

GULF STATES UTILITIES COMPANY

RIVER BEND STATION

IE BULLETIN 85-03
PROGRAM REPORT

FEBRUARY, 1988

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1.0 Background and Introduction

On November 15, 1985, NRC issued IE Bulletin 85-03, Motor-Operated Valve Common Mode Failures During Plant Transients Due to Improper Switch Settings. In response to the bulletin, Gulf States Utilities prepared and completed the IE Bulletin 85-03 Program for the River Bend Station. This report is submitted in compliance with Action Item (f) of the bulletin to present results of the River Bend I&E Bulletin 85-03 MOV Program.

1.1 Program Objective

The objective of the River Bend I&E Bulletin 85-03 Program was to assure that the switch settings on MOV operators under the bulletin scope were selected, set, and maintained correctly so that the MOV's will operate properly over the entire range of differential pressures that might be experienced across the valves during both normal operation and abnormal events within the design basis of the River Bend Station.

The program scope encompassed MOV's in the High Pressure Core Spray (HPCS) and the Reactor Core Isolation Cooling (RCIC) systems. Twenty-one (21) MOV's (7 HPCS and 14 RCIC) were identified based on plant specific design data and the utilization of the BWR Owners' Group Report NEDC-31322. Table 1 presents a listing of the twenty-one (21) MOV's, and Figures 1 and 2 provide simplified system diagrams to illustrate these MOV's and their functions.

1.2 Program Implementation and Results

The design review and calculations identified the proper switch setting requirements. The testing program was designed to demonstrate MOV operability by verifying that these requirements were met. Some MOV maintenance/adjustments were performed to further enhance MOV performance and readiness. Detailed discussions on MOV testing, results, adjustments, and operability are presented on an individual MOV basis in Appendix A of this report.

2.0 IE Bulletin 85-03 Compliance

GSI compliance with requirements of IE Bulletin 85-03 is described below.

2.1 Bulletin Action (a) required a design review of each bulletin valve to establish the maximum differential pressure expected during valve operation in design basis events. This review was completed and the results were submitted to the NRC in a letter dated October 2, 1986 (RPG-24508).

To ensure that the GSU review methodology was consistent with generic BWR design basis and operating philosophy, GSU participated as a member in the BWR Owners' Group IE Bulletin 85-03 Committee. Based on input from the BWR Owners' Group Report, NEDC-31322, GSU performed a plant specific review to: 1) identify the River Bend bulletin MOV's and the associated design basis, and 2) calculate maximum valve differential pressures for design basis events. The differential pressure calculation methodology was consistent with the conservative assumptions and techniques in the Owners' Group Report NEDC-31322.

2.2 Bulletin Action (b) required a review to establish the correct switch settings based on differential pressure calculations performed in Action (a). GSU completed this review and established switch setting requirements based on the following criteria.

- a) The open position limit switch is used to stop MOV travel in the open direction. Its setting is designed to ensure that the valve will reach an open position to allow full flow and stop before it becomes backseated. The open position limit switch is used on all bulletin valves at River Bend to stop the valve in the open direction. The position limit switch is not used at River Bend to stop any bulletin valve in the closed direction.
- b) Torque switch bypasses are used to prevent the MOV from de-energization by torque switch activation. River Bend's design philosophy is to bypass the torque switch for the safety direction(s) of the valve for 95% of valve travel to ensure that the valve will perform its safety function.

Both the open position limit and the torque switch bypasses are operated by geared rotors. These switches are set in accordance with River Bend Maintenance Procedure CMP-1253.

- c) Torque switches are used on River Bend bulletin MOV's to provide stop control in the closed direction and as backup to the open position limit switch to stop the MOV in the open direction. Settings for these torque switches were controlled by River Bend Maintenance Procedure CMP-1253 prior to the availability of thrust signature testing techniques. CMP-1253 provides minimum and maximum torque switch settings that were based on torque switch calibration data provided by Limitorque.
- d) Thermal overloads for all bulletin MOV's are bypassed when the MOV is automatically operated in design basis

events. The design of their control circuits provides this automatic feature. If the motor trips due to the operation of the thermal overloads during a manual initiation, operations personnel may bypass the thermal overloads and restart the motor by holding the valve control switch in the desired direction of travel.

These criteria were verified by a review of design documents and torque switch settings vs. torque output data provided by Limitorque. In addition, torque switch setting calculations were performed to determine required setpoints in stem thrust for use as the criteria in setting torque switches during thrust signature testing.

Based on the review of design documents, Limitorque data, and calculations, all bulletin MOV's were determined operable with respect to compliance with the above stated criteria.

- 2.3 Bulletin Action (c) required demonstration of valve operability by testing at calculated maximum differential pressures. For cases where testing with maximum differential pressure cannot be practically performed, justification including alternative means of switch setting verification shall be provided.

The River Bend IE Bulletin 85-03 Program objective was to test the bulletin MOV's at full flow maximum differential that could be achieved without jeopardizing equipment operability and plant safety. An engineering review of the bulletin valves and the maximum differential pressure conditions was conducted to determine the best test method to verify correct switch settings. A major consideration in this review was whether or not it was practical or safe to establish system conditions and configurations that would be required for full flow differential pressure testing. An engineering evaluation of the testing methods was also performed in view of the very low calculated differential pressures associated with some valves.

Three test methods were chosen: 1) Full flow differential pressure testing, 2) Differential pressure testing with hydrostatically established pressure, 3) Thrust signature testing using signature analysis devices and techniques. As a minimum, thrust signature testing was performed for all bulletin valves. Full flow differential pressure testing was performed on seven MOV's (4 RCIC and 3 HPCS). Hydrostatic differential pressure testing was performed on two HPCS MOV's and one RCIC MOV. The testing methods and basis are presented in detail in the form of individual MOV testing and operability summaries contained in Appendix A, as well as in a tabular format in Appendix B.

- 2.4 Bulletin Action (d) required procedures to ensure correct switch settings are maintained throughout the life of the plant.

Procedure CMP-1253 currently provides control of switch settings. Based on this MOV program, CMP-1253 has been reviewed to ensure that switch setting values and instructions are clearly specified. A torque switch balancing section was added to CMP-1253 as a result of this effort.

Since the torque switch trip points for the bulletin valves were verified with signature testing, River Bend will use signature testing techniques to re-verify proper switch settings for the bulletin valves after major maintenance affecting MOV thrust settings and capabilities is performed. Such maintenance includes the adjustment or replacement of the torque switch, spring pack, actuator drive train, or valve internals.

- 2.5 Bulletin Action (e) required the submittal of a written report to address results of Bulletin Action (a) and a program plan including the schedule for completion of Actions (b) through (d). GSU met this requirement by a letter transmitted to the NRC on October 2, 1986 (RBG-24508).
- 2.6 Bulletin Action (f) required a written report of the above program. This report satisfies that requirement. As requested, this report provides (1) a verification of the completion of IE Bulletin 85-03 requirements, (2) a summary of findings regarding valve operability prior to any adjustments, and (3) a summary of data required to evaluate the response to the bulletin.

3.0 Testing Program and Results

3.1 Flow Testing Program

The application of full flow testing was evaluated for each valve based on equipment/plant operating and safety constraints. If full flow testing was determined impractical, differential pressure testing with hydrostatic pressure was considered. For those MOV's with low differential pressure thrust components, only static thrust signature testing was performed based on engineering evaluation.

Based on the above considerations, full flow testing was performed for four (4) RCIC and three (3) HPCS MOV's. Flow testing with hydrostatic pressure was performed on one (1) RCIC and two (2) HPCS valves.

RCIC valves 13, 19, 22, and 59 were full flow tested prior to unit shutdown for the refueling outage. HPCS valves 1, 10, and 12 were full flow tested during the refueling outage. Flow testing with hydrostatic pressure was performed during the outage for RCIC 013, and HPCS 04 and 15.

3.2 Signature Testing Program

All the bulletin MOV's were signature tested, as a minimum under static conditions. Signature testing was also performed for one RCIC MOV and five HPCS MOV's under differential pressure conditions.

The signature testing technique used in the River Bend Test Program provides measurement of spring pack movement for calculation of stem thrust associated with torque switch settings. The use of signature test data allows the determination of available stem thrust provided by the torque switch settings to operate against differential pressure conditions. Motor current, and applicable limit switches (position limit and bypasses) are also monitored during the signature test.

A signature testing system offered by Impell Corporation was used on the bulletin MOV's. A technical description of the QATIS system is provided in Appendix C.

3.3 Test Results

Based on differential pressure testing and signature testing, all bulletin MOV's were evaluated for operability. Detailed test results, evaluation criteria, and operability discussions are provided in Appendix A.

The maximum differential pressures given in the individual Appendix A MOV summaries were calculated based on assumptions and techniques from the BWR Owners Group Report NEDC-31322. The minimum required stem thrust given was calculated using standard valve vendor equations and valve factors provided by Limitorque, and packing load data provided by the valve suppliers. The maximum available stem thrust given was calculated assuming 80% of the nominal voltage to the motor.

The minimum and maximum thrust criteria were used as a reference to verify torque switch thrust trip points. They were not absolute criteria for determining valve operability because of conservatism and variability inherent in the calculation assumptions. Each MOV was evaluated for operability based on a review and comparison of applicable data such as torque switch setting in relation to Limitorque torque switch calibration data,

measured thrust trip points in relation to running load and spring pack preload, full flow and differential pressure test data, etc. MOV specific operability criteria that were used are discussed in the individual summaries in Appendix A.

TABLE 1

The RBS IE Bulletin 85-03 Program

The maximum expected differential pressures were provided to the NRC in our October 2, 1986 letter and are tabulated here for convenience.

