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SUBJECT: Forwards suppl response to GL 95-07, "Pressure Locking & Thermal Binding of SR Power-Operated Gate Valves." Partial calculation rept encl.

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W. R. McCollum, Jr.
Vice President

August 21, 1997

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Subject: Oconee Nuclear Station
Docket Nos. 50-269, 50-270, 50-287
Supplemental Response to Generic Letter 95-07: Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves

Generic Letter (GL) 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves", was issued on August 17, 1995. GL 95-07 requested licensees to determine if safety-related power-operated gate valves are susceptible to pressure locking and thermal binding phenomena which could lead to inoperability of the valves. Duke Energy Corporation (Duke) responded to GL 95-07 in submittals to the NRC dated October 16, 1995, November 15, 1995, January 6, 1996, February 13, 1996, and July 18, 1996. In an NRC letter dated June 23, 1997, the staff requested additional information regarding GL 95-07. Please find the response to the staff's questions in Attachment 1.

Please address any questions to D. A. Nix at (864) 885-3634.

Very truly yours,

M.K.Nolan for WRM

W. R. McCollum, Jr.
Site Vice President

A056

030072
Attachments

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ATTACHMENT 1

Response to NRC questions related to Generic Letter 95-07

Question 1:

The February 13 and July 18, 1996 submittals stated that pressure locking and thermal binding long-term corrective actions would be fully implemented in Unit 1 by end-of-cycle (EOC) 17 refueling outage scheduled for May, 1997, in Unit 2 by EOC 16 refueling outage scheduled for October 1997, and in Unit 3 by EOC 16 refueling outage scheduled for December 1996. Confirm that the corrective actions have been completed or will be completed as scheduled.

Answer:

The long term GL 95-07 motor operated gate valve corrective actions from previous GL 95-07 correspondence are provided in the following table. In addition, the table contains new corrective actions which are committed to in this submittal. These new commitments are denoted by an asterisk (*).

Valve Tag Number	Description	Status
1CCW-269	will be replaced with globe valve during the EOC-17 refueling outage (RFO)	Planned
2CCW-269	has already been replaced with a globe valve by minor modification OE-6771	Complete
3CCW-269	has already been replaced with a globe valve by minor modification OE-7215	Complete
1CCW-287*	will receive a bonnet relief modification during the EOC-17 RFO	Planned
2CCW-287*	will receive a bonnet relief modification during the EOC-16 RFO	Planned
3CCW-287*	will receive a bonnet relief modification during the EOC-17 RFO	Planned
1FDW-347	will be replaced with globe valve during the EOC-17 RFO	Planned
2FDW-347	has already been replaced with a globe valve by minor modification OE-6770	Complete
3FDW-347	has already been replaced with a globe valve by minor modification OE-7085	Complete
1HP-409	has already been replaced with a globe valve by minor modification OE-7328	Complete
2HP-409	has already been replaced with a globe valve by minor modification OE-8318	Complete

Valve Tag Number	Description	Status
3HP-409	has already been replaced with a globe valve by minor modification OE-7088	Complete
1HP-410	has already been replaced with a globe valve by minor modification OE-7329	Complete
2HP-410	has already been replaced with a globe valve by minor modification OE-8319	Complete
3HP-410	has already been replaced with a globe valve by minor modification OE-7089	Complete
1HP-428*	will receive a bonnet relief modification during the EOC-17 RFO	Planned
2HP-428*	will receive a bonnet relief modification during the EOC-16 RFO	Planned
3HP-428*	will receive a bonnet relief modification during the EOC-17 RFO	Planned
1LP-001	upstream wedge has been provided with a relief hole by major modification NSM 12454	Complete
2LP-001	upstream wedge has been provided with a relief hole by major modification NSM 22454	Complete
3LP-001	upstream wedge has been provided with a relief hole by major modification NSM 32454	Complete
1LP-002	Bonnet relief line was provided by minor modification OE-9133	Complete
2LP-002	Bonnet relief line was provided by minor modification OE-8912	Complete
3LP-002	Bonnet relief line was provided by minor modification OE-9067	Complete
2LP-003	Control Logic has been changed to limit seating to limit closing forces, see response to question 3 to address additional pressure locking	Complete
1LP-015	PT/1/A/0152/012 will be revised to alleviate TB concerns during the EOC-17 RFO	In progress
2LP-015	PT/2/A/0152/012 was revised to alleviate TB concerns	Complete
3LP-015	PT/3/A/0152/012 was revised to alleviate TB concerns	Complete
1LP-016	PT/1/A/0152/012 will be revised to alleviate TB concerns during the EOC-17 RFO	In progress
2LP-016	PT/2/A/0152/012 was revised to alleviate TB concerns	Complete

Valve Tag Number	Description	Status
3LP-016	PT/3/A/0152/012 was revised to alleviate TB concerns	Complete
1LP-017*	will receive a bonnet relief modification during the EOC-17 RFO	Planned
1LP-017	PT/1/0150/015E was revised to alleviate TB concerns	Complete
1LP-017*	completely replace with globe valve to eliminate PLTB concerns during the EOC-18 RFO	Planned
2LP-017*	will receive a bonnet relief modification during the EOC-16 RFO	Planned
2LP-017	PT/2/0150/015E is being revised to alleviate TB concerns prior to next cold shutdown	In progress
2LP-017*	completely replace with globe valve to eliminate PLTB concerns during the EOC-17 RFO	Planned
3LP-017*	bonnet relief line has been provided by minor modification OE-9315	Complete
1LP-018	PT/1/0150/015E will be revised to alleviate TB concerns prior to next cold shutdown	In Progress
1LP-018*	will receive a bonnet relief modification during the EOC-17 RFO	Planned
1LP-018*	completely replace with globe valve to eliminate PLTB concerns during the EOC-18 RFO	Planned
2LP-018	PT/2/0150/015E will be revised to alleviate TB concerns during the EOC-16 RFO	Planned
2LP-018*	will receive a bonnet relief modification during the EOC-16 RFO	Planned
2LP-018*	replaced with globe valve to eliminate PLTB concerns	Complete
3LP-018	bonnet relief line has been provided by minor modification OE-9316.	Complete

Valve Tag Number	Description	Status
1LP-103	upstream bridge wall has been provided with a relief hole by minor modification OE-8621	Complete
1LP-104	upstream bridge wall has been provided with a relief hole by minor modification OE-8620	Complete
1LP-105	upstream bridge wall has been provided with a relief hole by minor modification OE-8627	Complete
2LP-103	will receive a bonnet relief modification during the EOC-16 RFO	Planned
2LP-104	will receive a bonnet relief modification during the EOC-16 RFO	Planned
3LP-103	bonnet relief line has been provided by minor modification OE-9317	Complete
3LP-104	bonnet relief line has been provided by minor modification OE-9318	Complete
3LPSW-566	replaced with ball valve by minor modification OE-8873	Complete
1SF-082*	will receive a bonnet relief modification during the EOC-17 RFO	Planned
2SF-082*	will receive a bonnet relief modification during the EOC-16 RFO	Planned
3SF-082*	will receive a bonnet relief modification during the EOC-17 RFO	Planned
1SF-097*	will receive a bonnet relief modification during the EOC-17 RFO	Planned
2SF-097*	will receive a bonnet relief modification during the EOC-16 RFO	Planned
3SF-097*	will receive a bonnet relief modification during the EOC-17 RFO	Planned

The start dates for the outages in this table are different than the start dates shown in the February 13, 1996, response due to the unplanned outages on all three Oconee units during the past year. The revised start dates for the associated end of cycle (EOC) refueling outages are provided in the following list.

Refueling Outage	Tentative Start Date
Unit 1 EOC-17	9/18/97
Unit 2 EOC-16	3/15/98
Unit 3 EOC-17	8/30/98

Eighteen valves have been added to the schedule for bonnet relief modifications that were not shown on the February 13, 1997, response. These additional valves are 1,2,3 CCW-287; 1,2,3 HP-428; 1,2,3 LP-17; 1,2,3 LP-18; 1,2,3 SF-82; and 1,2,3 SF-97. Although there is available margin in the sizing calculations, physical modifications will alleviate all pressure locking concerns.

Question 2:
The February 13 submittal stated that valves 1, 2, LP-017, 018 (Unit 1 and 2 low pressure injection A and B isolation valves), are susceptible to thermal binding, and that procedures would be modified to periodically cycle the valves or a detailed thermal binding analysis would be performed as a long-term corrective action. Describe the corrective action that was implemented to resolve the thermal binding concerns. If a thermal binding analysis was performed, provide a description of the methodology used and the results of your analysis for our review.

