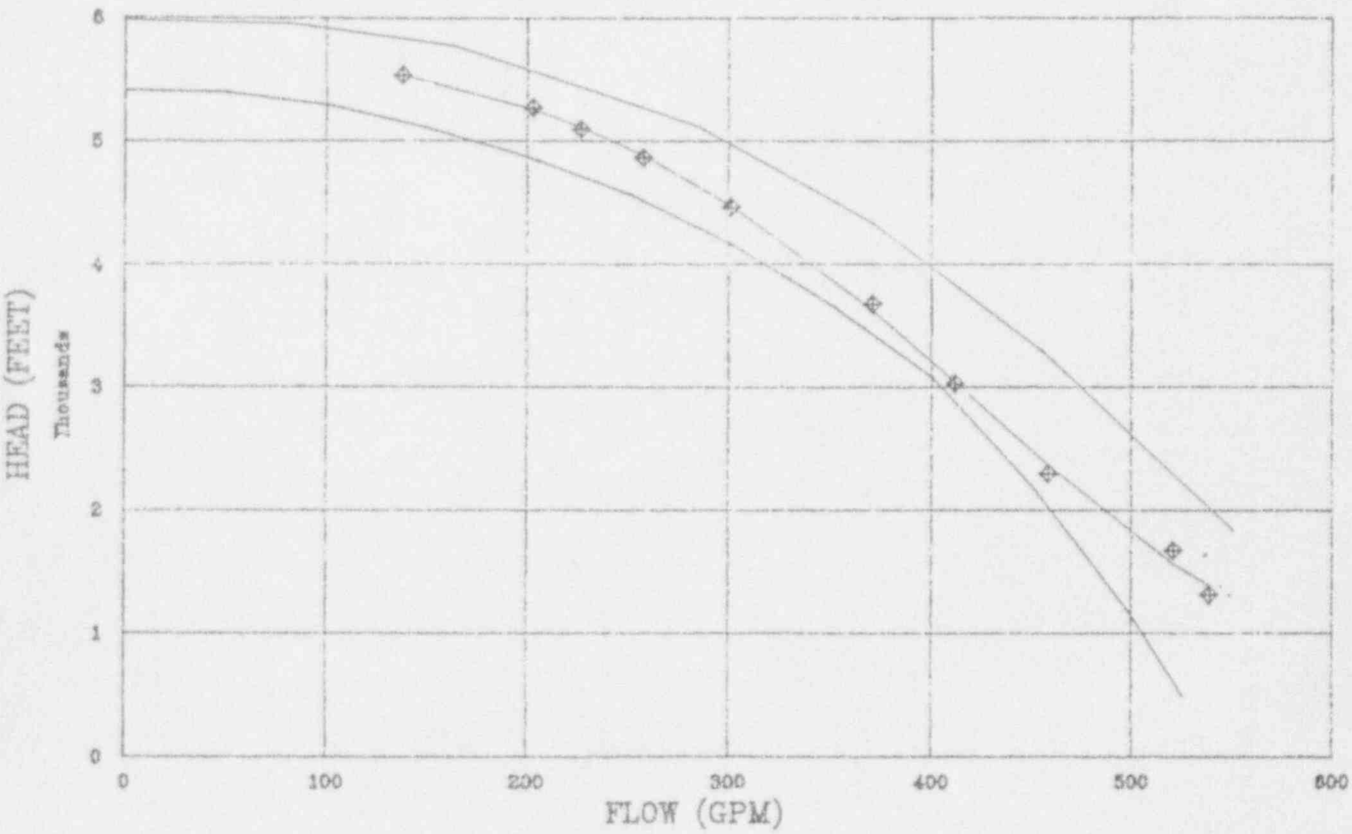


GRAPH V

2B-B CCP TEST DATA

ECCS MINIMUM PERFORMANCE		U2C5R0 DATA		VENDOR DATA		CURVE FIT COEFFICIENTS FOR TEST DATA	
HEAD (FEET)	FLOW (GPM)	HEAD (FEET)	FLOW (GPM)	HEAD (FEET)	FLOW (GPM)		
5410	0	1319.63	538.24	5988	0	C=	6247.455
5400	50	1675.06	520.6	5907	84	X=	-9.70844
5300	100	2298.38	458.1	5826	164	X^2=	0.058383
5110	150	3028.18	411.6	5098	284	X^3=	-0.00021
4875	200	3679.45	370.7	4331	370	X^4=	1.9E-07
4575	250	4464.67	300.9	3326	454		
4175	300	4871.13	257.3	1836	550		
3675	350	5102.08	226.3				
3085	400	5275.29	202.9				
2200	450	5536.26	137.9				
1140	500						
500	525						