<u>MARK #</u>	<u>SIZE</u>	<u>TYPE</u>	<u>MFR.</u>	<u>FUNCTION</u>	<u>OPEN dP</u>	<u>CLOSE dP</u>
E22*F001	16"	Gate	A/D	CST Suction Valve	(a)	131
E22*F004	10"	Gate	A/D	Injection Valve	1423	1486
E22*F010	10"	Globe	A/D	CST Test Return	(a)	1431
E22*F011	10"	Globe	A/D	CST Test Return	(a)	1431
E22*F012	4"	Gate	A/D	Min Flow Valve	1446	1608
E22*F015	20"	Gate	A/D	Sup Pool Suction	94	17
E22*F023	10"	Globe	A/D	Sup Pool Return	(a)	1431
E51*F010	6"	Gate	Velan	CST Suction	(a)	71
E51*F013	6"	Gate	Velan	Injection	1371	1546
E51*F019	2"	Globe	Velan	Min Flow Valve	1455	1469
E51*F022	4"	Globe	Velan	CST Test Return	(a)	1430
E51*F031	6"	Gate	Velan	Sup Pool Suction	19	17
E51*F045	4"	Globe	Velan	Turb Steam Supply	1165	1165
E51*F046	2"	Globe	Velan	Lube Oil Cooler	1386	(a)
E51*F059	4"	Gate	Velan	CST Test Return	(a)	1430
E51*F063	8"	Gate	Velan	Inbd Steam Isol	(a)	1165
E51*F064	8"	Gate	Velan	Outbd Steam Isol	(a)	1165
E51*F068	12"	Gate	Velan	Steam Dischg Vlv	(a)	8
E51*F076	.75"	Globe	Velan	Line Warming Vlv	(a)	1165
E51*F077	1.5"	Globe	Velan	Vacuum Bkr Valve	(a)	23
E51*F078	2.5"	Globe	Velan	Vacuum Bkr Valve	(a)	23

(a) The valve has no safety function in this direction.