Answer:
Valves 1,2 LP-17 & 1,2 LP-18 (Walworth 10" gate valves) have very pronounced openings (small hub to disk diameter ratio) in their flexible wedge designs. These valves also have spring compensated actuators to minimize the wedging force and minimize the effect of stem growth due to additional wedging forces. Procedures PT/1/2/0150/015E, "LP-17 and LP-18 Pressure Verification", were revised to stroke these valves subsequent to inter-system LOCA testing during startup when system temperature would be well under 200 degrees F. A modification is planned to replace these valves for reasons not related to PLTB. The replacement valves will be either globe valves or parallel seated gate valves. The thermal binding concerns will be totally eliminated upon replacement of these valves. These valve replacements are planned to begin on 1EOC-18 in April of 1999.

Question 3:
The February 13 submittal stated that valves 1, 2, 3 LP-1, 2 (low pressure injection return block valves from reactor coolant system) and 2, 3 LP-3 (low pressure injection return block valves from reactor coolant system/secondary boron dilution valves) are not susceptible to thermal binding because operational experience shows that these valves do not thermally bind. Discuss operating experience that demonstrates that these valves do not thermally bind. Discuss operating experience that demonstrates that these valves are not susceptible to thermal binding. Include historical wedging and unwedging forces and any modifications implemented that may have made the valves more susceptible to thermal binding. For example, increasing actuator output thrust causes the disk to wedge more tightly into the seat making the valve more susceptible to thermal binding. Also, please describe any procedure modifications implemented to minimize the potential for thermal binding.

Answer:
Thermal binding can be caused by stem growth, wedge growth, and/or by body contraction as driven by thermal conditions. Thermal binding is most prevalent during transient conditions where one component is heated or cooled faster than its mated component, or where material thermal expansion coefficients differ.

The thermal conditions experienced by these valves during normal operation closely matches the conditions expected during design basis conditions. Since these valves are not opened until 15 hours after a loss of coolant accident (LOCA), a column of dead-headed water is maintained between these valves and the affected flowpath. Therefore, no temperature transients are expected to occur in these valves during the first 15 hours of a LOCA. 1,2,3LP-1, 1,2,3LP-2, and 2,3LP-3 are well insulated up to the valve yoke to limit the effects of rapid temperature transients. Both the wedge and body are constructed of the same material (A351 CF8M) for valves 1,2LP-1; 1,2LP-2 and 2,3LP-3. This design limits the probability that expansion and contraction of these parts would be significantly different at these temperatures (maximum = 250 deg F, minimum = 100 deg F). 3LP-1 and 3LP-2 have valve bodies which are manufactured from F316 ASTM A182 and wedges manufactured from A351 CF8M. These materials have similar heat

transfer coefficients (A351 CF8M = 8.9 min/in deg F., ASTM A182 F316 = 8.8 min/in deg F.). This design also limits the differences of expansion and contraction between the valve body and the valve wedge.

The past successful operating experience in opening these valves has occurred under conditions of higher closing loads. In the future, these valves will be set up with lower closing loads which will provide additional margin to ensure valve opening.

Although the actuators were replaced on 3LP-1 and 3LP-2 to provide these valves with greater opening margin, the required closing thrust has been lowered. All of these valves are normally stroked against the temperature transients that are modeled in the system calculation. During these stroke tests, there have been no recorded failure incidents. These valves are normally operated during unit mode change from power operation to cold shutdown to align the Low Pressure Injection System to the Reactor Coolant System to establish and maintain decay heat removal. Procedures OP/1,2,3/A/1104/04, "Low Pressure Injection System" were revised to cycle 1,2,3LP-2 to relieve pressure and drain some of the water between LP-1 and LP-2 to eliminate the potential for a water solid pipe between LP-1 and LP-2. This procedure change was implemented to eliminate the concerns of pressure locking between LP-1 and LP-2 for GL 96-06, "Assurance of Containment Integrity and Equipment Operability during Design Basis Conditions".

Question 4:

The February 13 submittal stated that the Commonwealth Edison pressure locking prediction methodology was used to demonstrate that valves 1, 2, 3 CCW-287 (safe shutdown facility auxiliary service water discharge valves) would open during a pressure locking condition. Provide 1, 2, 3 CCW-287 pressure locking, actuator capability, and thermal induced pressure calculations for our review.

Answer:

The thermally induced pressure locking (TIPL) concerns revolving around 1,2,3CCW-287 are only applicable to ambient seasonal changes. In an NRC summary on GL 95-07 public workshops dated January 3, 1996, (page 2, item 6), it is stated that the staff believes that slow ambient temperature changes that normally

occur in nuclear power plants would not be a principal concern. Duke realizes that laboratory testing has been able to achieve pressurization rates of 50 psi / °F, with no apparent temperature threshold at which thermal pressurization rates change. Duke believes that these laboratory results are not necessarily representative of actual plant conditions due to the design and orientation of the valves. In addition, the temperature source in the plant would be slow ambient seasonal changes as opposed to an internal heating element used in a laboratory. However, since the validation of the assumptions used in our calculation would be time consuming, Duke has elected to implement the bonnet relief tubing modifications at the next respective refueling outages. Attachment 2 contains the existing calculations for 1,2,3 CCW-287.

Question 5:

The February 13 submittal stated that valves 1, 2, 3 CCW-287 (safe shutdown facility auxiliary service water discharge valves); 1, 2, 3 HP-428 (reactor coolant return from letdown line valves); and 1, 2, 3 SF-97 (reactor coolant return from letdown line valves) are susceptible to thermal induced pressure locking. The submittal stated that below 130°F, a thermal induced pressurization rate of 5 psi/°F was assumed, and between 130°F and 140°F, a 23 psi/°F thermally induced pressurization rate was assumed. Walworth flexible wedge and Anchor Darling double disk gate valve test results obtained from testing sponsored by the NRC, conducted by Idaho National Engineering and Environmental Laboratory (INEEL), identified that thermal pressurization begins when the air that is entrapped in the fluid collapses and that there is not a temperature threshold at which thermal pressurization rates change. The testing conducted by INEEL, identified that for temperatures up to 250 °F, when the air in the fluid collapses, the thermal pressurization rate was 50 psi/°F. These test results have been placed in the NRC's Public Document Room. Explain the basis for your thermal induced pressure assumptions and why your thermal induced pressurization rates are different than the INEEL test results.

Answer:

Question 5 again addresses safe shutdown motor operated valves associated with the Standby Shutdown Facility. Valves 1,2,3CCW-287, 1,2,3HP-428 and 1,2,3 SF-97 are susceptible to

TIPL only as it pertains to seasonal temperature changes. The answer to Question 5 is similar to that for Question 4. It would be difficult to realize the effects of thermally induced pressure locking from a slow seasonal temperature source. Since the time required and difficulty in validating our calculation assumptions exceed that of providing bonnet relief modifications, the modifications will be implemented at the next respective refueling outages for these valves. Our basis for pressurization rates is as stated in program calculation DPC 1205.19-00-0004 in section 10.2.5 sub-section E which was developed based on the Westinghouse Document "Thermally Induced Pressurization Rates In Gate Valves", Document No. V-EC-162 dated 5/1/96. This is a proprietary document that is available on site. All testing referred to in this document has low pressurization rates for gate valves with slow seasonal temperature changes.

Question 6:

The February 13 submittal stated that calculations were used to demonstrate that valves 1, 2, 3 HP-428 (reactor coolant return from letdown valves) are capable of opening under pressure locking conditions. A double disk gate valve pressure locking prediction methodology was used to calculate the thrust required to open the valves during pressure locking conditions. Provide the test procedure/results that validated this pressure locking prediction methodology and the information necessary to evaluate if valves 1, 2, 3 HP-428 are similar to the rest of the valves. Recent pressure locking testing sponsored by the NRC and performed by INEEL indicated that thrust requirements exceeded double disk pressure locking prediction calculation results. The results of this testing have been placed in the NRC's Public Document Room. Discuss if these INEEL pressure locking test results can be used to validate your double disk gate valve pressure locking prediction methodology. Provide 1, 2, 3 HP-428 pressure locking, actuator capability, and thermal induced pressure calculations for our review.

