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Detailed Analysis for Output Thrust Capabilities in the Scope of the NMP2 G.L. 89-10 Program Extension

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1.0 EXECUTIVE SUMMARY

This analysis identifies the methodology used to quantify the margin of actuator output thrust/torque at the existing torque switch settings (TSS) to the minimum needed to perform the safety function for all valves included in the scope of program extension. The valves in the scope of program extension are comprised of gate, globe, and quarter-turn valves. These are listed in Attachment C. This analysis has also evaluated the valve factor capability for each gate valve included in the scope of program extension with respect to the existing TSS. The valve factor capabilities for gate valves are included in Attachment A. The confirmation of operability for these valves is due largely to the capability of these valves to provide sufficient thrust/torque at existing torque switch settings (TSS) as determined by this analysis. Valve factor capability discussed in this report has been used to develop significant assurance in each gate valve's output thrust/torque to meet design expectations. This methodology is discussed in Section 2.0 along with a detailed analysis of one gate valve to show step-by-step the process of determining valve output thrust/torque capability and valve factor capability.

2.0 EVALUATION OF THE VALVE FACTOR CAPABILITY FOR GATE VALVES

Confirmation for operability was documented for each valve included in the scope of program extension by the report entitled, "Operability Assessments for Motor Operated Valves in the Scope of Program Extension". That report explained applicable references, how they have been interpreted with respect to relevant information, and what each has offered in support towards confirmation of operability. Operability assessments have been based on reviews of NMP2 design basis documentation including but not limited to; vendor and NMP2 sizing calculations, original vendor and Limitorque test data reports, design basis reviews, extensive historical documentation reviews, and operational surveillance test procedures and results. A large part of confirming the operability of each gate valve was the ability to determine that at design conditions, sufficient margin exists between the minimum required thrust and the maximum output thrust capability at present day torque switch setting.

A measure of margin between required minimum thrust and valve output capability is the valve factor capability. The valve factor capability is a measure of how high valve factors can be before the actuator/valve output thrusts are no longer capable of torque switch trip at the present day torque switch settings. A valve factor of 0.3 is the NMP2 design basis assumption and industry standard for gate valves. A valve factor capability significantly higher than 0.3 indicates that the existing TSS is conservative, and has significant margin to accomodate the uncertainty in the actual valve factor for the valve.

Diagnostics will enable the verification of the valve's actual thrust/torque output and allow better selection of torque switch settings to provide optimal margin for consideration of uncertainties in rate of loading, coefficient of friction, and increased valve factors; however, NMP2 has sufficient valve factor capability for each of the gate valves included in the scope of program extension and this provides the assurance, that at existing TSS, the NMP2 gate valves can perform their safety function.

2.1 Methodology in Determination of Valve Thrust/Torque Capability

The technique for evaluating the valve factor capability on each of the valves listed in Attachments A and C involves the review of original Vendor Test Data, existing torque switch settings(TSS), and design basis requirements as delineated in both NMP2 MOV Sizing Calculations and original vendor sizing calculations. The two calculated design parameters critical to expected thrust margins are discussed below:

A. Evaluation of Expected Design Basis Operational criteria

Maximum expected differential pressures (MEDP) have been taken from design basis reviews which have been completed in support of the NMP2 G.L. 89-10 Program. These pressures represent the greatest differential pressures the MOVs are expected to operate against and are listed for each valve. In addition, the MEDP is also conservatively used in this analysis as the worst case line pressure.

B. Quantifying Minimum Required Thrust

The minimum required stem thrusts used in this analysis are based on the MEDP and the industry standard sizing equations. A valve factor of 0.3 was applied as it is both the original vendor's, and NMP2 design basis. The minimum required thrusts at MEDP have been calculated using NMP2 MOV Sizing Calculations and original vendor sizing calculations.

2.2 Indications of Valve/Actuator Capabilities

Determining the capability of the actuator to produce a certain stem thrust has been contingent upon the coefficient of friction assumed, and the actual spring pack and torque switch setting existing for that actuator. Conversion from torque to thrust is based on stem factors which have been calculated at a coefficient of friction of 0.15. This is also an industry standard, original vendor, and NMP2 design basis assumption under the G.L. 89-10 Program.