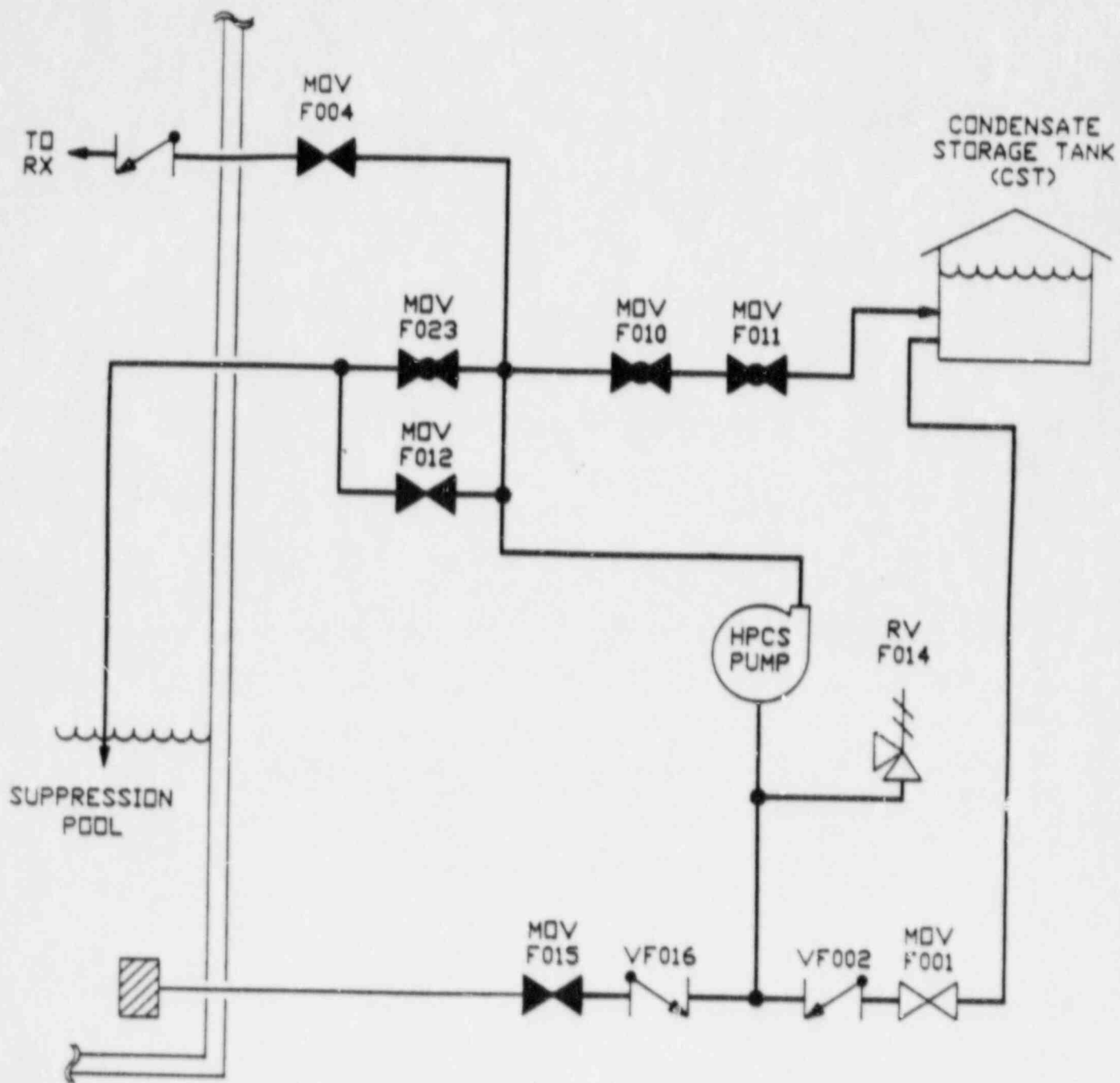


Figure 1. HPCS System P & ID

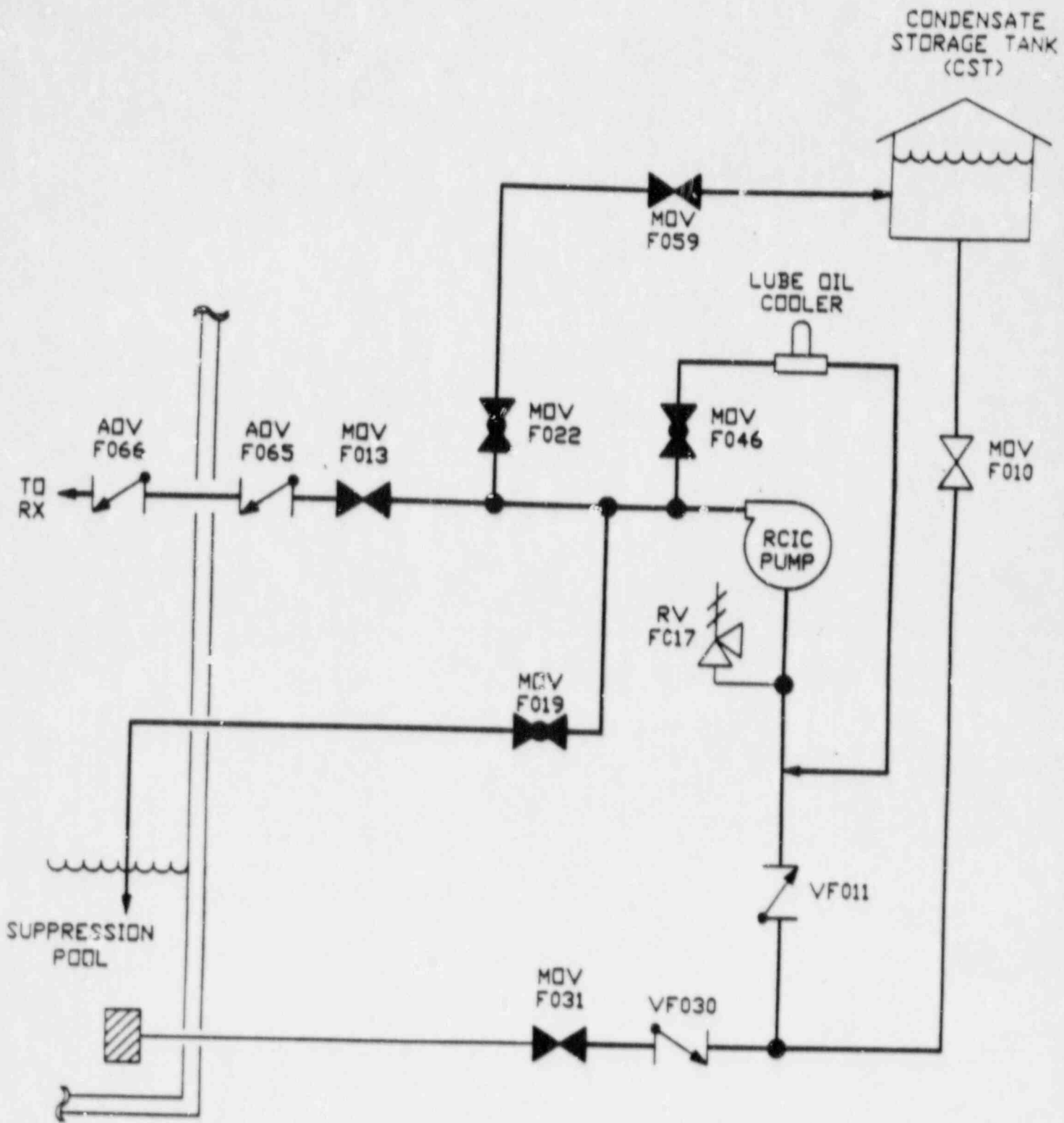


Figure 2. RCIC System P & ID

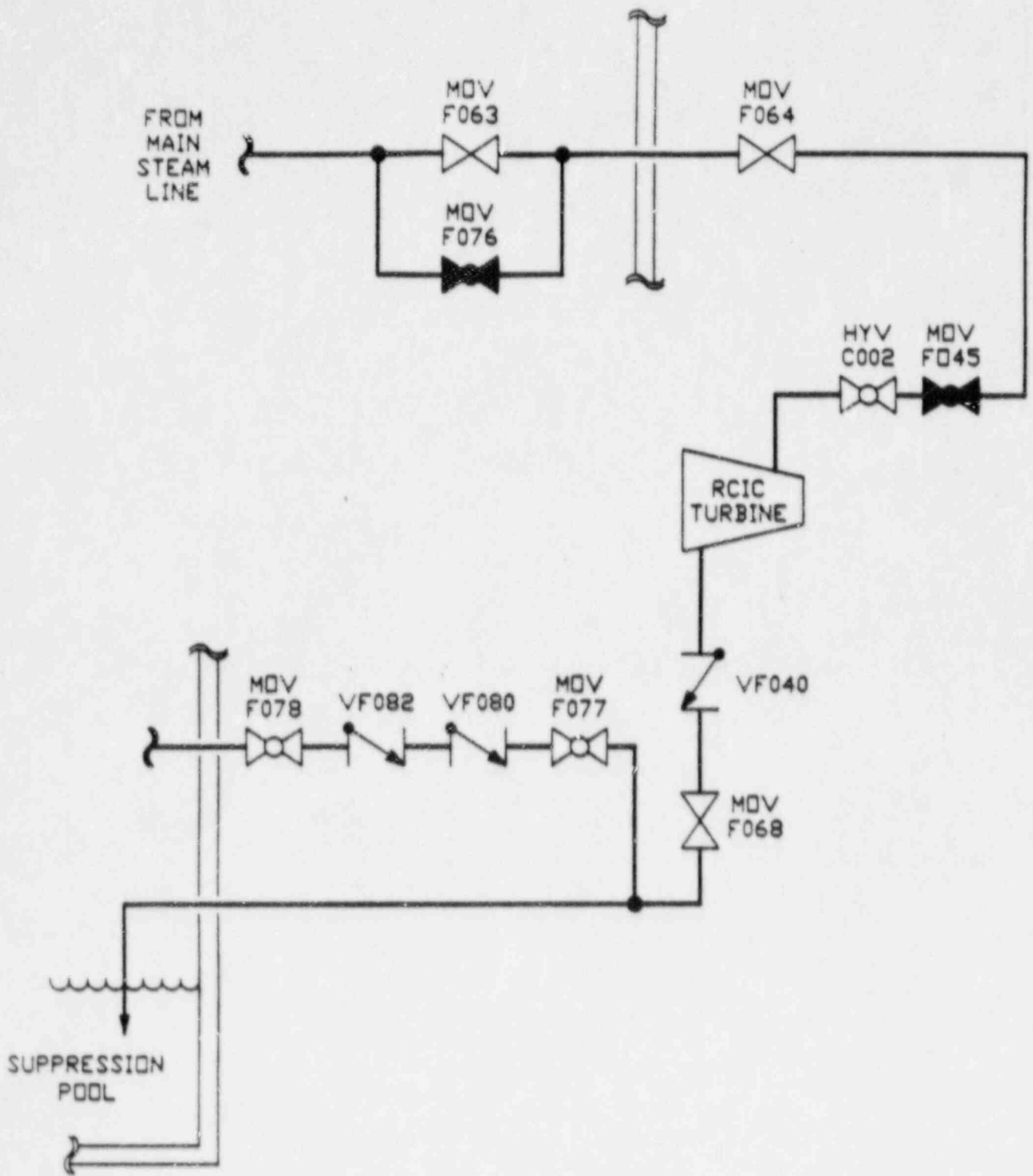


Figure 2 (Con't). RCIC System P & ID

APPENDIX A
SUMMARY OF MOV TESTING,
RESULTS AND OPERABILITY

TESTING AND OPERABILITY SUMMARY

Valve ID: E22*F001 Type & Size: 16" 150 lbs Anchor Darling Gate

Operator: Limitorque SMB-00-10 Motor: 480 VAC 1700 RPM 0.7 Hp

Valve Function: HPCS Suction From the CST

Calculated Maximum Differential Pressure: Closed/131 psi Open/N/A

Minimum Required Stem Thrust Based
on Differential Pressure Piston Effect,
and Packing Load: . . . 8439 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 11954 lbs

Testing Performed and Basis: A full flow thrust signature test was conducted in which the MOV was operated closed and open against differential pressure conditions duplicating those upon which the calculations were based. This differential pressure was achieved by closing F001 as soon as F015 started to open with the HPCS pump running. The flow test duplicated the design basis conditions by establishing a final differential pressure of 23 psi and an initial flow rate of 5000 gpm. The calculated differential pressure of 131 psi was based on 17.3 psi (due to CST and suppression pool static head difference) + 113 psi (differential pressure associated with fluid deceleration due to valve closure). The fluid deceleration differential pressure component could not be measured because of instrumentation limitations. However, the flow conditions and the stroke time used in the calculation were duplicated. The calculation was based on approximately 5400 gpm and a stroke time 71.6 sec. The actual flow during the test was 5000 gpm and the stroke time was 74.56 sec. Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations.

As Found Conditions: Torque switch settings of 1.0 and 1.0 were found which produced thrust trip points of 8.0 and 4.75 Klbs for the closed and open directions, respectively. Both torque switch bypasses were set at greater than 90% of their respective stroke times.

Adjustments/Actions Performed: The torque switch was balanced and settings adjusted from 1.0 to 1.5 to obtain higher trip points.

As Left Conditions: As-left torque switch settings of 1.5 and 1.5 produced thrust trip points of 9.5 and 11.8 Klbs for the closed and open directions, respectively.

Valve ID: E22*F001

Operability Evaluation: The MOV was determined operable. The flow test was performed after the torque switch adjustment. Therefore, valve operability was verified for the as-left conditions. A review of the full flow signature data and the as-found data also indicated the MOV was operable before the torque switch adjustment. A 4.36 Klbs spring pack preload was measured indicating an available thrust margin of 8.03 Klbs to close against the thrust requirement. Since the maximum thrust observed during valve closing for the full flow test was 5.7 Klb, the as-found available thrust margin would have been adequate to close the valve against full flow conditions. The as-found open torque switch trip point (4.75 Klbs) had no operability impact because the torque switch was bypassed for greater than 90% of stroke time.

Adjustments that were made further enhanced valve performance by increasing the thrust margin as evidenced by the as-left data.

TESTING AND OPERABILITY SUMMARY

Valve ID: E22*F004 Type & Size: 10" 655 Lbs Anchor Darling Gate

Operator: Limitorque SB-3-80 Motor: 480 VAC 3380 RPM 10.3 Hp

Valve Function: HPCS Injection Valve

Calculated Maximum Differential Pressure: Closed/1486 psi Open/1423 psi

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 31366 lbs

Maximum Available Stem Thrust Eased
on 80% Available Voltage: . . . 45760 lbs

Testing Performed and Basis: A differential pressure flow signature test was conducted in which the MOV was operated open against a hydrostatic differential pressure of 1555 psi. The flow test data indicated that the differential pressure accounted for about 27,000 lbs of thrust during the first moments of valve opening. This finding further validates the engineering calculation for thrust requirements. Full flow testing of F004 could not be practicably performed because it is the injection valve to the reactor vessel. Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations.

As Found Conditions: Torque switch settings of 2.1 and 2.0 were found which produced thrust trip points of 71.03 and 67 Klbs for the closed and open directions, respectively. Both torque switch bypasses were set at greater than 90% of their respective stroke times.

Adjustments/Actions Performed: The torque switch settings were adjusted from 2.1 and 2.0 (closed and open) to 1.5 (for both) to obtain trip point values that would be more consistent with the calculated maximum available thrust under degraded voltage conditions.

As Left Conditions: As-left torque switch settings of 1.5 produced thrust trip points of 47.91 and 45.35 Klbs for the closed and open directions, respectively.

Valve ID: E22*F004

Operability Evaluation: The MOV was determined operable. The torque switch trip points provided more than adequate thrust to open and close the valve. Although higher than expected thrust was observed, the MOV operated much below the operator's 140 Klbs thrust limit. The as-found trip points were evaluated with respect to the calculated maximum available thrust under degraded voltage. This evaluation demonstrated MOV operability based on the following. Using torque switch settings vs torque values provided by Limitorque, recalculation of the stem factor was performed based on the actual measured trip points and torque switch settings. This was valid since the torque switch trip points indicated a balanced torque switch. A revised stem factor of 0.01258 was calculated as follows. A torque switch setting of 2.1 would result in a torque trip point of 894 ft-lbs (based on the linear relationship that torque switch settings of 1 3/4 to 2 3/4 are equivalent to 704 to 1248 ft-lbs). This torque divided by the measured stem thrust is the revised stem factor ($894/71030 = .01258$). This revised stem factor would change the calculated maximum available thrust under degraded voltage from 47560 lbs to approximately ($993/0.01258$) = 78.9 Klbs. Based on this, the MOV would have tripped going closed under degraded voltage conditions. For the open direction, the limit switch would stop the MOV. Therefore, the high torque switch trip point was inconsequential.

Adjustments that were made further enhanced valve performance by decreasing operating stresses and making the torque switch trip points more consistent with the calculated available thrust under degraded voltage conditions.

TESTING AND OPERABILITY SUMMARY

Valve ID: E22*F010 'Type & Size: 10" 900 Lbs Anchor Darling Globe

Operator: Limitorque SMB-4-200 Motor: 480 VAC 1700 RPM 13 Hp

Valve Function: HPCS Test Return to the CST

Calculated Maximum Differential Pressure: Closed/1431 psi Open/N/A

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 91992 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 169493 lbs

Testing Performed and Basis: A full flow thrust signature test was conducted in which the MOV was operated closed against a differential pressure of 1090 psi which was the maximum that could be practicably obtained based on approved test procedures. The flow test maximized the differential pressure across F010 by isolating all flow paths from the HPCS pump discharge except for the minimum flow line and the test return line, and by placing F011 (downstream of F010) in the full open position. This duplicated the design basis conditions with the exception of F012 (minimum flow) which was required open for pump protection during the test. Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations.

As Found Conditions: Torque switch settings of 2.0 and 2.0 were found which produced thrust trip points of 182.7 and 192.93 Klbs for the closed and open directions, respectively. The bypass for the closed torque switch was set at 78% of stroke. The bypass for the open torque switch was set at 9.5% of stroke time.