Answer:

Although Duke now plans to perform modifications on these valves to eliminate any possibility of pressure locking, in our February 13 submittal, Oconee Engineering relied upon the best available methodology at the time in performing calculations necessary to verify the possible affects of pressure locking on valve operability. The methodology was

not validated by testing but was based on conservative analysis. For double disc gate valves, a dual seat DP load plus a static unwedging model were used that were similar to our standard GL 89-10 methodology. Additional conservatism was added (use of a 0.6 valve factor and ignoring stem rejection loads), to the methodology due to the lack of available test results. In addition, since the upstream depressurization was only 17%, the overall DP conditions for valves 1,2,3 HP-428 closely simulated a normal GL 89-10 DP condition across primarily one seat face. The original pressure locking, actuator capability, and thermally-induced pressure locking calculations are shown in Attachment 3.

Ongoing pressure-locking evaluations have concluded that valve reliability would be assured by implementing valve modifications to eliminate pressure locking. As a result, Duke has since planned to perform these modifications on valves 1,2,3 HP-428 during the upcoming outages as stated above in Question 1.

However, Duke was interested in using the INEEL test results to review our original methodology. Although the results from INEEL are preliminary in that they lack final conclusions and detailed test descriptions, Duke has used the INEEL Anchor Darling preliminary test results dated January 23, 1997, as a check to ensure our methodology is sound.

When using a 0.6 Valve Factor and neglecting stem rejection loads, our dual seat DP load methodology bounds all of the preliminary test data for the 6-inch Anchor Darling double disc gate valve tested by INEEL.

See Figure 1 for the calculation data and Figure 2 for the comparative graph.

Question 7:

The February 13 submittal stated that valve 2 LP-3 (low pressure injection return from reactor coolant system/secondary boron dilution valve) is susceptible to pressure locking. The submittal stated that the valve would be modified to prevent pressure locking or procedures would be revised to stroke the valve prior to startup to alleviate pressure locking concerns. What corrective action was implemented? If procedures were revised to stroke the valve, explain why the valve bonnet will not be pressurized to

Reactor Coolant System pressure and susceptible to pressure locking when opening the valve to place shutdown cooling in operation.

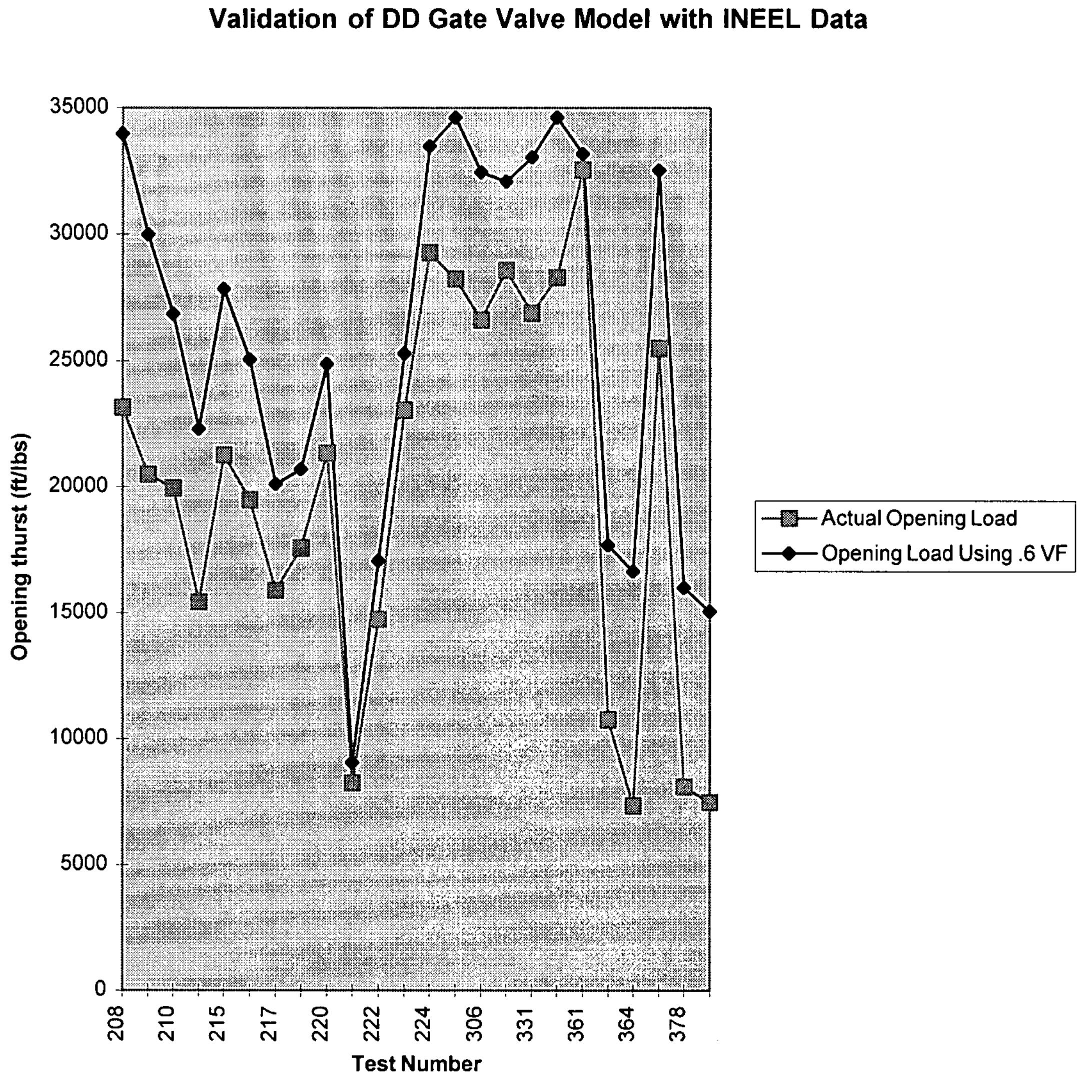
Answer:
An NRC summary on GL 95-07 public workshops was provided in a letter dated January 3, 1996. On page 3 of this letter, Item # 8 states that "gate or globe valves with continuous seating force will minimize the potential for a significant pressure increase between these valves (2LP-1 and 2LP-2) and the valve (2LP-3) being evaluated for pressure locking, provided that the inservice test results and methods to reveal the pressure increase are considered". Both 2LP-1 and 2LP-2 have locking actuator gear sets and are considered to provide continuous seating force. There is no historical evidence that LP-1 or LP-2 have ever leaked at the same time. During RCS heat-up, procedure OP/1,2,3/A/1104/04, "Low Pressure Injection System", requires 1, 2, 3 LP-1 and 1, 2, 3 LP-2 to be closed first. This requirement will limit the DP, pressure, and temperature that 2, 3 LP-3 would be exposed to. A relief valve is provided between LP-2 and LP-3. This relief valve has a setting low enough so that if any significant pressures had occurred between LP-2 and LP-3, then this relief valve would have lifted. There has been no evidence that this relief valve has lifted.

The actuator gear ratio was changed to provide greater opening force while the control logic was changed to position seating to limit the closing force. This change provides 2LP-3 with greater opening margin. Duke does not believe it is prudent to perform a bonnet relief modification to 2LP-3. Valves 2LP-1 and 2LP-2 were modified with a relief hole and a bonnet relief line, respectively. Since 2LP-3 is the first valve in the auxiliary building, adding a relief path to the bonnet of 2LP-3 could create an undesirable leakage path. The risks associated with potential bonnet pressurization of 2LP-3 due to PLTB are much lower than the risks associated with downstream seat integrity of 2LP-3 if 2LP-1 and 2LP-2 leaked past. If LP-1 and LP-2 did leak, then the relief valve would activate and the leak would be limited to inside the containment building.

