Project: Nine Mile Point Nuclear Station Unit: 2 Disposition —

Originator / Date	Checker / Date	Calc. No.	Rev.
SJP 6/15/95	HEB / 6-19-95	A10.1-AD-003	0

1.0 PURPOSE/SCOPE:

The purpose of this calculation is to assess the capability of various motor operated gate valves to open against pressure locking conditions as described in NUREG 1275.

The scope of this calculation is restricted to only nine (9) MOVs that are requested by NRC during Phase II audit of GL 89-10 program.

2.0 METHOD:

1. For all MOVs that are susceptible to the pressure locking condition, the most limiting pressure locking conditions will be identified.

2. Using equation shown below, the thrust required to open the valve under pressure locking condition will be determined.

3. The motor output torque/thrust capability is determined under the most limiting of structural and/or voltage conditions.

4. The calculated required thrust is then compared to the actuator capability.

The following equation will be used to calculate the required thrust to open the valve under the pressure locking condition:

$$THreq = Ao\,(Vf)\,(2P3 - P1 - P2) + O9$$

Where,

THreq = Required thrust to open the valve (lbs)
Ao = Area over which bonnet pressure acts (sq inches)
Vf = Valve factor
P3 = Bonnet Pressure (psig)
P1 = Valve upstream pressure (psig)
P2 = Valve downstream pressure (psig)
O9 = Actual disk pullout thrust from VOTES test (lbs)

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The first term of the equation accounts for the frictional resistance due to the differential pressure acting normally across each disk under pressure locking condition.

The second term of the equation is the actual disk pullout thrust obtained fron the VOTES test.

This equation was developed by the NMP2 GL 89-10 engineering team and reviewed with the NRC inspectors during the phase II audit of the GL 89-10 program. It simply considers the differential pressure against the valve disk and the bonnet pressure as forces that must be overcome in addition to the unwedging force resulting from the closing stroke. This equation is conservative as it assumes no deflection of the disks. It is considered appropriate as an upper bounding determination for justifying operability.

3.0 REFERENCES:

1. See individual valve calculation sheets attached to this calculation.

2. NUREG-1275, Vol. 9, Operating Experience Feedback Report - Pressure Locking and Thermal Binding of Gate Valves.

4.0 CONCLUSION:

See individual valve calculation sheets attached to this calculation.

5.0 CALCULATION:

The scope of this calculation includes the following MOVs:

2CSH*MOV105	2ICS*MOV126	2RHS*MOV15A
2CSH*MOV107	2ICS*MOV136	2RHS*MOV15B
2CSH*MOV118		2RHS*MOV25A
		2RHS*MOV25B

For each MOVs, the pressure locking calculation will be done for two separate events, the first event will be the "non-credible" event and the second event will be the "credible" event as described below:

A. **Non-credible Event:** This assumes that the valve is 100% leak tight, no leakage exists from the bonnet thru the disks or the packing. It also assumes that the rate of bonnet fluid temperature increase and therefore the pressure increase is very fast. No credit is taken for insulation, if any, on the valve or piping.

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In this case, the bonnet pressure will be calculated using the method identified in Reference 2, i.e. pressure rise due to temperature increase is 33 psi per deg. F.

B. **Credible Event:** This event takes credit for valve leakage measured periodically during Type C or other testing requirements. The bonnet fluid temperature rise and as such the pressure rise is considered to be slower than the valve leakage rate. This is based on the fact that all but three MOVs included in this calculation are insulated. MOVs that are not insulated are connected to the suppression pool. The bonnet temperature increase due to the suppression pool water temperature is also considered too slow to cause pressurization of the bonnet. For these reasons this event is considered more realistic than described in item A, above.

In this case, the bonnet pressure will be assumed to be the same as the maximum piping pressure.

Basis for Above Events:

The non-credible event is derived from literal interpretation of reference 2 information. The critical nature of this event is that the valve is 100% leak tight and that the valve bonnet pressure would be able to increase due to ambient temperature changes. As evidenced by Attachment A (page A5), these valve are not leak tight. Therefore, the assumption of 100% leak tightness is not considered realistic or credible. Therefore, the credible pressure locking scenario is that the valve bonnet is pressurized from the higher pressure side of the valve disk and required to operate against that pressure in the bonnet.

See following pages for calculations.