Adjustments/Actions Performed: The torque switch settings were adjusted from 2.0 and 1.75 (closed and open) to obtain trip point values that would be more consistent with the calculated maximum available thrust under degraded voltage conditions. The bypass for the closed torque switch was reset to 94% of stroke time (from 78%). This was done to give additional protection margin to ensure valve is near the closed position before the torque switch is made active. The bypass for the open torque switch was reset to 6% of stroke time (from 9.5%). This was done to ensure the valve closed position light (red light to de-energize) does not de-energize until the valve is very close to being seated (both contacts on the same rotor).

As Left Conditions: As-left torque switch settings of 1.75 and 1.75 produced thrust trip points of 129.47 and 136.26 Klbs for the closed and open directions, respectively. The bypass for the closed torque switch was left at 94% of stroke time and the bypass for the open torque switch was left at 6%.

Valve ID: E22*F010

Operability Evaluation: The MOV was determined operable. The flow test data indicated that 83 Klbs was required to overcome a differential pressure of 1090 psi for closing. Therefore, the extrapolated thrust requirement for 1431 psi (design basis) is $1431/1090 \times 83K = 108.9$ Klbs, since thrust is linearly proportional to the differential pressure and the valve factor. Based on this, the torque switch trip points provided more than adequate thrust to open and close the valve. Because as-found trip points showed higher than expected thrust, General Electric was requested to review the original stress analysis for impact. Their review indicated valve operability, but recommended a visual inspection of the stem clamp key. The inspection of the stem clamp key and stem clamp revealed no apparent damage. The torque switch settings were reduced to decrease component stresses. The as-left open torque switch bypass setting of 6% of stroke time has no impact on operability because the torque switch setpoint is sufficiently high and the valve has no safety function to open.

TESTING AND OPERABILITY SUMMARY

Valve ID: E22*F011 Type & Size: 10" 900 lbs Anchor Darling Globe

Operator: Limitorque SMB-4-200 Motor: 480 VAC 1720 RPM 13 Hp

Valve Function: HPCS Test Return to the CST

Calculated Maximum Differential Pressure Closed/1431 psi Open/N/A

Minimum Required Stem Thrust Based
on Differential Pressure, piston effect,
and packing load: . . . 91992 lbs

Maximum Available Stem Thrust Based
on 80% available voltage: . . . 169493 lbs

Testing Performed and Basis: Flow testing data from F010 was used to demonstrate F011 operability because both MOV's were identical in design and application. Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations.

As Found Conditions: Torque switch settings of 2.25 and 2.25 were found which produced thrust trip points of 132.33 and 130.65 Klbs for the closed and open directions, respectively. The closed torque switch bypass was set at 90% of stroke. The open torque switch bypass was set at 0.7% of stroke time. The open position limit switch was set too close to the backseat resulting in 99.9 Klbs of stem thrust to the backseat.

Adjustments/Actions Performed: The torque switch settings were adjusted from 2.25 to 2.1 (both closed and open) to obtain lower trip points. The open position limit switch was adjusted to eliminate backseating.

As Left Conditions: As-left torque switch settings of 2.1 and 2.1 produced thrust trip points of 111.27 and 113.83 Klbs for the closed and open directions, respectively. Backseating was eliminated.

Operability Evaluation: The MOV was determined operable. Based on F010 flow data, 108.9 Klbs of thrust was required to close against 1431 psid. Both as-found and as-left data indicated MOV operability. The as-found and as-left torque switch trip points provided more than adequate thrust to open and close the valve. The open torque switch bypass setting of 0.7% of stroke time has no impact on operability because the torque switch setpoint is sufficiently high and the valve has no safety function to open. The as-found backseating condition did not affect operability since the valve was operated satisfactorily during thrust signature testing. This condition was also evaluated by General Electric. Their review of the original stress analysis indicated the stress was below design and that valve operability was not affected. Adjustments that were made further enhanced valve performance by eliminating backseating and lowering operating stresses to the MOV components.

TESTING AND OPERABILITY SUMMARY

Valve ID: E22*F012 Type & Size: 4" 900 lbs Anchor Darling Gate

Operator: Limitorque SB-0-25 Motor: 480 VAC 3400 RPM 3 Hp

Valve Function: HPCS Min Flow to the Suppression Pool

Calculated Maximum Differential Pressure: Closed/1608 psi Open/1446 psi

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 9878 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 13349 lbs

Testing Performed and Basis: A full flow thrust signature test was conducted in which the valve was closed and opened against a differential pressure of 1140 psi and 520 psi, respectively. These differential pressure conditions were the maximum that could be achieved based on approved test procedures. The flow test initially maximized the HPCS discharge line pressure by isolating all paths except for F012 to the suppression pool. F012 was required to be open for pump protection. F023 was then throttled open, hence causing F012 to automatically close. A differential pressure of 1140 psi was recorded across F012 after it was closed. Maximum opening differential pressure was achieved by closing F023, hence causing F012 to open. 520 psi was recorded prior to closing F023. Therefore, actual differential pressure that the valve opened against was higher than 520 psi. Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations.

As Found Conditions: Torque switch settings of 1.75 and 1.5 were found which produced thrust trip points of 20.39 and 5.3 Klbs for the closed and open directions, respectively. The closed and open torque switch bypasses were set at 85% of stroke times. 24 Klbs of backseating was observed.

Adjustments/Actions Performed: The open position limit switch was adjusted to eliminate valve backseating. The torque switch settings were first lowered, then readjusted to the approximate original settings to ensure valve seat tightness.

As Left Conditions: As-left torque switch settings of 1.75 and 1.5 produced thrust trip points of 18.19 and 8.62 Klbs for the closed and open directions, respectively. Due to the open position limit switch adjustment which shortened the stroke times, the as-left bypass settings were 97% and 85% of stroke times for the open and closed torque switches, respectively.

Valve ID: E22*F012

Operability Evaluation: The MOV was determined operable. There was more than adequate thrust in the closed torque switch trip points (20.39 K as-found and 18.19 K as-left) to close the valve. Based on the flow data, a thrust of 9.3 Klbs was observed during the test for overcoming the differential pressure effects. The differential pressure that was overcome was the recorded differential pressure (1140 psi) plus the fluid deceleration differential pressure component of 181 psi that was not recorded because of instrument limitation. This deceleration component was part of the total maximum calculated differential pressure. Therefore, using an effective differential pressure of 1321 psi (1140 + 181) and the measured required thrust of 9.3 Klbs, a required thrust of 11.32 Klbs was extrapolated for a differential pressure of 1608 psi. Valve opening was assured because the torque switch was bypassed for 85% of stroke time. The backseating condition was evaluated by General Electric via a review of the original stress analysis. This review indicated valve operability and recommended a liquid penetrant test of the backseat in the next scheduled valve maintenance of F012. The open position limit was adjusted to eliminate backseating.

The closed torque switch trip points of 20.39 and 18.19 Klbs were evaluated with respect to the calculated available thrust of 13349 lbs under degraded voltage. This evaluation demonstrated MOV operability based on a recalculation of the stem factor using Limitorque- provided torque switch data and the as-found measured thrust. The torque switch settings were 1.5 and 1.75 for the closed and open directions. Limitorque data indicated a 1 3/4 setting would yield 144 ft-lbs for F012. Since the thrust data indicate a unbalanced torque switch, the stem thrust at 1.75 setting was calculated as $(20.39 + 5.3)/2 = 12.84$ Klbs. A new stem factor of 0.0112 was calculated based on $(144/12840 = 0.0112)$. Using this stem factor, available thrust at degraded voltage was recalculated as $217.6/.0112 = 19403$ lbs which demonstrated that the as-left trip point would stop the MOV under degraded voltage.

TESTING AND OPERABILITY SUMMARY

Valve ID: E22*F015 Type & Size: 20" 150 lbs Anchor Darling Gate

Operator: Limitorque SB-1-40 Motor: 480 VAC 3450 RPM 5.3 Hp

Valve Function: HPCS Suction from the Suppression Pool

Maximum Differential Pressure: Closed/17 psi Open/94 psi

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 3967 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 21281 lbs

Testing Performed and Basis: A differential pressure flow signature test was conducted in which the MOV was operated open against a hydrostatic differential pressure of 63.3 psi. This was the maximum pressure that could be practically achieved because of proximity to the pump suction relief valve (RVF014) setpoint of 90 psig. Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations.

As Found Conditions: Torque switch settings of 1.5 and 1.5 were found which produced thrust trip points of 18.8 and 19.04 Klbs for the closed and open directions, respectively. The closed and open torque switch bypasses were set at 94% and 96% of their respective stroke times.

Adjustments/Actions Performed: The torque switch settings were lowered slightly from 1.5 to 1.4 (both closed and open) to obtain lower trip points.

As Left Conditions: As-left torque switch settings of 1.4 and 1.4 produced thrust trip points of 14.81 and 14.86 Klbs for the closed and open directions, respectively.

Operability Evaluation: The MOV was determined operable. The as-left closed torque switch trip point of 14.81 Klbs represented available thrust to operate against differential pressure since a spring pack preload of 6.41 Klbs was measured. The as-left available thrust (14.81 Klbs) was significantly larger than the calculated differential pressure thrust requirement of 1226 lbs. The as-found torque switch trip points provided even more margin (18.8 Klbs vs 1226 lbs) to operate against design differential pressure conditions. Adjustments that were made enhanced performance by decreasing valve operating stresses.

TESTING AND OPERABILITY SUMMARY

Valve ID: E22*F023 Type & Size: 10" 900 lbs Anchor Darling Globe

Operator: Limitorque SMB-3-150 Motor: 480 VAC 1655 RPM 10 Hp

Valve Function: HPCS Return to Suppression Pool

Maximum Differential Pressure: Closed/1431 psi Open/N/A

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 91930 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 127,126 lbs

Testing Performed and Basis: Flow test data from F010 was used to demonstrate operability for F023 because F010 and F023 were identical in valve design. In addition, the flow test performed for F012 required F023 to close against the maximum testing differential pressure conditions, which further demonstrated MOV operability. Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations.

As Found Conditions: Torque switch settings of 3.0 and 2.0 were found which produced thrust trip points of 104.9 and 123.87 Klbs for the closed and open directions, respectively. The closed torque switch bypass was set at greater than 90% of stroke time. The open torque switch bypass was set at 7% of stroke time.

Adjustments/Actions Performed: None

As Left Conditions: Same as As Found Conditions.