CCP 2B-B PERFORMANCE CURVE



ECCS MINIMUM CURVE U2C5R0 TE⁻

FSE/FSDA-94-2386

From: Fluid Systems Engineering
WIN: 284-5917
Date: January 7, 1994
Subject: CCP Failure Evaluation
To: J. Steinmetz

cc: L. Walker
M.P. Osborne
K.N. Garner
File : Sequoyah Operating Plant

The Sequoyah Nuclear Station Unit 2 experienced a failure of the 2-BB Centrifugal Charging Pump (CCP) on January 7, 1994. Sequoyah Engineering requested Westinghouse to evaluate the replacement element impact on the system performance.

Westinghouse (Auxiliary Equipment Group and Fluid Systems) evaluated the following system performance areas:

* Normal Charging Function
* Safety Injection Function
    * Flow Balancing
    * Pump Runout Issue
    * ECCS Minimum Performance
    * Brake Horse Power
    * NPSH Requirements
    * RPM Comparison
* Testing

General Comment :

The replacement rotating element, as shown in the attached Table, is very similar to CCP 2BB. The replacement element head is slightly higher(50 to 100 ft) from 0 to 300 GPM, the same at 400 and 500 gpm and 50 ft. lower at the pump runout of 550 gpm. Also, the replacement vender curve data falls in between the installed 2AA and the failed 2BB vender curves.

The test performance curve numbers for the rotating elements are as follows :

2AA 36532C Revised
2BB 36532D
Spare 36532C-Spare II

* Normal Charging Function :

The replacement element will meet the normal charging functions.

* Safety Injection Function

* Flow Balancing :

The failed element, CCP 2BB, was installed and the system balanced in 9/83. The spare/replacement element pump characteristics are very similar (See attached Table) to that of the 2BB vender data. In fact, the replacement element vender curve data lies between the 2AA and 2BB test performance curves.
Conclusion : Based on the pumps characteristics being very similar and the system not being rebalanced since the initial installation of elements 2AA and 2BB, the system need not be rebalanced with the installation of the spare element. The system resistance has not been significantly changed.

* Pump Runout Issue : Not an issue since the spare element runout head is less than that of 2BB.

* ECCS Minimum Performance : Not a issue since the replacement pump performance is similar to 2BB and slightly higher than 2AA (See Attached Table). The system configuration/resistance has not been significantly changed, therefore there is not an impact to the Sequoyah ECCS model.

* Brake Horse Power : Not an issue since they are the similar.
Spare BHP is 670 and 2BB BHP is 680.

* NPSH Requirements :Not an issue since the NPSH requirements for the replacement element (NPSHR @ 550 is 16.5) is less than that of 2BB (NPSHR @ 550 is 18).

* RPM Comparison : Not an issue. The speed requirements are slightly less than the original installed element. The effect to pump head is negligible.

* Testing :

Westinghouse Recommendation :

Initial Installation : Test Data at Mini-flow and or at the maximum flowrate the plant can achieve during plant operating conditions. Evaluate the replacement element data against that of 2BB.

Next Plant Shutdown : Perform a pump test curve. Evaluate the replacement element data against that of 2BB.

Verified By

D. F. Dudek, Engineer
Fluid System Design and Analysis

J.G. Dudiak, Engineer
Auxiliary Equipment Group

Reviewed and approved.

FCDiAgostino for
J.N. STEINMETZ
PROJECT MANAGER

Sequoyah U-2 CCP Shaft Failure Evaluation							
Flow (GPM)	00	100	200	300	400	500	550
2AA Head (FT) Vender Curve 36532C	5950	5900	5700	5100	4000	2550	1750
2AA Head Test (FT)		114 gpm 5504 ft	214 gpm 5181 ft		392 gpm 3541 ft	505 gpm 1972 ft	552 gpm 1395 ft
2BB Head (FT) Vender Curve 36532D	6000	5900	5700	5000	4000	2650	1850
2BB Head Test (FT)			202 gpm 5275 ft	300 gpm 4454 ft	411 gpm 3028 ft		538 gpm 1319 ft
Spare Head (FT) Vender Curve 36532C-Spare II	6100	6050	5800	5050	4000	2650	1800

ENCLOSURE 2

Commitment

The full flow tests described in Technical Specification 4.5.2.h that involve flow from the 2B-B centrifugal charging pump will be performed during Unit 2 Cycle 6 refueling outage.