A. Thrust/torque Output Analysis

The spring pack and as-built torque switch settings are taken from the Maintenance Procedures and NMP2 Design Basis Historical Reviews, i.e., walkdown information. These TSS have been evaluated for output thrust against first the original Vendor Test Data with Limitorque test results and next to the published Limitorque generic curves for actuator torque vs settings. The Limitorque testing specifically identifies actual measured output thrust at several settings under degraded voltage conditions. The value listed in Attachment A and C under 'Thrust at as-built TSS' is the lesser output thrust of the two evaluations, where Limitorque testing and Limitorque generic curves at as-built TSS are compared.

As an example, the original Limitorque test data for the motor operated gate valve 2CCP*MOV15A is provided as Attachment B. The review of the original Limitorque test data for the valve 2CCP*MOV15A has revealed that for the as-built setting of 2-1/4 the actuator/valve stem was able to provide 3400 lbs of output stem thrust. Review of the published Limitorque generic curves for the installed spring pack with a setting of 2-1/4 revealed that 39.5 ft-lbs of torque and 3435 lbs of thrust corresponds to this valve's output with a stem factor of 0.011499 and a coefficient of friction of 0.15. To be conservative the lesser of the two evaluated output thrusts, 3400 lbs of output thrust at an as-built setting of 2-1/4, is listed in Attachment A for this valve for further analysis.

B. Determination of Valve Factor Capabilities

The valve factor capability is a measure of how high valve factors can be before the actuator/valve output thrusts are no longer capable of torque switch trip at the present day torque switch settings. The step above, done to determine thrust/torque output at the as-built TSS, is followed by the following analysis to determine the valve factor capability.

The output thrust at the as-built TSS is reduced by the expected Torque Switch Repeatability (TSR). This conservatively provides for the Limitorque's specified uncertainties in Technical Limitorque Maintenance Update 92-2, (i.e., 5%, 10%, etc.). For example; valve 2CCP*MOV15A was noted above as capable of 3400 lbs of output thrust at an as-built setting of 2-1/4. The corrected thrust for 10% TSR now yields 3060 lbs of thrust.

Valve factor capabilities for each of the gate valves listed in Attachment A have been calculated at torque switch trip using critical design parameters included in the NMP2 MOV Sizing Calculations. These include packing loads, stem and seat areas, differential and line pressures (MEDP). The actual equation is expressed in the following:

Valve Factor Capability:

$$= \{ (\text{Expected Thrust output at the as-built TSS}) - (\text{Packing Load}) - (\text{Stem Area} \times \text{MEDP}) \} \div (\text{Seat Area} \times \text{MEDP})$$

To follow the example given in the analysis of the valve 2CCP*MOV15A, the following would apply:

$$\{ (3060 \text{ lbs} - 2177 \text{ lbs packing load}) - (1.48 \text{ in}^2 \times 52 \text{ psig}) \} \div (9.28 \text{ in}^2 \times 52 \text{ psig}) = \text{a 1.67 valve factor capability}$$

For the valve 2CCP*MOV15A, even with a valve factor as high as 1.67, the as-built TSS will allow the actuator to produce enough thrust to overcome minimum required thrust based on MEDP. Note design basis assumes a valve factor of 0.3; therefore, sufficient margin in the actuator's output thrust exists to confirm this valve's ability to complete it's safety function.

Note: In the report entitled "Operability Assessments for Motor Operated Valves in the Scope of Program Extension", individual operability assessments for several valves included valve factor capability approximations. These approximations were based on design line and differential pressures. This analysis utilizes MEDP and as such valve factor capabilities may not be consistent with their individual operability assessments.

3.0 THRUST / TORQUE MARGIN VERIFICATION FOR MOVs TESTED AFTER 6/28/94

The margin in output thrust/torque has been listed in Attachment B for all the valves included in the scope of program extension. Required thrusts are based on a valve factor of 0.3 for gate valves, and 1.1 for globe valves. Quarter-turn valves are evaluated for required torque with respect to vendor supplied torque requirements. The margin in output thrust/torque listed in Attachment B is essentially the difference between what is required and how much more is available at the existing torque switch settings under the worst case line and differential pressures.

The available output thrust/torque for each valve at the existing TSS has been evaluated to the methodology identified in Section 2.1 and 2.2. The evaluation technique provided in Sections 2.1 and 2.2 is with respect to evaluation of valve factor capability in gate valves; however, the technique in evaluating output thrust/torque is identical for gate, globe, and quarter-turn valves and applies to results of calculations listed in Attachment B as well.