Operability Evaluation: The MOV was determined operable. The torque switch trip points were adequate to operate against expected differential pressure conditions. Based on F010 flow test data, it was conservatively calculated that approximately 108.9 Klbs would be needed to close against 1431 psid. Although the F023 torque switch trip point was marginally smaller, total thrust (i.e., including inertial load) was 124 Klbs which would give additional assurance for valve closing.

MOV operability was further demonstrated by the F012 full flow test. In the F012 flow test, test conditions demonstrated that F023 will close, although the differential pressure achieved was less than the calculated maximum. The calculated maximum was based on a very conservative assumption that F012 had not yet opened when F023 closed. This assumption was proven unrealistic by the F012 flow test which demonstrated that as F023 started to close, F012 automatically opened.

TESTING AND OPERABILITY SUMMARY

Valve ID: E51*F010 Type & Size: 6" 150 lbs Velan Gate
Operator: Limitorque SMB-00-10 Motor: 125 VDC 1900 RPM 0.72 Hp
Valve Function: RCIC Suction from the CST

Calculated Maximum Differential Pressure: Closed/71 psi Open/N/A

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 3887 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 9024 lbs

Testing Performed and Basis: Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations. No flow testing was performed because of the low differential pressure value and its associated low thrust requirement (529 lbs calculated). This calculated differential pressure thrust requirement represents less than 15% of the overall thrust requirement for valve closing. This basis is further supported by the as-found conditions shown below which indicate significant margins in both torque switch trip points to accommodate design differential pressure conditions.

As Found Conditions: Torque switch settings of 2.0 and 2.0 were found which produced thrust trip points of 8.03 and 10.04 Klbs for the closed and open directions, respectively. Both torque switch bypasses were set at greater than 90% of their respective stroke times.

Adjustments/Actions Performed: None

As Left Conditions: Same as As Found Conditions

Operability Evaluation: The MOV was determined operable. A review of the as-found closed torque switch trip point and maximum running load indicated a thrust margin of at least 4280 lbs to close against the calculated thrust requirements of 529 lbs for differential pressure, and 176 lbs for line pressure. The open torque switch provided even more margin. The open torque switch trip point was evaluated with respect to the maximum available thrust under degraded voltage. It had no impact on MOV operability because the MOV would be stopped by the limit switch in the open direction.

TESTING AND OPERABILITY SUMMARY

Valve ID: E51*F013 Type & Size: 6" 900 lbs Velan Gate
Operator: Limitorque SMB-0-40 Motor: 125 VDC 1900 RPM 2.9 Hp
Valve Function: RCIC Injection to the Reactor
Maximum Differential Pressure: Closed/1546 psi Open/1371 psi

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 18594 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 19620 lbs

Testing Performed and Basis: A full flow test with motor amp signature was conducted in which the MOV was operated closed and open against differential pressures of 800 and 890 psig, respectively. Because of instrument limitation, these recorded differential pressure data did not include approximately 175 psi of the fluid deceleration component of the maximum calculated differential pressure. Adding the 175 psi to the recorded differential pressure would result in an effective differential pressure of 975 psi for closing. These full flow differential pressure conditions were the maximum that could be practicably obtained during the reactor shutdown/depressurization process for the refueling outage. The valve line-up for the test maximized the differential pressure between the RCIC pump discharge and the reactor by isolating all discharge flow paths except for minimum flow (F019) and the lube oil cooler (F046). The calculated maximum closing differential pressure was based on a conservative assumption that F019 had not started to open when F013 closed. This condition was not duplicated because it would have jeopardized pump operability. A hydrostatic differential pressure thrust signature test was also conducted in which the MOV opened against differential pressures of 750 and 1450 psi. Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations.

As Found Conditions: Torque switch settings of 2.125 and 2.0 were found which produced thrust trip points of 18.97 and 16.45 Klbs for the closed and open directions, respectively. Both torque switch bypasses were set at greater than 90% of their respective stroke times.

Adjustments/Actions Performed: None

As Left Conditions: Same as As Found Conditions

Operability Evaluation: The MOV was determined operable. The torque switch trip points were adequate. Hydrostatic differential pressure test results also indicated that the valve could be opened against 1450 psid. In addition, the static signature test results indicated an inertial load of greater than 12 K lbs attributable to the fast operation of the valve. This inertial load further ensures that the valve will close against design differential pressure conditions.

TESTING AND OPERABILITY SUMMARY

Valve ID: E51*F019 Type & Size: 2" 1500 lbs Velan Globe
Operator: Limitorque SMB-00-10 Motor: 125 VDC 1900 RPM 0.72 Hp
Valve Function: RCIC Minimum Flow to Suppression Pool
Maximum Differential Pressure: Closed/1469 psi Open/1455 psi

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 5640 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 9736 lbs

Testing Performed and Basis: A full flow differential pressure test was conducted in which the MOV was operated closed and open against a differential pressure of 1605 psi. The test differential pressure was higher than the calculated maximum because test conditions established were more conservative than the design basis assumptions. The differential pressure calculation was based on the assumption that F019 closed when flow in the main line was equal to the required minimum flow rate. The actual flow test conditions established were that F019 closed with no other flow path except for the lube oil cooler flow. Therefore, a test differential pressure higher than the calculated was obtained. Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations.

As Found Conditions: Torque switch settings of 1.25 and 1.25 were found which produced thrust trip points of 5.73 and 4.97 Klbs for the closed and open directions, respectively. Both torque switch bypasses were set at greater than 90% of their respective stroke times.

Adjustments/Actions Performed: None

As Left Conditions: Same as As Found Conditions

Operability Evaluation: The MOV was determined operable. A spring pack preload of 1.47 Klbs was measured, which indicated an available thrust of 5.73 Klbs to close against the calculated differential pressure thrust requirement of 2855 lbs. The full differential pressure test further supports this conclusion.

TESTING AND OPERABILITY SUMMARY

Valve ID: E51*F022 Type & Size: 4" 900 lbs Velan Globe
Operator: Limitorque SMB-0-10 Motor: 125 VDC 1900 RPM 0.72 Hp
Valve Function: RCIC Test Return to the CST
Maximum Differential Pressure: Closed/1430 psi Open/N/A

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 12505 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 17426 lbs

Testing Performed and Basis: A full flow differential pressure test was conducted in which the MOV was operated closed and open against a differential pressure of 1498 psi. The differential pressure produced by the test was consistent with the calculated maximum. The small variance was attributable to expected reading errors associated with analog gauges. Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations.

As Found Conditions: Torque switch settings of 2.75 and 2.75 were found which produced thrust trip points of 15.1 and 16.72 Klbs for the closed and open directions, respectively. The bypass for the closed torque switch was set at greater than 90% of stroke time. The bypass for the open torque switch was set at 3% of stroke time.

Adjustments/Actions Performed: None

As Left Conditions: Same as As Found Conditions

Operability Evaluation: The MOV was determined operable. A comparison of the torque switch trip point and the running load indicated an available thrust of approximately 11.6 Klbs to close against the calculated differential pressure thrust requirement of 9395 lbs. The full differential pressure test further supports this conclusion. The bypass setting for the open torque switch is per design since the valve has no safety function to open.

TESTING AND OPERABILITY SUMMARY

Valve ID: E51*F031 Type & Size: 6" 150 lbs Velan Gate
 Operator: Limitorque SMB-00-10 Motor: 125 VDC 1900 RPM 0.72 Hp
 Valve Function: RCIC Suction from the Suppression Pool
 Calculated Maximum Differential Pressure: Closed/17 psi Open/19 psi

Minimum Required Stem Thrust Based
 on Differential Pressure, Piston Effect,
 and Packing Load: . . . 3484 lbs

Maximum Available Stem Thrust Based
 on 80% Available Voltage: . . . 9040 lbs

Testing Performed and Basis: Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations. No flow testing was performed because of the calculated low differential pressure thrust requirement of 126 lbs. This calculated differential pressure thrust requirement represents less than 4% of the overall thrust requirement for valve closing. This basis is further supported by the as-found conditions shown below which indicate significant margins in both torque switch trip points to accommodate differential pressure conditions.

As Found Conditions: Torque switch settings of 2.0 and 1.5 were found which produced thrust trip points of 6.51 and 8.84 Klbs for the closed and open directions, respectively. Both torque switch bypasses were set at greater than 90% of their respective stroke times.

Adjustments/Actions Performed: None

As Left Conditions: Same as As Found Conditions

Operability Evaluation: The MOV was determined operable. A comparison of the torque switch trip point and the running load indicated an available thrust of approximately 4.8 Klbs to close against the calculated differential pressure thrust requirement of 126 lbs and line pressure thrust requirement of 176 lbs.

TESTING AND OPERABILITY SUMMARY

Valve ID: E51*F045 Type & Size: 4" 900 lbs Velan Gate
Operator: Limitorque SMB-0-10 Motor: 125 VDC 1900 RPM 0.72 Hp
Valve Function: RCIC Turbine Steam Supply
Calculated Maximum Differential Pressure: Closed/1165 psi Open/1165 psi

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 10718 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 11582 lbs

Testing Performed and Basis: Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations. No flow testing was performed because the required dp conditions could not be practicably achieved. The calculated maximum differential pressure is based on the reactor being isolated and maintained at pressure by the reactor relief valves operating on their opening setpoint. However, since F045 was identical to F022 in design, a comparison of flow test data and static test data for F022 was performed to determine MOV operability.

As Found Conditions: Torque switch settings of 2.0 and 2.125 were found which produced thrust trip points of 9.13 and 10.92 Klbs for the closed and open directions, respectively. The bypass for the open torque switch was set at 95% of the stroke time. The bypass for the closed torque switch was set at 1% of the stroke time.