FIGURE 1

PL TEST #	Pu	Pb	Pd	Pb-Pu	Pb-Pd	Static Load	Opening Loads	
							Actual	**VF of 0.6**
205	-4	231	-5	265	266	2945	6626	10559
206	-4	496	-4	500	500	2945	12588	17285
207	-4	775	-5	779	780	2945	18128	25301
208	-4	1077	-5	1081	1082	2945	23165	33962
209	-4	1085	298	1089	787	2945	20490	29974
210	-4	1119	592	1123	527	2945	19952	26856
211	-3	1100	878	1103	222	2945	15429	22316
215	307	1024	-4	717	1028	2945	21276	27838
216	609	1082	-4	473	1086	2945	19487	25044
217	927	1073	-5	146	1078	2945	15891	20106
219	606	1071	288	465	783	2945	17579	20708
220	307	1066	296	759	770	2945	21356	24866
221	-4	208	-5	212	213	2945	8248	9039
222	-4	488	-5	492	493	2945	14739	17069
223	-4	774	-5	778	779	2945	23069	25272
224	-4	1021	-5	1025	1026	4066	29277	33477
229	0	1006	-1	1006	1007	5743	28258	34609
306	49	1046	-6	997	1052	3077	26627	32437
318	48	1025	-4	977	1029	3330	28596	32074
331	52	1065	-4	1013	1069	3213	26877	33045
344	47	1105	-4	1058	1109	3555	28301	34608
361	61	1096	-3	1035	1099	2597	32540	33172
363	1124	1127	46	3	1081	2597	10765	17689
364	139	1083	1075	944	8	2597	7348	16642
375	53	1105	2	1052	1103	1626	25479	32507
378	1090	1093	64	3	1029	1626	8078	15994
379	66	969	962	903	7	1626	7459	15052
404	-4	1028	-5	1032	1033	1633	15371	31245
405	-4	1094	-4	1098	1098	1633	18803	33124
406	-4	1062	-5	1066	1067	1633	17774	32220

FIGURE 2



Validation of DD Gate Valve Model with INEEL Data
35000
30000
25000
20000
15000
10000
5000
0
Opening thurst (ft/lbs)
208
210
215
217
220
222
224
306
331
361
364
378
Test Number
Actual Opening Load
Opening Load Using .6 VF

ATTACHMENT 2

Calculation OSC-6072, Pages pertaining to 1,2,3 CCW-287

Calculation Number: OSC-6072 Revision 0
February 12, 1996
Initials: UDK

1CCW-287 Page 1 of 4

Valve Information

Function	SSF Aux Ser Water Disch
Manufacturer	Borg Warner
Item Number	6J-251
Drawing No.	OM 245-1319
Press Class	1500
Size	6.00
Disc Type	Flex
Mean Seat Diam	5.625
Disc Diam	6.25
Hub Diam	3
Hub Length	1
Disk Thickness	1.875
Wedge Angle	4
Stem Diam	1.75
Bonnet Vent	No
Body Material	SA 105
Wedge Material	SA351 CF8M
BB or PS	PS

PLTB System Calc Inputs

(A) Highest System Temp during closing	120
(B) Lowest System Temp since closing	60
(C) Highest Press on either side since closure	1060.5
(D) Lowest Press for opening on same side as (C) above	0
(E) Lowest Press For opening on opposite side as (C) above on either side since closure	0
(F) Lowest System Temp when closed	60
(G) Highest System Temp when opened	120
(H) Highest Ambient Temp when opened	120

Actuator Information

Type	EMO
Manufacturer	Rotork
Model No.	30NA1/57
Compensator	No
RPM	57
Torque Rating	660
Gear Ratio	N/A
Unit Effic.	N/A

System Information

GL 89-10	Yes
Flow Diagram	OFD-133A-2.5
Coordinates	H13
Normal Position	
Safety Position	Close/Open
Req'd To Open	Y
Dp To close	1100
Dp To Open	1440
Dwnstrm Press	0

Thermal Binding Review

Is this valve a double disc or parallel seated designed gate valve ?	No	
The temperature differential is________ / The max temp during closing is_______.	60	120
Is the maximum temperature during closing 200 F. or less ?	Yes	
Is wedge design flex and temp differential 100 F or less / or solid and temp differential 50 F or less ?	Yes	
Is this valve furnished with a spring compensated actuator ?	No	
Is the body and wedge constructed of the same material ?	No	

1CCW-287 has been determined to be susceptable to thermal binding? Yes / No **No**

Hydraulically Induced Pressure Locking

Does this valve have a wedge design that is susceptable to pressure locking ?	Yes
Has a bonnet vent been added or has the seat or bridge wall been tapped to relieve pressure?	No

1CCW-287 has been determined to be susceptable to hydraulically induced pressure locking? Y/N **Yes**

If this valve is susceptable, see page 2 for sizing equation?

Thermally Induced Pressure Locking

Does this valve have a wedge design that is susceptable to pressure locking ?	YES
Is valve bonnet designed such that air will be entrapped ? (For interim operation only)	Yes
Has a bonnet vent been added or has the seat or bridge wall been tapped to relieve pressure?	No

1CCW-287 has been determined to be susceptable to thermally induced pressure locking? Y/N **No**

Calculation Number: OSC-6072 Revision 0
February 12, 1996
Initials: DDK

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Calculation Inputs

HIPL Bonnet Press(PSIG)	Pb_1	1061	Hub Length (in)	L	1
TIPL Bonnet Press(PSIG)	Pb_2	300	Seat Angle (deg)	theta	4
Bonnet Press (PSIG)	Pb	1,361	Stem Diam (in)	Dstem	1.75
Upstream Press (PSIG)	Pu	0	Poisson's Ratio	v	0.3
Dwnstrm Press (PSIG)	Pd	0	Modulus of Elasticity	E	2.76E+07
Disk Thickness (in)	t	1.875	Static Unwedging Thrust	_O9	13,248 lbs
Mean Seat Diam (in)	dm	5.625	Unwedging Uncertainty	O9unc	9%
Seat Radius (in)	a	2.8125	Static Unwedging Thrust	Fpo	14,462 lbs
Valve Hub Radius (in)	b	1.5	Valve Factor	VF	0.6
Stem Factor	SF	0.0139	Torque Rating	Trq	660 lbs
High Temp Factor	TF	0	Gear Ratio	OAGR	N/A
Spring Pack	Spack	N/A	Pullout Effic.	PE	N/A
Valve Struct.	Vstruct	38,172 lbs	Voltage Avail.	Volt	89%
Actuat. Struct	Astruct	50,000 lbs			

PRESSURE LOCKING CALCULATION

Coefficient Of Friction Between Disk & Seat Rings

mu=VF*(COS(theta*PI()/180))/(1-(VF*SIN(theta*PI()/180))) mu= 0.624683877

Average Dp across disks

DPavg=Pb-((Pu+Pd)/2) DPavg= 1360.5

Disk Stiffness Constants

D=(E*t^3)/(12*(1-v^2)) D= 16660585.51

G=E/(2*(1+v)) G= 10615384.62

Geometric Influences

C2=0.25*(1-(b/a)^2*(1+2*LN(a/b))) _C2= 0.089486768

C3=b/(4*a)*(((b/a)^2+1)*LN(a/b)+(b/a)^2-1) _C3= 0.012247646

C8=0.5*(1+v+(1-v)*(b/a)^2) _C8= 0.749555556

C9=(b/a)*(((1+v)/2)*LN(a/b)+(((1-v)/4)*(1-(b/a)^2))) _C9= 0.284702854

L11=(1/64)*((1+4*(b/a)^2)-(5*(b/a)^4)-((4*(b/a)^2)*(2+(b/a)^2)*LN(a/b))) _L11= 0.001552518

L17=0.25*(1-((1-v)/4)*(1-(b/a)^4)-((b/a)^2*(1+((1+v)*LN(a/b))))) _L17= 0.080567264

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Moment

Mrb=(-DPavg*a^2/_C8)*((_C9/(2*a*b))*(a^2-b^2)-_L17)	Mrb= -1585.37157
Qb=(DPavg/(2*b))*(a^2-b^2)	Qb= 2566.880859

Deflection Due to pressure and bending

Ybq=((Mrb*a^2*_C2)/D)+((Qb*a^3*_C3)/D)-((DPavg*a^4*_L11)/D)	Ybq= -3.33096E-05

Deflection due to pressure and shear stress

Ksa=(-0.3*(2*LN(a/b)-1+(b/a)^2)	Ksa= -0.162499
Ysq=(Ksa*DPavg*a^2)/(t*G)	Ysq= -8.78610E-05

Deflection due to hub stretch

P force=PI()*(a^2-b^2)*DPavg	Pforce= 24192.28215
Ystretch=(Pforce/(PI()*b^2))*L/(2*E)	Ystretch= 6.20020E-05

Deflection due to pressure forces

Yq=Ybq+Ysq-Ystretch	Yq= -1.83173E-04

Deflection due to seat contact force and shear stress

Ysw=-(1.2*(a/a)*LN(a/b)*a)/(t*G)	Ysw= -1.06590E-07

Deflection due to seat contact force and bending

Ybw=-(a^3/D)*((_C2/_C8)*((a*_C9/b))-((a/b)*_C3))	Ybw= -5.44363E-08

Deflection due to hub compression

Ycompr=(2*a*PI()/(PI()*b^2))*(L/(2*E))	Ycompr= 4.52899E-08

Total deflection due to seat contact force

Yw=Ybw+Ysw-Ycompr	Yw= -2.1E-07

Seat contact force to create

Fs=2*PI()*a*Yq/Yw	Fs= 15689.14

Unseating forces

Fpiston=(PI()/4)*(Dstem^2*Pb)	Fpiston= 3272.39
Fvert=(PI()*a^2)*SIN(theta*PI()/180)*(2*Pb-Pu-Pd)	Fvert= 4716.81
Fpreslock=2*Fs*(mu*COS(theta*PI()/180)-SIN(theta*PI()/180))	Fpreslock= 17364.9