NIAGARA MOHAWK POWER CORPORATION
Nine Mile Point Nuclear Station Unit 2
Originator: SLP. Date: 6/15/95
Checker: [illegible] Date: 6-19-95

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Disposition: NA
Calc No.: A10.1-AD-003, R-0

PRESSURE LOCKING CALCULATION FOR: 2CSH*MOV107 (NON CREDIBLE EVENT)

				REF's/NOTES
Seat Outside Diameter	OD	=	12.19 in.	1
Seat Inside Diameter	ID	=	9.5 in.	1
Hub Diameter	HD	=	4 in.	1
Mean Seat Dia = (OD-ID)/2+ID	MSD	=	10.845 in.	Calculated
Seat Pressure Area = PI(MSD^2-HD^2)/4	Ap	=	79.7670096 sq in.	Calculated
Valve Upstream Pressure	P1	=	0 psig	2
Valve Downstream Pressure	P2	=	1035 psig	3
Bonnet Fluid Temp	T1	=	79.5 deg F	4
Maximum Normal Environmental Temp	T2	=	104 deg F	5
Delta Temp = T2-T1	DT	=	24.5 deg F	Calculated
Valve Bonnet Pressure = (Max of P1 or P2)+(DT*33psi/F)	P3	=	1843.5 psig	Calculated
Unwedging Thrust (VOTES - O9)	O9	=	54639 lbs	6
Valve Factor (from DT test, if available)	Vf	=	0.35	7
Total Required Thrust= Ap*Vf(2*P3-P2-P1)+O9	THreq	=	128678.738 lbs	Calculated

ACTUATOR CAPABILITY:

Actuator Model/Size		=	SB-3-150	8
Motor torque output	TQm	=	146.18 ft-lbs	8
Gear Ratio	OGR	=	50.02	8
Application Factor	Af	=	0.9	8
Run Efficient	Eff	=	0.6	9
Torque Output	TQout	=	3948.43874 ft-lbs	Calculated
Stem Factor	Sf	=	0.02786	10
Thrust Capability	THcap	=	141724.291 lbs	Calculated

REFERENCES / NOTES:

1. Anchor/Darling Telecon (Attachment A, Pg A1)
2. P1 is assumed to be zero psig since the pump is not up to the full speed at the system initiation signal which also signals the subject valve to open.
3. Pressure Locking scenario assumes that the downstream RPV pressure pressurizes the bonnet. The downstream pressure, P2 = 1035 psig, Normal operating RPV pressure.
4. The bonnet fluid is assumed to be from the CST which was at 79.5 deg F on 6/6/95 (Pyrometer reading).
5. Maximum normal environmental temperature for zone SC289155 from EQEDC.
6. DP test traces, spring displacement corellation open to close (Attachment A, Pg A2).
7. DP test calculation No. A10.1-G-044, Rev. 0.
8. MOV sizing calculation No. A10.1-G-034, Rev.4.
9. Limitorque Manual, NMPC File No. N2L20000VALVE003, Rev. 0., and EPRI Application Guide for MOVs, Doc. no. NP-6660-D, Section 3.3.3.
10. Apparent stem factor during close seat sliding (C10+, Attachment A, Pg A3 & A4).

CONCLUSION:

Liquid entrapment can occur if the dual valve disks and valve packing provide a 100% seal. This is not credible due to the slow ambient temperature increase and the measured leakeage across the valve. This mechanism does not provide sufficient DP to seal the valve or energize the packing. This a conservative calculation of operator capability. No credit has been taken for motor inertia or the stall capability . During valve opening, torque switch is bypassed through most of the valve travel. Generic motor curve for this motor indicates approximately 165 ft-lbs of torque is available at stall conditions. Measured leakage of this valve of 0.1 gpm (Attachment A, Pg A5) provides reasonable assurance that adequate bonnet venting exists such that liquid entrapment and subsequent pressure locking is not an operability concern with the valve in its present condition.

PRESSURE LOCKING CALCULATION FOR: 2CSH*MOV107 (CREDIBLE EVENT)

					REF's/NOTES
Seat Outside Diameter	OD	=	12.19	in.	1
Seat Inside Diameter	ID	=	9.5	in.	1
Hub Diameter	HD	=	4	in.	1
Mean Seat Dia = (OD-ID)/2+ID	MSD	=	10.845	in.	Calculated
Seat Pressure Area = PI(MSD^2-HD^2)/4	Ap	=	79.7670096	sq in.	Calculated
Valve Upstream Pressure	P1	=	0	psig	2
Valve Downstream Pressure	P2	=	1035	psig	3
Bonnet Fluid Temp	T1	=	79.5	deg F	4
Maximum Normal Environmental Temp	T2	=	104	deg F	5
Delta Temp = T2-T1	DT	=	24.5	deg F	Calculated
Valve Bonnet Pressure = (Max of P1 or P2)	P3	=	1035	psig	Calculated
Unwedging Thrust (VOTES - O9)	O9	=	54639	lbs	6
Valve Factor (from DT test, if available)	Vf	=	0.35		7
Total Required Thrust= Ap*Vf(2*P3-P2-P1)+O9	THreq	=	83534.5992	lbs	Calculated