Adjustments/Actions Performed: Since the closed torque switch setpoint was less than the calculated minimum requirement, the torque switch setting was adjusted to obtain more available thrust. During this effort, the torque switch was removed and balanced. The spring pack was removed for inspection and cleaning, and subsequently re-installed. An as-left test yielded acceptable results. During the switch setting review process, it was determined that the closed torque switch bypass should be set at 95% of the closing stroke to comply with instruction drawing ESK-2u for Cat I MOV's with a closing safety function. Condition Report 87-1143 was issued to evaluate this condition. The Condition Report evaluation determined that operability could only be affected if the valve had internal damage that increased the closing thrust requirement. Operability was assured by STP-209-3302 which opened and closed F045 under rated steam pressure conditions and by a review of valve operating history that indicated no known operational failures. To be consistent with the River Bend design philosophy, Modification Request 87-0697 was issued to revise the control circuit so that the closed torque switch will be bypassed for 95% of the closing stroke.

As Left Conditions: As-left torque switch settings of 2.0 and 2.5 produced thrust trip points of 11.48 and 10.31 Klbs for the closed and open directions, respectively.

Valve ID: E51*F045

Operability Evaluation: The MOV was determined operable. The following basis was used. F022 was closed and opened against full flow differential pressure of 1498 psi without torque switch actuation. Using the conservative assumption that the F022 torque switch would trip at the differential pressure of 1498 psi and the available differential pressure thrust margin of 11600 lbs as measured under static conditions, it was calculated that a differential pressure of 1165 psi for F045 would produce a maximum differential pressure thrust requirement of 9021 lbs (i.e. $1165/1498 \text{ psi} \times 11600 \text{ lbs}$). This was based on the fact that F022 and F045 were identical in design. As the F045 as-left data indicated, there was an available thrust of 9.18 Klbs in the torque switch trip point to accommodate differential pressure requirements. Since this available thrust was greater than the maximum of 9021 lbs that may be required as validated by flow test data for F022, the as-left setpoints for F045 would ensure valve operability.

Although the as-found closed torque switch trip point was marginally less than the calculated minimum, a total thrust (i.e., including inertial thrust) of 14.10 Klbs was measured. This provided an available margin of 10.82 Klbs to close the valve against differential pressure conditions which could require as a maximum, 9021 lbs of thrust as analyzed in the basis above. In addition, the safety closing function that the valve performs is to shut down the RCIC turbine, which would have been effectively accomplished even if it is assumed that valve did not close with total seal tightness. The open torque switch trip point is of no concern since it is bypassed for 95% of stroke time. Adjustments that were made further enhanced valve performance by increasing the thrust margin and providing additional torque switch bypass time in the closed direction.

TESTING AND OPERABILITY SUMMARY

Valve ID: E51*F046 Type & Size: 2" 1500 lbs Velan Globe
Operator: Limitorque SMB-00-5 Motor: 125 VDC 1900 FPM 0.36 Hp
Valve Function: RCIC Lube Oil Cooler
Calculated Maximum Differential Pressure: Closed/N/A Open/1386 psi

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 5078 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 9690 lbs

Testing Performed and Basis: Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations. No flow testing was performed because valve operation in the safety direction (i.e., open) is assured due to the torque switch bypass setting of 89%. With the torque switch bypassed, the MOV can develop 12112 lbs of thrust at normal voltage and at least 9690 lbs of thrust under degraded voltage. This thrust capacity is significantly larger than the calculated minimum thrust requirement of 5078 lbs. Based on this conservative margin, flow testing at differential pressure conditions would not provide any significant additional assurance of valve operability.

As Found Conditions: Torque switch settings of 1.0 and 1.0 were found which produced thrust trip points of 5.21 and 6.63 Klbs for the closed and open directions, respectively. The bypass for the open torque switch was set at 89% of the stroke time. The bypass for the closed torque switch was set at 9% of the stroke time.

Adjustments/Actions Performed: None

As Left Conditions: Same as As Found Conditions

Operability Evaluation: The MOV was determined operable. A comparison of the torque switch trip points with the running load indicated a thrust margin of about 5 Klbs to close against the calculated differential pressure thrust requirement of 2694 lbs, and a thrust margin of 6.4 Klbs to open against differential pressure. The open torque switch bypass setting of 89% of stroke time further assures valve capability to open.

TESTING AND OPERABILITY SUMMARY

Valve ID: E51*F059 **Type & Size:** 4" 900 lbs Velan Gate
Operator: Limitorque SMB-0-10 **Motor:** 125 VDC 1900 RPM 0.72 Hp
Valve Function: RCIC Test Return to the CST

Calculated Maximum Differential Pressure: Closed/1430 psi Open/N/A

Minimum Required Stem Thrust Based on Differential Pressure, Piston Effect, and Packing Load: . . . 9469 lbs

Maximum Available Stem Thrust Based on 80% Available Voltage: . . . 9782 lbs

Testing Performed and Basis: A full flow testing differential pressure test was conducted in which the MOV was operated closed and open against a differential pressure of 1498 psi. The differential pressure produced by the test was consistent with the calculated maximum. The minor variance was attributable to expected reading errors associated with analog gauges. Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations.

As Found Conditions: Torque switch settings of 2.0 and 2.0 were found which produced thrust trip points of 8.08 and 9.72 Klbs for the closed and open directions, respectively. The bypass for the closed torque switch was set at greater than 90% of stroke time. The bypass of the open torque switch was set at 2.7%.

Adjustments/Actions Performed: None

As Left Conditions: Same as As Found Conditions

Operability Evaluation: The MOV was determined operable. The flow test verified that the measured thrust margin (trip point minus running load) was adequate to close the valve under design differential pressure conditions.

TESTING AND OPERABILITY SUMMARY

Valve ID: E51*F063 Type & Size: 8" 600 lbs Velan Gate
Operator: Limitorque SMB-1-60 Motor: 480 VAC 3405 RPM 7.8 Hp
Valve Function: RCIC Steam Supply Inboard Isolation
Calculated Maximum Differential Pressure: Closed/1165 psi Open/N/A

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 22092 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 26972 lbs

Testing Performed and Basis: Thrust signature testing was performed at static conditions. Flow testing was not feasible in that the maximum differential pressure of 1165 psi cannot be established. The calculated maximum differential pressure is based on the reactor being isolated and maintained at pressure by the reactor relief valves operating on their opening setpoint, and a down stream break that results in near atmospheric pressure when the valve is nearly closed. This valve is normally open and is required to close only to isolate a design basis down stream line break. As per the bulletin, valve testing under conditions simulating a break in the line containing the valve is not required.

As Found Conditions: Torque switch settings of 1.5 and 1.5 were found which produced thrust trip points of 11.5 and 11.77 Klbs for the closed and open directions, respectively. Both torque switch bypasses were set at greater than 90% of their respective stroke times.

Adjustments/Actions Performed: The torque switch settings were first increased to limiter plate values to increase the thrust margin. Based on retest, it was determined that there was still inadequate thrust in the torque switch trip points. A new spring pack was installed based on input from Limitorque. Acceptable test results were obtained.

As Left Conditions: As-left torque switch settings of 1.75 and 1.75 produced thrust trip points of 23.96 and 17.11 Klbs for the closed and open directions, respectively.

Operability Evaluation: Although the as-found torque switch settings were within the range specified by Limitorque, the actuator did not produce the expected thrust trip points for the torque switch settings. Condition Report CR 88-0082 was issued to evaluate the thrust trip points found. At the time of condition discovery, the plant was shut down for refueling and the RCIC system was inoperable and not required by Technical Specifications. During plant operation, the MOV was operated successfully in tests performed under the ISI program. The spring pack was removed for inspection and measurements of the Belleville washers taken to verify that the proper spring pack was installed. No apparent physical damage was found, although it was apparent from the test results that the spring pack had relaxed. A new spring pack was installed and the as-left test achieved satisfactory results.

TESTING AND OPERABILITY SUMMARY

Valve ID: E51*F064 Type & Size: 8" 600 lbs Velan Gate
Operator: Limitorque SB-1-60 Motor: 480 VAC 3405 RPM 7.8 Hp
Valve Function: RCIC Steam Supply Outboard Isolation
Calculated Maximum Differential Pressure: Closed/1165 psi Open/N/A

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 22092 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 26972 lbs

Testing Performed and Basis: Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations. Flow testing was not feasible in that the maximum differential pressure of 1165 psi cannot be established. The calculated maximum differential pressure is based on the reactor being isolated and maintained at pressure by the reactor relief valves operating on their opening setpoint, and a down stream break that results in near atmospheric pressure where the valve is nearly closed. This valve is normally open and is required to close only to isolate a design basis down stream line break. As per the bulletin, valve testing under conditions simulating a break in the line containing the valve is not required.

As Found Conditions: Torque switch settings of 1.5 and 1.5 were found which produced thrust trip points of 28.22 and 23.38 Klbs for the closed and open directions, respectively. Both torque switch bypasses were set at greater than 90% of their respective stroke times.

Adjustments/Actions Performed: None

As Left Conditions: Same as As Found Conditions

Operability Evaluation: The MOV was determined operable. The torque switch trip points provided more thrust than the calculated minimum requirement. The as-found closed torque switch trip point was evaluated with respect to the calculated maximum available thrust under degraded voltage. The evaluation indicated MOV operability because the calculation assumed a stem factor that was based on a conservative coefficient of friction between the stem and stem nut. Using the torque coefficient data provided by Limitorque, the as-found 1.5 setting would give a torque trip point of 350 ft-lbs. Using this and the average measured trip point thrust of 25.8 Klbs, a revised stem factor of 0.0135 is calculated. If this revised stem factor is used, the degraded voltage calculation would yield a maximum available thrust of 31965 lbs. In addition, the valve only has a safety function to close (i.e., steam line isolation in the event of a down stream break). Under this scenario, the valve will not be required to open after it performed its safety function.

TESTING AND OPERABILITY SUMMARY

Valve ID: E51*F068 Type & Size: 12" 150 lbs Velan Gate
Operator: Limitorque SMB-0-15 Motor: 125 VDC 1900 RPM 1.8 Hp
Valve Function: RCIC Turbine Steam Exhaust Isolation
Calculated Maximum Differential Pressure: Closed/8 psi Open/N/A

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 5825 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 10889 lbs

Testing Performed and Basis: Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations. No flow was performed because of the expected low differential pressure and line pressure thrust requirement (735 lbs calculated).