Calculation Number: OSC-6072 Revision 0
February 12, 1996
Initials: [handwritten initials]

Required Total Force

Ftotal=-Fpiston+Fvert+Fpreslock+Fpo **Ftotal= 33,271 lbs**

Undervoltage Thrust Available

Tuv = (Start Motor Torque)(Overall Gear Ratio)(Pullout Efficiency)(Undervoltage)^2
Tuv = 523 ft lbs
Tuv_{tf} = Tuv* (1-HighTemp Factor)
Tuv_{tf} = 523 ft lbs
Fuv = (Tuv_{tf})/(SF)
Fuv = 37,626 lbs (Torque to Thrust Conversion)

Where Tuv= torque @ undervoltage, Tuv_{tf}= Tuv w/High Temp Factor and Fuv= thrust @ undervoltage

Comparing the limits of Spring Pack, Valve Structural, Actuator Structural And Undervoltage Thrust

Max Spring Pack Thrust	S_{pack}	=	N/A
Valve Structural Limit	V_{struct}	=	38,172 lbs
Actuat. Structural Limit	A_{struct}	=	50,000 lbs

The Output maximum is 37,626 lbs

The actuator is capable of producing without damage 37,626 lbs of force.

The force required to overcome pressure locking is 33,271 lbs

Actuator Margin is Margin = (Fmax - Fmin) / Fmin
= 13.1%

The following provides the corrective actions for this valve to alleviate the concerns of:

COMMENTS

RAI 8/22/97
Attachment 2
page 5 of 12

Calculation Number: OSC-6072 Revision 0
February 12, 1996
Initials: [handwritten initials]

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Valve Information

Function	SSF Aux Ser Water Disch
Manufacturer	Borg Warner
Item Number	6J-251
Drawing No.	OM 245-1319
Press Class	1500
Size	6.00
Disc Type	Flex
Mean Seat Diam	5.625
Disc Diam	6.25
Hub Diam	3
Hub Length	1
Disk Thickness	1.875
Wedge Angle	4
Stem Diam	1.75
Bonnet Vent	No
Body Material	SA 105
Wedge Material	SA351 CF8M
BB or PS	PS

PLTB System Calc Inputs

(A) Highest System Temp during closing	120
(B) Lowest System Temp since closing	60
(C) Highest Press on either side since closure	1060.5
(D) Lowest Press for opening on same side as (C) above	0
(E) Lowest Press For opening on opposite side as (C) above on either side since closure	0
(F) Lowest System Temp when closed	60
(G) Highest System Temp when opened	120
(H) Highest Ambient Temp when opened	120

Actuator Information

Type	EMO
Manufacturer	Rotork
Model No.	30NA1/57
Compensator	No
RPM	57
Torque Rating	750
Gear Ratio	N/A
Unit Effic.	N/A

System Information

GL 89-10	Yes
Flow Diagram	OFD-133A-2.5
Coordinates	G13
Normal Position	Close
Safety Position	Close/Open
Req'd To Open	Y
Dp To close	1440
Dp To Open	1440
Dwnstrm Press	0

Thermal Binding Review

Is this valve a double disc or parallel seated designed gate valve ?	No	
The temperature differential is________ / The max temp during closing is_______.	60	120
Is the maximum temperature during closing 200 F. or less ?	Yes	
Is wedge design flex and temp differential 100 F or less / or solid and temp differential 50 F or less ?	Yes	
Is this valve furnished with a spring compensated actuator ?	No	
Is the body and wedge constructed of the same material ?	No	

2CCW-287 has been determined to be susceptable to thermal binding? Yes / No **No**

Hydraulically Induced Pressure Locking

Does this valve have a wedge design that is susceptable to pressure locking ?	Yes
Has a bonnet vent been added or has the seat or bridge wall been tapped to relieve pressure?	No

2CCW-287 has been determined to be susceptable to hydraulically induced pressure locking? Y/N **Yes**

If this valve is susceptable, see page 2 for sizing equation?

Thermally Induced Pressure Locking

Does this valve have a wedge design that is susceptable to pressure locking ?	YES
Is valve bonnet designed such that air will be entrapped ? (For interim operation only)	No
Has a bonnet vent been added or has the seat or bridge wall been tapped to relieve pressure?	No

2CCW-287 has been determined to be susceptable to thermally induced pressure locking? Y/N **Yes**

Calculation Number: OSC-6072 Revision 0
February 12, 1996
Initials: NAK

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Calculation Inputs

HIPL Bonnet Press(PSIG)	Pb_1	1061	Hub Length (in)	L	1
TIPL Bonnet Press(PSIG)	Pb_2	300	Seat Angle (deg)	theta	4
Bonnet Press (PSIG)	Pb	1,361	Stem Diam (in)	Dstem	1.75
Upstream Press (PSIG)	Pu	0	Poisson's Ratio	v	0.3
Dwnstrm Press (PSIG)	Pd	0	Modulus of Elasticity	E	2.76E+07
Disk Thickness (in)	t	1.875	Static Unwedging Thrust	_O9	17,191 lbs
Mean Seat Diam (in)	dm	5.625	Unwedging Uncertainty	O9unc	9%
Seat Radius (in)	a	2.8125	Static Unwedging Thrust	Fpo	18,766 lbs
Valve Hub Radius (in)	b	1.5	Valve Factor	VF	0.60
Stem Factor	SF	0.0139	Torque Rating	Trq	750 lbs
High Temp Factor	TF	0	Gear Ratio	OAGR	N/A
Spring Pack	Spack	N/A	Pullout Effic.	PE	N/A
Valve Struct.	Vstruct	38,172 lbs	Voltage Avail.	Volt	89%
Actuat. Struct	Astruct	50,000 lbs			

PRESSURE LOCKING CALCULATION

Coefficient Of Friction Between Disk & Seat Rings

mu=VF*(COS(theta*PI()/180))/(1-(VF*SIN(theta*PI()/180))) mu= 0.624683877

Average Dp across disks

DPavg=Pb-((Pu+Pd)/2) DPavg= 1360.5

Disk Stiffness Constants

D=(E*t^3)/(12*(1-v^2)) D= 16660585.51

G=E/(2*(1+v)) G= 10615384.62

Geometric Influences

C2=0.25*(1-(b/a)^2*(1+2*LN(a/b))) _C2= 0.089486768

C3=b/(4*a)*(((b/a)^2+1)*LN(a/b)+(b/a)^2-1) _C3= 0.012247646

C8=0.5*(1+v+(1-v)*(b/a)^2) _C8= 0.749555556

C9=(b/a)*(((1+v)/2)*LN(a/b)+(((1-v)/4)*(1-(b/a)^2))) _C9= 0.284702854

L11=(1/64)*((1+4*(b/a)^2)-(5*(b/a)^4)-((4*(b/a)^2)*(2+(b/a)^2)*LN(a/b))) _L11= 0.001552518

L17=0.25*(1-((1-v)/4)*(1-(b/a)^4)-((b/a)^2*(1+((1+v)*LN(a/b))))) _L17= 0.080567264

Moment

Mrb=(-DPavg*a^2/_C8)*((_C9/(2*a*b))*(a^2-b^2)-_L17)	Mrb= -1585.37157
Qb=(DPavg/(2*b))*(a^2-b^2)	Qb= 2566.880859

Deflection Due to pressure and bending

Ybq=((Mrb*a^2*_C2)/D)+((Qb*a^3*_C3)/D)-((DPavg*a^4*_L11)/D)	Ybq= -3.33096E-05

Deflection due to pressure and shear stress

Ksa=(-0.3*(2*LN(a/b)-1+(b/a)^2)	Ksa= -0.162499
Ysq=(Ksa*DPavg*a^2)/(t*G)	Ysq= -8.78610E-05

Deflection due to hub stretch

P force=PI()*(a^2-b^2)*DPavg	Pforce= 24192.28215
Ystretch=(Pforce/(PI()*b^2))*L/(2*E)	Ystretch= 6.20020E-05