Attachment A:

Motor Operated Gate Valves Tested After 6/28/94

VALVE FACTOR CALCULATION
FOR GATE VALVES TESTED
AFTER 6/28/94

NO.	MARK NUMBER	VALVE TYPE	NOM SIZE	RISK	AUTOMATIC SAFETY FUNCTION UNLESS OTHERWISE NOTED	MEDP (PSI)	MIN. REQ. THRUST AT MEDP (LBS)	SPRING PACK NO.	AS-BUILT T.S.S.	THRUST AT T.S.S. (LBS)	CORRECTED THRUST FOR T.S. REPEATABILITY	VALVE FACTOR AT T.S. TRIP
1	2CCP*MOV15A	GATE	4	LOW	CLOSE on LOCA signal	52	2399	0023	2.25	3400	3060	1.67
2	2CCP*MOV15B	GATE	4	LOW	CLOSE on LOCA signal	49	2386	0023	2.5	3100	2790	1.19
3	2CCP*MOV16A	GATE	4	LOW	CLOSE on LOCA signal	52	2399	0023	2	3131	2818	1.17
4	2CCP*MOV16B	GATE	4	LOW	CLOSE on LOCA signal	49	2386	0023	2	3131	2818	1.25
5	2CCP*MOV17A	GATE	4	LOW	CLOSE on LOCA signal	84	2536	0023	2	3131	2818	0.66
6	2CCP*MOV17B	GATE	4	LOW	CLOSE on LOCA signal	76	2502	0023	2.5	3739	3365	1.53
7	2CCP*MOV94A	GATE	4	LOW	CLOSE on LOCA signal	84	2536	0023	2	3131	2818	0.66
8	2CCP*MOV94B	GATE	4	LOW	CLOSE on LOCA signal	76	2502	0023	2	2800	2520	0.33
9	2CCP*MOV122	GATE	8	LOW	CLOSE on LOCA signal	62	5072	0048	2.5	8950	8503	1.57
10	2CCP*MOV124	GATE	8	LOW	CLOSE on LOCA signal	62	5072	0048	2	6800	6460	0.82
11	2CCP*MOV273	GATE	8	LOW	CLOSE on LOCA signal	97	5324	0048	2.5	8750	8313	1.01
12	2HCS*MOV1A	GATE	3	LOW	OPEN and CLOSE manually after LOCA, also CLOSE on LOCA signal, if open	34	1597	0021	1.5	4315	3884	12.78
13	2HCS*MOV1B	GATE	3	LOW	OPEN and CLOSE manually after LOCA, also CLOSE on LOCA signal, if open	34	1597	0021	2.25	6904	6214	25.49
14	2HCS*MOV3A	GATE	3	LOW	OPEN and CLOSE manually after LOCA, also CLOSE on LOCA signal, if open	40	1614	0021	1.5	4315	3884	10.83
15	2HCS*MOV3B	GATE	3	LOW	OPEN and CLOSE manually after LOCA, also CLOSE on LOCA signal, if open	40	1614	0021	1.5	4315	3884	10.83

LEGEND:

T.S. / T.S.S.: Torque Switch / Torque Switch Setting
MEDP: Maximum Expected Differential Pressure

Attachment B:

Vendor Test Data:
Limitorque Test Data for 2CCP*MOV15A

Attachment B

Date 5-24-83

LIMITORQUE TEST DATA

Order No. 3H9729-C1

Unit Size SMB-000 5TH

Ref.: P3-7026-TT91

Cust. P.O. No. W-09912

Parameters	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Notes
T.S.SETTING	1	1½	2	2½	3	3½	4	CLOSE
THRUST OUTPUT	1600	2400	3160					POUNDS
VOLTAGE	460	460	460					VOLTS
CURRENT	.50	.60	.80					AMPS
CYCLES	60	60	60					HERTZ
460 volts NORMAL SETTING	@ 1 3/4	LOAD 2800 LB	VOLTS 460	AMPS .70		HERTZ 60		
460 volts MAXIMUM SETTING	@ 2¼	LOAD 3400 LB	VOLTS 460	AMPS .85		HERTZ 60		
632 volts STALL VOLTAGE	110 %	LOAD 11,360 LB	VOLTS 632	AMPS 5.1		HERTZ 60		

THRUST TEST PROCEDURE REV. 1 DATED 2-21-79

ALL TEST VALUES ARE BEING TAKEN FROM RECORDING STRIP CHARTS, AND ARE KEPT ON FILE.