ACTUATOR CAPABILITY:

Actuator Model/Size		=	SB-3-150		8
Motor torque output	TQm	=	146.18	ft-lbs	8
Gear Ratio	OGR	=	50.02		8
Application Factor	Af	=	0.9		8
Run Efficient	Eff	=	0.6		9
Torque Output	TQout	=	3948.43874	ft-lbs	Calculated
Stem Factor	Sf	=	0.02786		10
Thrust Capability	THcap	=	141724.291	lbs	Calculated

REFERENCES / NOTES:

1. Anchor/Darling Telecon (Attachment A, Pg A1)
2. P1 is assumed to be zero psig since the pump is not up to the full speed at the system initiation signal which also signals the subject valve to open.
3. Pressure Locking scenario assumes that the downstream RPV pressure pressurizes the bonnet. The downstream pressure, P2 = 1035 psig, Normal operating RPV pressure.
4. The bonnet fluid is assumed to be from the CST which was at 79.5 deg F on 6/6/95 (Pyrometer reading).
5. Maximum normal environmental temperature for zone SC289155 from EQEDC.
6. DP test traces, spring displacement corellation open to close (Attachment A, Pg A2).
7. DP test calculation No. A10.1-G-044, Rev. 0.
8. MOV sizing calculation No. A10.1-G-034, Rev.4.
9. Limitorque Manual, NMPC File No. N2L20000VALVE003, Rev. 0., and EPRI Application Guide for MOVs, Doc. no. NP-6660-D, Section 3.3.3.
10. Apparent stem factor during close seat sliding (C10+, Attachment A, Pg A3 & A4).

CONCLUSION:

Per above calculation, the actuator capability is sufficient to overcome the postuated pressure locking scenario.

NIAGARA MOHAWK POWER CORPORATION
Nine Mile Point Nuclear Station Unit 2
Originator: SJP Date 6/15/95
Checker: RCB Date: 6-19-95

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Disposition: N/A
Calc No.: A10.1-AD-003; Rev. 0

PRESSURE LOCKING CALCULATION FOR: 2ICS*MOV126 (NON CREDIBLE EVENT)

				REF's/NOTES
Seat Outside Diameter	OD	=	6 in.	1
Seat Inside Diameter	ID	=	5.1875 in.	1
Hub Diameter	HD	=	3 in.	1
Mean Seat Dia = (OD-ID)/2+ID	MSD	=	5.59375 in.	Calculated
Seat Pressure Area = PI(MSD^2-HD^2)/4	Ap	=	17.4976807 sq in.	Calculated
Valve Upstream Pressure	P1	=	0 psig	2
Valve Downstream Pressure	P2	=	1035 psig	3
Bonnet Fluid Temp	T1	=	79.5 deg F	4
Maximum Normal Environmental Temp	T2	=	104 deg F	5
Delta Temp = T2-T1	DT	=	24.5 deg F	Calculated
Valve Bonnet Pressure = (Max of P1 or P2)+(DT*33psi/F)	P3	=	1843.5 psig	Calculated, 10
Unwedging Thrust (VOTES - O9) .	O9	=	12963 lbs	6
Valve Factor (from DT test, if available)	Vf	=	0.5	7
Total Required Thrust= Ap*Vf(2*P3-P2-P1)+O9	THreq	=	36164.9246 lbs	Calculated

ACTUATOR CAPABILITY:

Actuator Model/Size		=	SMB-0-40	7
Motor torque output (Reduced)	TQm	=	39 ft-lbs	7
Gear Ratio	OGR	=	39.11	7
Application Factor	Af	=	1	7
Run Efficient	Eff	=	0.55	8
Reduced Voltage	RV	=	0.8586	7
Torque Output	TQout	=	720.287697 ft-lbs	Calculated
Stem Factor	Sf	=	0.0173856	9
Thrust Capability	THcap	=	41430.1316 lbs	Calculated

REFERENCES / NOTES:

1 Velan Fax(Attachment A, Pg A7)
2 P1 is assumed to be zero since the pump is not up to the full speed at the system initiation signal which also signals the subject valve to open.
3 Pressure Locking scenario assumes that the downstream RPV pressure pressurizes the bonnet. The downstream presure, P2 = 1035 psig, Normal Operating RPV pressure.
4 CST water temperature, pyrometer reading (6/6/95).
5 Maximum normal environmental temperature for zone SC289155.
6 Spring displacement correlation open to close Test #11 dated 5/6/95 (Attachment A, Pg A16 & A17).
7 MOV sizing calculation No. A10.1-H-035, Rev.3.
8 Limitorque Manual, NMPC File No. N2L20000VALVE003, Rev. 0., and EPRI Application Guide for MOVs Doc. no. NP-6660-D.
9 Conservative Stem COF of 0.15 applied from ref. 7, although 5/4/95 As-Left test indicated a stem COF of 0.09.
10 Pressure rise due to temperature increase is 33 psi/degree F, NUREG-1275, Vol. 9

CONCLUSION:

Liquid entrapment can occur if the dual valve disks and valve packing provide a 100% seal. This evaluation takes no credit for leakeage across the valve disks. This a conservative calculation of operator capability. No credit has been taken for motor inertia or the stall capability . During valve opening, torque switch is bypassed through most of the valve travel. The generic motor curve for this motor indicates approximately 62.5 ft-lbs of torque is available at stall conditions for which no credit is taken. Measured leakage for this valve of 1.9090 scfh (Attachment A, Pg A5) provides reasonable assurance that adequate bonnet venting exists such that liquid entrapment and subsequent pressure locking is not anticipated. However, this evaluation verifies the valve will open even against the worst case pressure locking conditions; and, adequate margin exists for the pressure locking scenario given.

PRESSURE LOCKING CALCULATION FOR: 2ICS*MOV126 (CREDIBLE EVENT)

				REF's/NOTES
Seat Outside Diameter	OD	=	6 in.	1
Seat Inside Diameter	ID	=	5.1875 in.	1
Hub Diameter	HD	=	3 in.	1
Mean Seat Dia = (OD-ID)/2+ID	MSD	=	5.59375 in.	Calculated
Seat Pressure Area = PI(MSD^2-HD^2)/4	Ap	=	17.4976807 sq in.	Calculated
Valve Upstream Pressure	P1	=	0 psig	2
Valve Downstream Pressure	P2	=	1035 psig	3
Bonnet Fluid Temp	T1	=	79.5 deg F	4
Maximum Normal Environmental Temp	T2	=	104 deg F	5
Delta Temp = T2-T1	DT	=	24.5 deg F	Calculated
Valve Bonnet Pressure = (Max of P1 or P2)	P3	=	1035 psig	Calculated
Unwedging Thrust (VOTES - O9)	O9	=	12963 lbs	6
Valve Factor (from DT test, if available)	Vf	=	0.5	7
Total Required Thrust= Ap*Vf(2*P3-P2-P1)+O9	THreq	=	22018.0497 lbs	Calculated

ACTUATOR CAPABILITY:

Actuator Model/Size		=	SMB-0-40	7
Motor torque output (Reduced)	TQm	=	39 ft-lbs	7
Gear Ratio	OGR	=	39.11	7
Application Factor	Af	=	1	7
Run Efficient	Eff	=	0.55	8
Reduced Voltage	RV	=	0.8586	7
Torque Output	TQout	=	720.287697 ft-lbs	Calculated
Stem Factor	Sf	=	0.0173856	9
Thrust Capability	THcap	=	41430.1316 lbs	Calculated

REFERENCES / NOTES:

1 Velan Fax(Attachment A, Pg A7)
2 P1 is assumed to be zero since the pump is not up to the full speed at the system initiation signal which also signals the subject valve to open.
3 Pressure Locking scenario assumes that the downstream RPV pressure pressurizes the bonnet. The downstream presure, P2 = 1035 psig, Normal Operating RPV pressure.
4 CST water temperature, pyrometer reading (6/6/95).
5 Maximum normal environmental temperature for zone SC289155.
6 Spring displacement correlation open to close Test #11 dated 5/6/95 (Attachment A, Pg A16 & A17).
7 MOV sizing calculation No. A10.1-H-035, Rev.3.
8 Limitorque Manual, NMPC File No. N2L20000VALVE003, Rev. 0., and EPRI Application Guide for MOVs, Doc. no. NP-6660-D.
9 Conservative Stem COF of 0.15 applied from ref. 7, although 5/4/95 As-Left test indicated a stem COF of 0.09.

CONCLUSION:

Per above calculation, the actuator capability is sufficient to overcome the postuated pressure locking scenario.