Deflection due to pressure forces

Yq=Ybq+Ysq-Ystretch	Yq= -1.83173E-04

Deflection due to seat contact force and shear stress

Ysw=-(1.2*(a/a)*LN(a/b)*a)/(t*G)	Ysw= -1.06590E-07

Deflection due to seat contact force and bending

Ybw=-(a^3/D)*((_C2/_C8)*((a*_C9/b))-((a/b)*_C3))	Ybw= -5.44363E-08

Deflection due to hub compression

Ycompr=(2*a*PI()/(PI()*b^2))*(L/(2*E))	Ycompr= 4.52899E-08

Total deflection due to seat contact force

Yw=Ybw+Ysw-Ycompr	Yw= -2.1E-07

Seat contact force to create

Fs=2*PI()*a*Yq/Yw	Fs= 15689.14

Unseating forces

Fpiston=(PI()/4)*(Dstem^2*Pb)	Fpiston= 3272.39
Fvert=(PI()*a^2)*SIN(theta*PI()/180)*(2*Pb-Pu-Pd)	Fvert= 4716.81
Fpreslock=2*Fs*(mu*COS(theta*PI()/180)-SIN(theta*PI()/180))	Fpreslock= 17364.9

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Required Total Force

Ftotal=-Fpiston+Fvert+Fpreslock+Fpo Ftotal= 37,575 lbs

Undervoltage Thrust Available

Tuv = (Start Motor Torque)(Overall Gear Ratio)(Pullout Efficiency)(Undervoltage)^2
Tuv = 594 ft lbs
Tuv_{tf} = Tuv* (1-HighTemp Factor)
Tuv_{tf} = 594 ft lbs
Fuv = (Tuv_{tf})/(SF)
Fuv = 42,734 lbs (Torque to Thrust Conversion)

Where Tuv= torque @ undervoltage, Tuv_{tf}= Tuv w/High Temp Factor and Fuv= thrust @ undervoltage

Comparing the limits of Spring Pack, Valve Structural, Actuator Structural And Undervoltage Thrust

Max Spring Pack Thrust	S_{pack}	=	N/A
Valve Structural Limit	V_{struct}	=	38,172 lbs
Actuat. Structural Limit	A_{struct}	=	50,000 lbs

The Output maximum is 38,172 lbs

The actuator is capable of producing without damage 38,172 lbs of force.

The force required to overcome pressure locking is 37,575 lbs

Actuator Margin is Margin = (Fmax - Fmin) / Fmin
= 1.6%

The following provides the corrective actions for this valve to alleviate the concerns of:

COMMENTS

~~Using 10% for Unwedging uncertainty is validated by analizing motor power on the calibrated closing stroke~~ Completed during 2EOC-15 4/5/96 DDK
~~Will be retested during unit RFO (EOC-15) with open stroke calibration to justify use of 10 % uncertainty in the open direction.~~ Completed during 2EOC-15 4/5/96 DDK

RAI 8/22/97
Attachment 2
page 9 of 12

Calculation Number: OSC-6072 Revision 0
February 12, 1996
Initials: KDK

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Valve Information

Function	SSF Aux Ser Water Disch
Manufacturer	Borg Warner
Item Number	6J-251
Drawing No.	OM 245-1319
Press Class	1500
Size	6.00
Disc Type	Flex
Mean Seat Diam	5.625
Disc Diam	6.25
Hub Diam	3
Hub Length	1
Disk Thickness	1.875
Wedge Angle	4
Stem Diam	1.75
Bonnet Vent	No
Body Material	SA 105
Wedge Material	SA351 CF8M
BB or PS	PS

PLTB System Calc Inputs

(A) Highest System Temp during closing	120
(B) Lowest System Temp since closing	60
(C) Highest Press on either side since closure	1060.5
(D) Lowest Press for opening on same side as (C) above	0
(E) Lowest Press For opening on opposite side as (C) above on either side since closure	0
(F) Lowest System Temp when closed	60
(G) Highest System Temp when opened	120
(H) Highest Ambient Temp when opened	120

Actuator Information

Type	EMO
Manufacturer	Rotork
Model No.	30NA1/57
Compensator	No
RPM	57
Torque Rating	700
Gear Ratio	N/A
Unit Effic.	N/A

System Information

GL 89-10	Yes
Flow Diagram	OFD-133A-2.5
Coordinates	G12
Normal Position	
Safety Position	Close/Open
Req'd To Open	Y
Dp To close	1440
Dp To Open	1440
Dwnstrm Press	0

Thermal Binding Review

Is this valve a double disc or parallel seated designed gate valve ?	No	
The temperature differential is________ / The max temp during closing is_______.	60	120
Is the maximum temperature during closing 200 F. or less ?	Yes	
Is wedge design flex and temp differential 100 F or less / or solid and temp differential 50 F or less ?	Yes	
Is this valve furnished with a spring compensated actuator ?	No	
Is the body and wedge constructed of the same material ?	No	

3CCW-287 has been determined to be susceptable to thermal binding? Yes / No **No**

Hydraulically Induced Pressure Locking

Does this valve have a wedge design that is susceptable to pressure locking ?	Yes
Has a bonnet vent been added or has the seat or bridge wall been tapped to relieve pressure?	No

3CCW-287 has been determined to be susceptable to hydraulically induced pressure locking? Y/N **Yes**

If this valve is susceptable, see page 2 for sizing equation?

Thermally Induced Pressure Locking

Does this valve have a wedge design that is susceptable to pressure locking ?	YES
Is valve bonnet designed such that air will be entrapped ? (For interim operation only)	Yes
Has a bonnet vent been added or has the seat or bridge wall been tapped to relieve pressure?	No

3CCW-287 has been determined to be susceptable to thermally induced pressure locking? Y/N **No**

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Calculation Inputs

HIPL Bonnet Press(PSIG)	Pb_1	1061	Hub Length (in)	L	1
TIPL Bonnet Press(PSIG)	Pb_2	300	Seat Angle (deg)	theta	4
Bonnet Press (PSIG)	Pb	1,361	Stem Diam (in)	Dstem	1.75
Upstream Press (PSIG)	Pu	0	Poisson's Ratio	v	0.3
Dwnstrm Press (PSIG)	Pd	0	Modulus of Elasticity	E	2.76E+07
Disk Thickness (in)	t	1.875	Static Unwedging Thrust	_O9	6,471 lbs
Mean Seat Diam (in)	dm	5.625	Unwedging Uncertainty	O9unc	9%
Seat Radius (in)	a	2.8125	Static Unwedging Thrust	Fpo	7,064 lbs
Valve Hub Radius (in)	b	1.5	Valve Factor	VF	0.6
Stem Factor	SF	0.0139	Torque Rating	Trq	700 lbs
High Temp Factor	TF	0	Gear Ratio	OAGR	N/A
Spring Pack	Spack	N/A	Pullout Effic.	PE	N/A
Valve Struct.	Vstruct	38,172 lbs	Voltage Avail.	Volt	83%
Actuat. Struct	Astruct	50,000 lbs			

PRESSURE LOCKING CALCULATION

Coefficient Of Friction Between Disk & Seat Rings

mu=VF*(COS(theta*PI()/180))/(1-(VF*SIN(theta*PI()/180))) mu= 0.624683877

Average Dp across disks

DPavg=Pb-((Pu+Pd)/2) DPavg= 1360.5

Disk Stiffness Constants

D=(E*t^3)/(12*(1-v^2)) D= 16660585.51

G=E/(2*(1+v)) G= 10615384.62

Geometric Influences

C2=0.25*(1-(b/a)^2*(1+2*LN(a/b))) _C2= 0.089486768

C3=b/(4*a)*(((b/a)^2+1)*LN(a/b)+(b/a)^2-1) _C3= 0.012247646

C8=0.5*(1+v+(1-v)*(b/a)^2) _C8= 0.749555556

C9=(b/a)*(((1+v)/2)*LN(a/b)+(((1-v)/4)*(1-(b/a)^2))) _C9= 0.284702854

L11=(1/64)*((1+4*(b/a)^2)-(5*(b/a)^4)-((4*(b/a)^2)*(2+(b/a)^2)*LN(a/b))) _L11= 0.001552518

L17=0.25*(1-((1-v)/4)*(1-(b/a)^4)-((b/a)^2*(1+((1+v)*LN(a/b))))) _L17= 0.080567264

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Moment

Mrb=(-DPavg*a^2/_C8)*((_C9/(2*a*b))*(a^2-b^2)-_L17)	Mrb= -1585.37157
Qb=(DPavg/(2*b))*(a^2-b^2)	Qb= 2566.880859

Deflection Due to pressure and bending

Ybq=((Mrb*a^2*_C2)/D)+((Qb*a^3*_C3)/D)-((DPavg*a^4*_L11)/D)	Ybq= -3.33096E-05

Deflection due to pressure and shear stress

Ksa=(-0.3*(2*LN(a/b)-1+(b/a)^2)	Ksa= -0.162499
Ysq=(Ksa*DPavg*a^2)/(t*G)	Ysq= -8.78610E-05