As Found Conditions: Torque switch settings of 3.0 and 3.0 were found which produced thrust trip points of 12.63 and 14.45 Klbs for the closed and open directions, respectively. Both torque switch bypasses were set at greater than 90% of their respective stroke times.

Adjustments/Actions Performed: None

As Left Conditions: Same as As Found Conditions

Operability Evaluation: The MOV was determined operable. The torque switch trip points provided more than adequate thrust to close and open the valve. The as-found closed torque switch trip point was evaluated with respect to the calculated maximum available thrust under degraded voltage. The evaluation indicated MOV operability because the calculation assumed a stem factor that was based on a conservative coefficient of friction between the stem and the stem nut. Using the torque output data provided by Limitorque, the as-found 3.0 torque switch setting would give a torque trip point of 173.5 ft-lbs. Using this and the average measured trip point thrust of 13.54 Klbs, a revised stem factor of 0.0128 is calculated. If this revised stem factor is used, the degraded voltage calculation would yield a maximum available thrust of 13195 lbs.

TESTING AND OPERABILITY SUMMARY

Valve ID: E51PF076 Type & Size: 0.75" 1500 lbs Velan Globe
Operator: Limitorque SMB-000-2 Motor: 460 VAC 1700 RPM 0.125 Hp
Valve Function: RCIC Steam Line Warming Valve
Calculated Maximum Differential Pressure: Closed/1105 psi Open/N/A

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 2393 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 3636 lbs

Testing Performed and Basis: Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations. No flow testing was performed because of the expected low thrust requirement due to the small valve orifice area. The calculated differential pressure thrust requirement of 393 lbs accounts for 16% of calculated total thrust requirement.

As Found Conditions: Torque switch settings of 3.5 and 3.0 were found for the closed and open directions, respectively. Signature testing yielded inconclusive results regarding torque switch thrust trip points. Corrective actions were taken as described below. Satisfactory retest data was obtained (see As Left Conditions).

Adjustments/Actions Performed: The operator was disassembled to access the torque switch and spring pack. The torque switch and the spring pack were removed and inspected. Degradation of the torque switch contacts was noted, and the torque switch was replaced. Because the MOV was located in a radiation area very difficult to access (in the drywell), it was decided that additional maintenance should be performed while the operator was already disassembled. As an added measure to assure valve operability, the spring pack, limit switch assembly, and the actuator internals were replaced.

As Left Conditions: As-left torque switch settings of 3.5 and 3.0 produced thrust trip points of 3.65 and 3.87 Klbs for the closed and open directions, respectively. Both torque switch bypasses were set at greater than 90% of their respective stroke times.

Operability Evaluation: The MOV was determined operable. This evaluation was based on the satisfactory LLRT that was performed prior to the signature testing. The MOV was electrically operated closed and the LLRT performed. Satisfactory LLRT results indicated the valve was able to close satisfactorily against at least 84% of the total thrust requirements prior to the signature test. As-left data indicated more than adequate thrust in the trip points to close and open the valve.

TESTING AND OPERABILITY SUMMARY

Valve ID: E51*F077 Type & Size: 1.5" 600 lbs Velan Globe
Operator: Limitorque SMB-000-2 Motor: 480 VAC 1700 RPM 0.125 Hp
Valve Function: Vaccum Breaker Valve

Calculated Maximum Differential Pressure: Closed/23 psi Open/N/A

Minimum Required Stem Thrust Based
on Differential Pressure, Piston Effect,
and Packing Load: . . . 2413 lbs

Maximum Available Stem Thrust Based
on 80% Available Voltage: . . . 3200 lbs

Testing Performed and Basis: Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations. No flow testing was performed because of expected low differential pressure thrust requirement of 28 lbs.

As Found Conditions: Torque switch settings of 1.25 and 1.25 were found which produced thrust trip points of 3.92 and 3.13 Klbs for the closed and open directions, respectively. Both torque switch bypasses were set at greater than 90% of their respective stroke times.

Adjustments/Actions Performed: None

As Left Conditions: Same as As Found Conditions

Operability Evaluation: The MOV was determined operable. The torque switch trip points provided more than adequate thrust to close and open the valve. Because a spring pack preload of 1.25Klbs was measured, the closed torque switch trip point of 3.92 Klbs represented available thrust to operate against the calculated differential pressure thrust requirement of 28 lbs. The closed torque switch trip point was evaluated with respect to the calculated available thrust under degraded voltage. The evaluation indicated MOV operability because the calculation assumed a conservative coefficient of friction between the stem and the stem nut. Using the torque output data provided by Limitorque, the as-found 1.25 setting would give a torque trip point of 25.5 ft-lb. Using this and the measured trip point thrust of 3.92 Klbs, a revised stem factor of 0.0065 is calculated. If this revised stem factor is used, the degraded voltage calculation would yield a maximum available thrust of 4923 lbs.

TESTING AND OPERABILITY SUMMARY

Valve ID: E51*F078 Type & Size: 2.5" 600 lbs Velan Globe
 Operator: Limitorque SMB-000-2 Motor: 480 VAC 1700 RPM 0.125 Hp

Valve Function: Vacuum Breaker Valve

Calculated Maximum Differential Pressure: Closed/23 psi Open/N/A

Minimum Required Stem Thrust Based
 on Differential Pressure, Piston Effect,
 and Packing Load: . . . 1707 lbs

Maximum Available Stem Thrust Based
 on 80% Available Voltage: . . . 3364 lbs

Testing Performed and Basis: Thrust signature testing was performed at static conditions to determine torque switch and limit switch actuations. No flow testing was performed because of the expected low differential pressure thrust requirement of 125 lbs which accounts for 7% of the total thrust requirement.

As Found Conditions: Torque switch settings of 2.0 and 2.0 were found which produced thrust trip points of 1.71 Klbs and 950 lbs for the closed and open directions, respectively. The open torque switch bypass was set at greater than 90% of stroke time. The closed torque switch bypass was set at 71% of stroke time. 1.26 Klbs of backseating was observed.

Adjustments/Actions Performed: The open limit switch was adjusted to eliminate backseating. The red indication light contact (rotor 3) was adjusted from 76% to about 95% of full closed.

As Left Conditions: The torque switch settings and thrust trip points, and the bypasses were the same as As Found. The backseating condition was eliminated.

Operability Evaluation: The MOV was determined operable. Torque switch trip points provided for more than adequate thrust to close and open the valve. Since a spring pack preload of 660 lbs was measured, the closed torque switch trip point of 1.71 Klbs represented available thrust to close the valve against the calculated differential pressure thrust requirement of 125 lbs. The closed torque switch bypass setting of 71% of stroke time did not affect operability because the valve was stroked closed satisfactorily, indicating that the torque switch was more than adequate to operate against the packing load which was below the spring pack preload. Since the packing load represents 93% of the total calculated load, the valve would easily close against the differential pressure thrust requirement even with the bypass set at 71%. The adjustments that were made further enhanced MOV performance by eliminating the backseating.

APPENDIX B
TEST PROGRAM TO DEMONSTRATE
VALVE OPERABILITY

APPENDIX B

TEST PROGRAM TO DEMONSTRATE VALVE OPERABILITY

<u>MOV ID</u>	<u>SIZE/TYPE</u>	<u>METHOD</u>	<u>COMMENTS</u>
E22*F001	16" GTE	FULL FLOW SIGNATURE TEST	COLLECT DYNAMIC SIGNATURE DATA
E22*F004	10" GTE	HYDROSTATIC dP SIGNATURE TEST	COLLECT SIGNATURE DURING TEST
E22*F010	10" GLB	FULL FLOW SIGNATURE TEST	COLLECT DYNAMIC SIGNATURE DATA
E22*F011	10" GLB	STATIC SIGNATURE TEST	IDENTICAL TO E22*F010, SET TORQUE SWITCH BASED UPON E22*F010 FLOW TEST DATA
E22*F012	4" GTE	FULL FLOW SIGNATURE TEST	COLLECT DYNAMIC SIGNATURE DATA
E22*F015	20" GTE	HYDROSTATIC dP SIGNATURE TEST	COLLECT SIGNATURE DURING TEST
E22*F023	10" GLB	STATIC SIGNATURE TEST	IDENTICAL TO E22*F010, SET TORQUE SWITCH BASED UPON E22*F010 FLOW TEST DATA
E51*C002	4" GLB	NO TEST REQUIRED	SPRING CLOSURE FOR SAFETY
E51*F010	6" GTE	STATIC SIGNATURE TEST	ENGINEERING ANALYSIS BASED ON LOW THRUST CONTRIBUTION DUE TO DIFFERENTIAL PRESSURE
E51*F013	6" GTE	FULL FLOW TEST WITH AMPS AND HYDROSTATIC dP TEST	COLLECT SIGNATURE DATA DURING TEST
E51*F019	2" GLB	FULL FLOW TEST WITH AMPS	REVIEW CURRENT DATA TAKEN DURING FULL FLOW TEST
E51*F022	4" GLB	FULL FLOW TEST WITH AMPS	REVIEW CURRENT DATA TAKEN DURING FULL FLOW TEST
E51*F031	6" GTE	STATIC SIGNATURE TEST	ENGINEERING ANALYSIS BASED ON LOW THRUST CONTRIBUTION DUE TO DIFFERENTIAL PRESSURE
E51*F045	4" GLB	STATIC SIGNATURE TEST	IDENTICAL TO E51*F022, BUT STEAM FLOW VS WATER

APPENDIX B

TEST PROGRAM TO DEMONSTRATE VALVE OPERABILITY

<u>MOV ID</u>	<u>SIZE/TYPE</u>	<u>METHC.</u>	<u>COMMENTS</u>
E51*F046	2" GLB	STATIC SIGNATURE TEST	ENGINEERING ANALYSIS - GLOBE VALVE WITH PRESSURE UNDER THE SEAT AND SAFETY RELATED TO OPEN ONLY
E51*F059	4" GTE	FULL FLOW TEST WITH AMPS	REVIEW CURRENT DATA TAKEN DURING FULL FLOW TEST
E51*F063	8" GTE	STATIC SIGNATURE TEST	STEAM ISOLATION VALVE-BULLETIN DOES NOT REQUIRE TESTING TO SIMULATE A LINE BREAK
E51*F064	8" GTE	STATIC SIGNATURE TEST	STEAM ISOLATION VALVE-BULLETIN DOES NOT REQUIRE TESTING TO SIMULATE A LINE BREAK
E51*F068	12" GTE	STATIC SIGNATURE TEST	ENGINEERING ANALYSIS BASED ON LOW THRUST CONTRIBUTION DUE TO DIFFERENTIAL PRESSURE
E51*F076	.75" GLB	STATIC SIGNATURE TEST	STEAM LINE WARMING-BULLETIN DOES NOT REQUIRE TESTING TO SIMULATE A LINE BREAK
E51*F077	1.5" GLB	STATIC SIGNATURE TEST	ENGINEERING ANALYSIS BASED ON LOW THRUST CONTRIBUTION DUE TO DIFFERENTIAL PRESSURE
E51*F078	2.5" GLB	STATIC SIGNATURE TEST	ENGINEERING ANALYSIS BASED ON LOW THRUST CONTRIBUTION DUE TO DIFFERENTIAL PRESSURE

APPENDIX C
SIGNATURE TESTING USING THE
QATIS MOV SYSTEM

1.0 Signature Testing Methodology

Impell's OATIS MOV system (Operations Analysis and Testing Interpretive System) was utilized to test (i.e., collect data for) the GSU bulletin MOV's. The system's basic function was to measure/calculate stem load developed by the motor operator and setpoints associated with controlling the operation of the MOV.