Niagara Mohawk Power Corporation
Nine Mile Point Nuclear Station-Unit #2
P.O. #NMP2-P 304 R
Valve Motor Operator
Mark # 2CCP* MOV 15A
Limitorque Corporation
5114 Woodall Road
Lynchburg, Va. 24502

SWEC QA INSPECTED

W.A. Moore
W.A. Moore
Test Lab. Manager

I No. 358068

VELAN NO.: P3-7026-N
ITEM: 91

Tested by RA & CN

Attachment C:

Output Thrust at Existing Torque Switch Settings vs Required Thrust on Valves in Scope of Program Extension

THRUST / TORQUE MARGIN VERIFICATION FOR MOVs TESTED AFTER 6/28/94

NO.	MARK NUMBER	VALVE TYPE	NOM SIZE	RISK	AUTOMATIC SAFETY FUNCTION UNLESS OTHERWISE NOTED	MEDP (PSI)	MIN. REQ. THRUST AT MEDP *NOTE 1,3*	SPRING PACK NO.	AS-BUILT T.S.S.	THRUST AT T.S.S. *NOTE 1*	CORRECTED THRUST FOR T.S. REPEATABILITY *NOTE 1*	THRUST MARGIN AT T.S.S. & MEDP *NOTE 1, 3*
1	2CCP*MOV15A	GATE	4	LOW	CLOSE on LOCA signal	52	2399	0023	2.25	3400	3060	661
2	2CCP*MOV15B	GATE	4	LOW	CLOSE on LOCA signal	49	2386	0023	2.50	3100	2790	404
3	2CCP*MOV16A	GATE	4	LOW	CLOSE on LOCA signal	52	2399	0023	2.00	3131	2818	419
4	2CCP*MOV16B	GATE	4	LOW	CLOSE on LOCA signal	49	2386	0023	2.00	3131	2818	432
5	2CCP*MOV17A	GATE	4	LOW	CLOSE on LOCA signal	84	2536	0023	2.00	3131	2818	282
6	2CCP*MOV17B	GATE	4	LOW	CLOSE on LOCA signal	76	2502	0023	2.50	3739	3365	864
7	2CCP*MOV94A	GATE	4	LOW	CLOSE on LOCA signal	84	2536	0023	2.00	3131	2818	282
8	2CCP*MOV94B	GATE	4	LOW	CLOSE on LOCA signal	76	2502	0023	2.00	2800	2520	18
9	2CCP*MOV122	GATE	8	LOW	CLOSE on LOCA signal	62	5072	0048	2.50	8950	8503	3431
10	2CCP*MOV124	GATE	8	LOW	CLOSE on LOCA signal	62	5072	0048	2.00	6800	6460	1388
11	2CCP*MOV273	GATE	8	LOW	CLOSE on LOCA signal	97	5324	0048	2.50	8750	8313	2988
12	2CSL*MOV112	STOP TRI	20	LOW	Manually CLOSE for containment isolation and OPEN for core spray	37	187	0501-184	1.50	200	190	3
13	2HCS*MOV1A	GATE	3	LOW	OPEN and CLOSE manually after LOCA, also CLOSE on LOCA signal, if open	34	1597	0021	1.50	4315	3884	2287
14	2HCS*MOV1B	GATE	3	LOW	OPEN and CLOSE manually after LOCA, also CLOSE on LOCA signal, if open	34	1597	0021	2.25	6904	6214	4617
15	2HCS*MOV2A	GLOBE	3	LOW	OPEN and CLOSE manually after LOCA, also CLOSE on LOCA signal, if open	34	2026	0023	3.50	5400	4860	2834
16	2HCS*MOV2B	GLOBE	3	LOW	OPEN and CLOSE manually after LOCA, also CLOSE on LOCA signal, if open	34	2026	0023	3.75	5675	5108	3081
17	2HCS*MOV3A	GATE	3	LOW	OPEN and CLOSE manually after LOCA, also CLOSE on LOCA signal, if open	40	1614	0021	1.50	4315	3884	2270
18	2HCS*MOV3B	GATE	3	LOW	OPEN and CLOSE manually after LOCA, also CLOSE on LOCA signal, if open	40	1614	0021	1.50	4315	3884	2270
19	2HCS*MOV5A	GLOBE	3	LOW	OPEN and CLOSE manually after LOCA, also CLOSE on LOCA signal, if open	34	2026	0023	3.50	5400	4860	2834
20	2MSS*MOV111	GLOBE	6	LOW	CLOSE automatically on steam line break for Cont. Isol.	1020	24719	0072	3.00	36581	34752	10033
21	2MSS*MOV112	GLOBE	6	LOW	CLOSE automatically on steam line break for Cont. Isol.	1020	24719	0072	3.00	36581	34752	10033
22	2MSS*MOV208	GLOBE	2	LOW	CLOSE automatically on steam line break for Cont. Isol.	1020	3986	0023	3.00	5342	5075	1089
23	2RHS*MOV1A	STOP TRI	24	LOW	Manually CLOSE for containment isolation and OPEN to supply water to pump	37	201	0901-211	2.00	413	372	171
24	2RHS*MOV1B	STOP TRI	24	LOW	Manually CLOSE for containment isolation and OPEN to supply water to pump	37	201	0901-211	2.00	413	372	171
25	2RHS*MOV1C	STOP TRI	24	LOW	Manually CLOSE for containment isolation and OPEN to supply water to pump	37	290	0501-184	2.50	400	360	70
26	2RHS*MOV22A	GLOBE	8	LOW	CLOSE on LOCA signal, if open	1000	25593	0701-212	2.25	35315	33549	7956
27	2RHS*MOV22B	GLOBE	8	LOW	CLOSE on LOCA signal, if open	1000	25593	0701-212	2.25	35000	33250	7657
28	2RHS*MOV23A	GLOBE	8	LOW	CLOSE on LOCA signal, if open	465	14041	0701-212	2.25	35000	33250	19209
29	2RHS*MOV23B	GLOBE	8	LOW	CLOSE on LOCA signal, if open	465	14041	0701-212	2.00	30540	29013	14972
30	2RHS*MOV26A	GLOBE	1	LOW	Manually OPEN to vent Hx and CLOSE for containment/system boundary isol.	200	1121	0060	1.00	1351	1216	95