Deflection due to hub stretch

P force=PI()*(a^2-b^2)*DPavg	Pforce= 24192.28215
Ystretch=(Pforce/(PI()*b^2))*L/(2*E)	Ystretch= 6.20020E-05

Deflection due to pressure forces

Yq=Ybq+Ysq-Ystretch	Yq= -1.83173E-04

Deflection due to seat contact force and shear stress

Ysw=-(1.2*(a/a)*LN(a/b)*a)/(t*G)	Ysw= -1.06590E-07

Deflection due to seat contact force and bending

Ybw=-(a^3/D)*((_C2/_C8)*((a*_C9/b))-((a/b)*_C3))	Ybw= -5.44363E-08

Deflection due to hub compression

Ycompr=(2*a*PI()/(PI()*b^2))*(L/(2*E))	Ycompr= 4.52899E-08

Total deflection due to seat contact force

Yw=Ybw+Ysw-Ycompr	Yw= -2.1E-07

Seat contact force to create

Fs=2*PI()*a*Yq/Yw	Fs= 15689.14

Unseating forces

Fpiston=(PI()/4)*(Dstem^2*Pb)	Fpiston= 3272.39
Fvert=(PI()*a^2)*SIN(theta*PI()/180)*(2*Pb-Pu-Pd)	Fvert= 4716.81
Fpreslock=2*Fs*(mu*COS(theta*PI()/180)-SIN(theta*PI()/180))	Fpreslock= 17364.9

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Required Total Force

Ftotal=-Fpiston+Fvert+Fpreslock+Fpo **Ftotal=** **25,873 lbs**

Undervoltage Thrust Available

Tuv = (Start Motor Torque)(Overall Gear Ratio)(Pullout Efficiency)(Undervoltage)^2
Tuv = 482 ft lbs
Tuv_{tf} = Tuv* (1-HighTemp Factor)
Tuv_{tf} = 482 ft lbs
Fuv = (Tuv_{tf})/(SF)
Fuv = 34,676 lbs (Torque to Thrust Conversion)

Where Tuv= torque @ undervoltage, Tuv_{tf}= Tuv w/High Temp Factor and Fuv= thrust @ undervoltage

Comparing the limits of Spring Pack, Valve Structural, Actuator Structural And Undervoltage Thrust

Max Spring Pack Thrust	S_{pack}	=	N/A
Valve Structural Limit	V_{struct}	=	38,172 lbs
Actuat. Structural Limit	A_{struct}	=	50,000 lbs

The Output maximum is 34,676 lbs

The actuator is capable of producing without damage **34,676 lbs** **of force.**

The force required to overcome pressure locking is **25,873 lbs**

Actuator Margin is **Margin = (Fmax - Fmin) / Fmin**
= 34.0%

The following provides the corrective actions for this valve to alleviate the concerns of:

COMMENTS

ATTACHMENT 3

Calculation OSC-6072, Pages pertaining to 1,2,3 HP-428

Calculation Number: OSC-6072 Revision 0
February 12, 1996
Initials: OAK

1HP-428 Page 1 of 2

Valve Information

Function	RC Return from Letdown Line
Manufacturer	Anchor Darling
Item Number	5J-1512
Drawing No.	OM 245-0911
Press Class	1540
Size	3.00
Disc Type	DD
Mean Seat Diam	2.26
Area of Seat	4.01
Stem Diam	1.25
Bonnet Vent	No
Body Material	SA351 CF8M
Wedge Material	SA182 F316
BB or PS	PS

PLTB System Calc Inputs

(A) Highest System Temp during closing	N/A
(B) Lowest System Temp since closing	N/A
(C) Highest Press on either side since closure	2586
(D) Lowest Press for opening on same side as (C) above	2155
(E) Lowest Press For opening on opposite side as (C) above on either side since closure	22.6
(F) Lowest System Temp when closed	40
(G) Highest System Temp when opened	125
(H) Highest Ambient Temp when opened	125

Actuator Information

Type	EMO
Manufacturer	Rotork
Model No.	16NA1/57
Compensator	No
RPM	57
Torque Rating	350
Gear Ratio	N/A
Unit Effic.	N/A

System Information

GL 89-10	Yes
Flow Diagram	OFD-101A-1.5
Coordinates	J13
Normal Position	
Safety Position	Open
Req'd To Open	Y
Dp To close	2563
Dp To Open	2563
Dwnstrm Press	23

Thermal Binding Review

Is this valve a double disc or parallel seated designed gate valve ?	Yes	
The temperature differential is________ / The max temp during closing is_______.	N/A	N/A
Is the maximum temperature during closing 200 F. or less ?	No	
Is wedge design flex and temp differential 100 F or less / or solid and temp differential 50 F or less ?	No	
Is this valve furnished with a spring compensated actuator ?	No	
Is the body and wedge constructed of the same material ?	No	

1HP-428 has been determined to be susceptable to thermal binding? Yes / No **No**

Hydraulically Induced Pressure Locking

Does this valve have a wedge design that is susceptable to pressure locking ?	Yes
Has a bonnet vent been added or has the seat or bridge wall been tapped to relieve pressure?	No

1HP-428 has been determined to be susceptable to hydraulically induced pressure locking? Y/N **Yes**

If this valve is susceptable, see page 2 for sizing equation?

Thermally Induced Pressure Locking

Does this valve have a wedge design that is susceptable to pressure locking ?	YES
Is valve bonnet designed such that air will be entrapped ? (For interim operation only)	Yes
Has a bonnet vent been added or has the seat or bridge wall been tapped to relieve pressure?	No

1HP-428 has been determined to be susceptable to thermally induced pressure locking? Y/N **No**

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February 12, 1996
Initials: NDK

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Calculation Inputs

HIPL Bonnet Press(PSIG)	Pb_1	2586	Spring Pack	Spack	N/A
TIPL Bonnet Press(PSIG)	Pb_2	425	Valve Struct.	Vstruct	30,120 lbs
Bonnet Press (PSIG)	Pb	3,011	Actuat. Struct	Astruct	30,000 lbs
Upstream Press (PSIG)	Pu	2155	Packing Load	PL	1,250 lbs
Dwnstrm Press (PSIG)	Pd	22.6	Static Unwedging Thrust	_O9	832 lbs
Mean Seat Diam (in)	dm	2.26	Unwedging Uncertainty	O9unc	28%
Effective Seat Area	Aseat	4.01	Total Unwedging w/ uncert.	Fpo	1,062 lbs
Valve Hub Radius (in)	b	0	Valve Factor	VF	0.6
Stem Factor	SF	0.0106	Torque Rating	Trq	350
High Temp Factor	TF	0.13	Gear Ratio	OAGR	N/A
			Pullout Effic.	PE	N/A
			Voltage Avail.	Volt	78%

PRESSURE LOCKING CALCULATION

Required Force to overcome pressure locking

F= (Aseat)(VF)(Pb-Pu)+(Aseat)(VF)(Pb-Pd)+Fpo+PL

F= 11,562 lbs

Undervoltage Thrust Available

Tuv = (Torque from Certification Sheet)(Undervoltage)2
Tuv = 213 ft lbs
Tuv_{tf} = Tuv* (1-HighTemp Factor)
Tuv_{tf} = 185 ft lbs
Fuv = (Tuv_{tf})/(SF)
Fuv = 17,453 lbs (Torque to Thrust Conversion)

Where Tuv= torque @ undervoltage, Tuv_{tf}= Tuv w/High Temp Factor and Fuv= thrust @ undervoltage

Comparing the limits of Spring Pack, Valve Structural, Actuator Structural And Undervoltage Thrust

Max Spring Pack Thrust	S_{pack}	=	N/A
Valve Structural Limit	V_{struct}	=	30,120 lbs
Actuat. Structural Limit	A_{struct}	=	30,000 lbs

The Output maximum is 17,453 lbs

The actuator is capable of producing without damage 17,453 lbs of force.