1.1 General

The specific design of the Limitorque operators allows the calculation of stem loads by measurement of spring pack movement within the motor operator. By measuring valve stem loading and spring pack movement simultaneously, a correlation of the two parameters is established. The correlation is applied to the spring pack movement data obtained during valve operation to derive a stem thrust versus stroke time profile. Motor current, and limit and torque switch operation data are also obtained during valve operation to determine the motor current profile and the times at which the switches are actuated. The sensors used for obtaining the aforementioned data are: 1) a load cell that is mounted on top of the valve operator housing; 2) a linear displacement probe that is mounted on the spring pack cap or capcover; 3) an amp probe that is clamped around the motor lead; and 4) test leads that are clipped to the geared limit switch contacts and connected to RF sensors that are clamped around the torque switch wires.

1.2 Principles of MOV Operation

The OATIS MOV system is based on the specific design of Limitorque SMB/SB operators. The following describes their typical operation. Refer to Figure 1 for illustration.

The electric motor has a helical pinion mounted on its shaft extension. This pinion drives the worm shaft clutch gear which is engaged with the worm shaft clutch. This piece is splined to the worm shaft. The worm is splined to the worm shaft and when it is rotated, it turns the worm gear. The worm gear has two lugs cast onto the top portion which engages the two lugs on the drive sleeve. These lugs are spaced so that when the worm gear begins to turn during motor operation, there is a certain amount of lost motion before the lugs engage and cause the hammer blow effect within the operator.

As soon as the worm gear lugs engage, the drive sleeve being splined internally with the stem nut, causes the stem nut to rotate and open or close the threaded stem of the valve. The stem nut is threaded to fit the thread of any rising stem valve.

The sequence of typical gate valve closing is as follows:

The motor transmits rotary torque through the helical gearing and then through the second reduction worm and worm gear.

The worm gear drives the stem nut.

Rotation of threaded nut creates linear motion of the valve stem and resultant valve movement.

When the valve closes, the disc is pressed into the valve seat, thus seating the valve.

Since the valve is seated, the disc no longer can move in a downward direction. However, the motor drive still continues to rotate under increased load conditions.

Instead of the worm gear continuing to rotate, the worm actually threads itself along the worm gear as the spring pack is compressed. The worm rides on a precision spline which permits this axial movement.

Movement of the worm trips the torque switch which breaks the electrical motor circuit. The mechanical self-locking feature, inherent to the worm gear design, maintains valve seating force and assures a tight valve until the MOV is energized in the "Open" direction.

1.3 OATIS MOV Testing and Analysis Details

Stem Load Data

Stem load calculations require that a parameter directly relating to stem load be monitored for the entire valve stroke. The parameter is the spring pack movement. Because of the Limitorque design, the movement of the worm is proportional to the load being delivered to the valve stem. OATIS MOV utilizes a LVDT to monitor this movement.

To correlate stem load to spring pack movement, a method to measure actual stem load is required. OATIS MOV utilizes a compression load cell against which the valve

is electrically operated in the open direction during the spring pack calibration stroke. As the valve stem impacts the load cell, load data and spring pack movement data are collected. The measured load and the spring pack displacement data are evaluated to establish the stem load/spring pack correlation.

Motor Current Data

Motor current is measured for the valve stroke to provide secondary indication of MOV mechanical load condition. No thrust calculations are based on measured motor current. The motor current signature also provides indications of motor performance, and contactor drop out time information, etc.

Switch Operation Data

Switch actuations are detected to provide information regarding proper settings, trip times, and switch functionality. Geared limit switches providing the torque switch bypass functions and position limit functions are monitored to determine actuation times relative to stroke time. The torque switch is monitored to determine trip times which are correlated to stem thrust.

Data Acquisition

Data is automatically obtained for the above parameters concurrently during any one stroke (i.e. all data relating to the open stroke is captured during the stroke). The same applies to the closed stroke, and the spring pack calibration stroke. A minimum of 4000 points per parameter is captured during any one of the above three strokes.

Data obtained by the OATIS MOV sensors are processed to achieve specific characteristics necessary for input to the computer. The signal conditioning process includes excitation for passive sensors, signal amplification and ranging, and analog to digital conversion to make the output from the sensors compatible with the readout device (i.e. computer).

The computer and specially developed software are used to 1) control data acquisition, 2) store the acquired data, 3) assist the user in data evaluation, 4) calculate critical parameters, and 5) provide graphic (signatures) and written reports of the acquired and analyzed data.

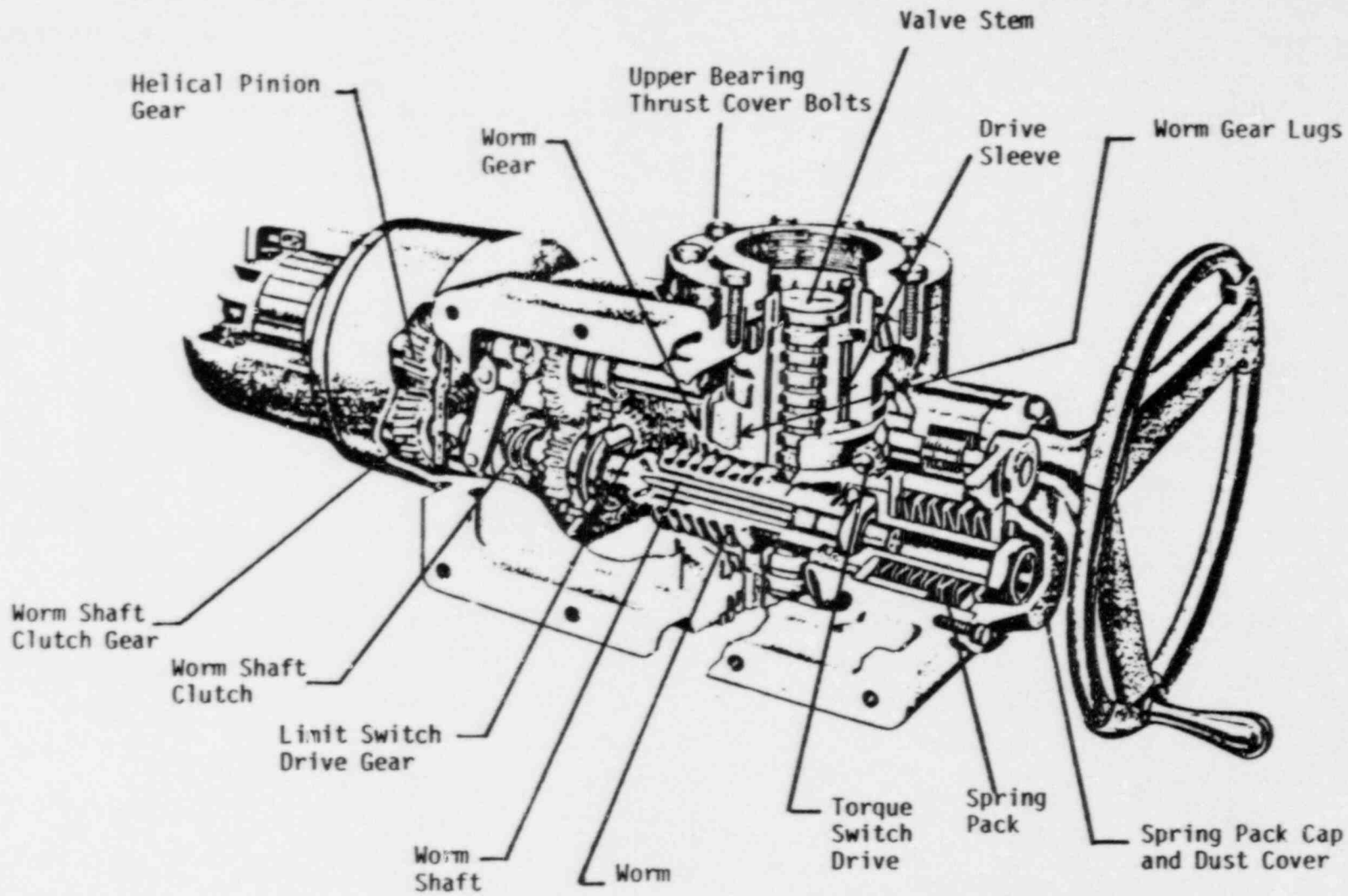
Data Analysis

Data is converted into engineering units and can be displayed on graphs (signatures). Calculations are performed to:

Correlate spring pack displacement data to measured stem load via a second order polynomial curve fit.

Convert spring pack displacement data from the valve strokes into stem load.

Determine critical MOV parameters relating to stem thrust, geared limit switch, and torque switch setpoints.



**CUTAWAY VIEW OF
SMB-0 LIMITORQUE VALVE CONTROL**