THRUST / TORQUE MARGIN
VERIFICATION FOR MOVs
TESTED AFTER 6/28/94

NO.	MARK NUMBER	VALVE TYPE	NOM SIZE	RISK	AUTOMATIC SAFETY FUNCTION UNLESS OTHERWISE NOTED	MEDP (PSI)	MIN. REQ. THRUST AT MEDP *NOTE 1,3*	SPRING PACK NO.	AS-BUILT T.S.S.	THRUST AT T.S.S. *NOTE 1*	CORRECTED THRUST FOR T.S. REPEATABILITY *NOTE 1*	THRUST MARGIN AT T.S.S. & MEDP *NOTE 1, 3*
31	2RHS*MOV26B	GLOBE	1	LOW	Manually OPEN to vent Hx and CLOSE for containment/system boundary isol.	200	1121	0060	1.00	1351	1216	95
32	2RHS*MOV27A	GLOBE	1	LOW	Manually OPEN to vent Hx and CLOSE for containment/system boundary isol.	200	1121	0060	1.00	1351	1216	95
33	2RHS*MOV27B	GLOBE	1	LOW	Manually OPEN to vent Hx and CLOSE for containment/system boundary isol.	200	1121	0060	1.00	1351	1216	95
34	2RHS*MOV30A	STOP TRI	18	LOW	Manually CLOSE for cont. isol. and OPEN for pool cooling/min flow	34	224	0501-184	2.25	350	333	109
35	2RHS*MOV30B	STOP TRI	18	LOW	Manually CLOSE for cont. isol. and OPEN for pool cooling/min flow	34	224	0501-184	2.25	350	333	109
36	2RHS*MOV80A	GLOBE	1	LOW	CLOSE on low Level 1 or high drywell pressure	1000	1805	0101-099	2.00	2567	2310	505
37	2RHS*MOV80B	GLOBE	1	LOW	CLOSE on low Level 1 or high drywell pressure	1000	1805	0101-099	2.00	2567	2310	505
38	2RHS*MOV104	GLOBE	6	LOW	CLOSE on Low Level 3, high Rx pressure, and high ambient temp	327	10354	0070	3.00	12580	11951	1597
39	2SLS*MOV5A	GLOBE-ST. CK.	2	LOW	Manually OPEN for injection and CLOSE for cont isolation	100	1695	0048	1.50	5400	5130	3435
40	2SLS*MOV5B	GLOBE-ST. CK.	2	LOW	Manually OPEN for injection and CLOSE for cont isolation	100	1695	0048	2.00	7200	6840	5145
41	2WCS*MOV200	GLOBE	8	LOW	Manually CLOSE for long term cont isol and control leakage	1097	26188	0068	2.25	35315	33549	7362

NOTES:

1 Torque (ft-lbs) values are identified for Quarter turn (Stop Tricentric) valves.
Thrust (lbs) values are identified for Gate and Globe valves.

2 LEGEND:

T.S. / T.S.S.: Torque Switch / Torque Switch Setting
MEDP: Maximum Expected Differential Pressure
(Maximum valve upstream pressure - 0 PSIG, Assumed downstream pressure)

3 All minimum required torques for Quarter Turn valves are calculated at Design Differential Pressures rather than at MEDP and as such will have a greater torque margin than shown above.

Differential Pressures for MOVs to be Tested Prior to Refueling Outage 3

Each valve listed in the following table is scheduled for completion of VOTES static and dynamic testing prior to refueling outage 3. The information provided on the attached table identifies the extent to which the Maximum Expected Differential Pressures (MEDP) will be observed under dynamic testing conditions.

DIFFERENTIAL PRESSURES FOR MOVs TO BE TESTED PRIOR TO REFUEL OUTAGE 3

NO.	MARK NUMBER	VALVE TYPE	NOM SIZE	RISK	AUTOMATIC SAFETY FUNCTION UNLESS OTHERWISE NOTED	MEDP	MAX ACHEIVABLE DP	PERCENT OF MEDP
1	**2CSL*MOV107**	GATE	4	LOW	CLOSE on set discharge flow and OPEN on low flow	500	500	100
2	**2CSL*FV114**	CONTROL	10	LOW	CLOSE on LOCA signal	510	506	99
3	**2ICS*MOV116**	GLOBE	2	HIGH	OPEN on system initiation	1340	1100	82
4	2ICS*MOV120	GLOBE	4	HIGH	OPEN on system initiation, and CLOSE on high Rx water level	1158	1050	91
5	2ICS*MOV124	GATE	4	LOW	CLOSE on RCIC system initiation	1342	1100	82
6	2ICS*MOV159	GLOBE	1	HIGH	OPEN on system initiation, and CLOSE on high Rx water level	1158	1050	91
7	**2RHS*FV38C**	CONTROL	14	LOW	CLOSE on LOCA signal	326	320	98
8	2RHS*MOV40B	GLOBE	12	LOW	CLOSE on Low Level 3, high Rx pressure, & high ambient temp	320	320	100
9	**2SWP*MOV74A**	STOP TRI	18	HIGH	OPEN when pump is started, & CLOSED when pump is stopped	108	20	19
10	**2SWP*MOV74B**	STOP TRI	18	HIGH	OPEN when pump is started, & CLOSED when pump is stopped	108	20	19
11	**2SWP*MOV74C**	STOP TRI	18	HIGH	OPEN when pump is started, & CLOSED when pump is stopped	108	20	19
12	**2SWP*MOV74D**	STOP TRI	18	HIGH	OPEN when pump is started, & CLOSED when pump is stopped	108	20	19
13	**2SWP*MOV74E**	STOP TRI	18	HIGH	OPEN when pump is started, & CLOSED when pump is stopped	108	20	19
14	**2SWP*MOV74F**	STOP TRI	18	HIGH	OPEN when pump is started, & CLOSED when pump is stopped	108	20	19
15	**2SWP*MOV94A**	GATE	8	HIGH	OPEN when diesel generator started, and CLOSE when stopped	108	80	74
16	**2SWP*MOV94B**	GATE	8	HIGH	OPEN when diesel generator started, and CLOSE when stopped	108	80	74

LEGEND:

MEDP: Maximum Expected Differential Pressure

All Valves which are in bold print have been statically tested with VOTES diagnostic equipment.