The force required to overcome pressure locking is 11,562 lbs

Actuator Margin is Margin = (Fmax - Fmin) / Fmin
= 51.0%

COMMENTS

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page 3 of 6

Calculation Number: OSC-6072 Revision 0
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Valve Information

Function	RC Return from Letdown Line
Manufacturer	Anchor Darling
Item Number	5J-1512
Drawing No.	OM 245-0911
Press Class	1540
Size	3.00
Disc Type	DD
Mean Seat Diam	2.26
Area of Seat	4.01
Stem Diam	1.25
Bonnet Vent	No
Body Material	SA351 CF8M
Wedge Material	SA182 F316
BB or PS	PS

PLTB System Calc Inputs

(A) Highest System Temp during closing	N/A
(B) Lowest System Temp since closing	N/A
(C) Highest Press on either side since closure	2586
(D) Lowest Press for opening on same side as (C) above	2155
(E) Lowest Press For opening on opposite side as (C) above on either side since closure	22.6
(F) Lowest System Temp when closed	40
(G) Highest System Temp when opened	125
(H) Highest Ambient Temp when opened	125

Actuator Information

Type	EMO
Manufacturer	Rotork
Model No.	16NA1/57
Compensator	No
RPM	57
Torque Rating	328
Gear Ratio	N/A
Unit Effic.	N/A

System Information

GL 89-10	Yes
Flow Diagram	OFD-101A-2.5
Coordinates	J13
Normal Position	
Safety Position	Close/Open
Req'd To Open	Y
Dp To close	2563
Dp To Open	2563
Dwnstrm Press	23

Thermal Binding Review

Is this valve a double disc or parallel seated designed gate valve ?	Yes	
The temperature differential is________ / The max temp during closing is_______.	N/A	N/A
Is the maximum temperature during closing 200 F. or less ?	No	
Is wedge design flex and temp differential 100 F or less / or solid and temp differential 50 F or less ?	No	
Is this valve furnished with a spring compensated actuator ?	No	
Is the body and wedge constructed of the same material ?	No	

2HP-428 has been determined to be susceptable to thermal binding? Yes / No **No**

Hydraulically Induced Pressure Locking

Does this valve have a wedge design that is susceptable to pressure locking ?	Yes
Has a bonnet vent been added or has the seat or bridge wall been tapped to relieve pressure?	No

2HP-428 has been determined to be susceptable to hydraulically induced pressure locking? Y/N **Yes**

If this valve is susceptable, see page 2 for sizing equation?

Thermally Induced Pressure Locking

Does this valve have a wedge design that is susceptable to pressure locking ?	YES
Is valve bonnet designed such that air will be entrapped ? (For interim operation only)	Yes
Has a bonnet vent been added or has the seat or bridge wall been tapped to relieve pressure?	No

2HP-428 has been determined to be susceptable to thermally induced pressure locking? Y/N **No**

Calculation Number: OSC-6072 Revision 0
February 12, 1996
Initials: NDK

2HP-428 Page 2 of 2

Calculation Inputs

HIPL Bonnet Press(PSIG)	Pb_1	2586	Spring Pack	Spack	N/A
TIPL Bonnet Press(PSIG)	Pb_2	425	Valve Struct.	Vstruct	30,120 lbs
Bonnet Press (PSIG)	Pb	3,011	Actuat. Struct	Astruct	30,000 lbs
Upstream Press (PSIG)	Pu	2155	Packing Load	PL	1,250 lbs
Dwnstrm Press (PSIG)	Pd	22.6	Static Unwedging Thrust	_O9	2,570 lbs
Mean Seat Diam (in)	dm	2.26	Unwedging Uncertainty	O9unc	9%
Effective Seat Area	Aseat	4.01	Total Unwedging w/ uncert.	Fpo	2,801 lbs
Valve Hub Radius (in)	b	0	Valve Factor	VF	0.6
Stem Factor	SF	0.0106	Torque Rating	Trq	328
High Temp Factor	TF	0.13	Gear Ratio	OAGR	N/A
			Pullout Effic.	PE	N/A
			Voltage Avail.	Volt	81%

PRESSURE LOCKING CALCULATION

Required Force to overcome pressure locking

F= (Aseat)(VF)(Pb-Pu)+(Aseat)(VF)(Pb-Pd)+Fpo+PL

F= 13,301 lbs

Undervoltage Thrust Available

Tuv = (Torque from Certification Sheet)(Undervoltage)2
Tuv = 215 ft lbs
Tuv_{tf} = Tuv* (1-HighTemp Factor)
Tuv_{tf} = 187 ft lbs
Fuv = (Tuv_{tf})/(SF)
Fuv = 17,642 lbs **(Torque to Thrust Conversion)**

Where Tuv= torque @ undervoltage, Tuv_{tf}= Tuv w/High Temp Factor and Fuv= thrust @ undervoltage

Comparing the limits of Spring Pack, Valve Structural, Actuator Structural And Undervoltage Thrust

Max Spring Pack Thrust	S_{pack}	=	N/A
Valve Structural Limit	V_{struct}	=	30,120 lbs
Actuat. Structural Limit	A_{struct}	=	30,000 lbs

The Output maximum is 17,642 lbs

The actuator is capable of producing without damage 17,642 lbs of force.

The force required to overcome pressure locking is 13,301 lbs

Actuator Margin is **Margin = (Fmax - Fmin) / Fmin**
= 32.6%

COMMENTS

Calculation Number: OSC-6072 Revision 0
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Initials: DDK

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Valve Information

Function	RC Return from Letdown Line
Manufacturer	Anchor Darling
Item Number	5J-1512
Drawing No.	OM 245-0911
Press Class	1540
Size	3.00
Disc Type	DD
Mean Seat Diam	2.26
Area of Seat	4.01
Stem Diam	1.25
Bonnet Vent	No
Body Material	SA351 CF8M
Wedge Material	SA182 F316
BB or PS	PS

PLTB System Calc Inputs

(A) Highest System Temp during closing	N/A
(B) Lowest System Temp since closing	N/A
(C) Highest Press on either side since closure	2586
(D) Lowest Press for opening on same side as (C) above	2155
(E) Lowest Press For opening on opposite side as (C) above on either side since closure	22.6
(F) Lowest System Temp when closed	40
(G) Highest System Temp when opened	125
(H) Highest Ambient Temp when opened	125

Actuator Information

Type	EMO
Manufacturer	Rotork
Model No.	16NA1/57
Compensator	No
RPM	57
Torque Rating	350
Gear Ratio	N/A
Unit Effic.	N/A

System Information

GL 89-10	Yes
Flow Diagram	OFD-101A-3.5
Coordinates	J13
Normal Position	
Safety Position	Open
Req'd To Open	Y
Dp To close	2416
Dp To Open	2416
Dwnstrm Press	23

Thermal Binding Review

Is this valve a double disc or parallel seated designed gate valve ?	Yes	
The temperature differential is________ / The max temp during closing is_______.	N/A	N/A
Is the maximum temperature during closing 200 F. or less ?	No	
Is wedge design flex and temp differential 100 F or less / or solid and temp differential 50 F or less ?	No	
Is this valve furnished with a spring compensated actuator ?	No	
Is the body and wedge constructed of the same material ?	No	

3HP-428 has been determined to be susceptable to thermal binding? Yes / No **No**

Hydraulically Induced Pressure Locking

Does this valve have a wedge design that is susceptable to pressure locking ?	Yes
Has a bonnet vent been added or has the seat or bridge wall been tapped to relieve pressure?	No

3HP-428 has been determined to be susceptable to hydraulically induced pressure locking? Y/N **Yes**

If this valve is susceptable, see page 2 for sizing equation?

Thermally Induced Pressure Locking

Does this valve have a wedge design that is susceptable to pressure locking ?	YES
Is valve bonnet designed such that air will be entrapped ? (For interim operation only)	Yes
Has a bonnet vent been added or has the seat or bridge wall been tapped to relieve pressure?	No

3HP-428 has been determined to be susceptable to thermally induced pressure locking? Y/N **No**

Calculation Number: OSC-6072 Revision 0
February 12, 1996
Initials: DDK

3HP-428 Page 2 of 2

Calculation Inputs

HIPL Bonnet Press(PSIG)	Pb_1	2586	Spring Pack	Spack	N/A
TIPL Bonnet Press(PSIG)	Pb_2	425	Valve Struct.	Vstruct	30,120 lbs
Bonnet Press (PSIG)	Pb	3,011	Actuat. Struct	Astruct	30,000 lbs
Upstream Press (PSIG)	Pu	2155	Packing Load	PL	1,250 lbs
Dwnstrm Press (PSIG)	Pd	22.6	Static Unwedging Thrust	_O9	2,947 lbs
Mean Seat Diam (in)	dm	2.26	Unwedging Uncertainty	O9unc	48%
Effective Seat Area	Aseat	4.01	Total Unwedging w/ uncert.	Fpo	4,376 lbs
Valve Hub Radius (in)	b	0	Valve Factor	VF	0.6
Stem Factor	SF	0.0106	Torque Rating	Trq	350
High Temp Factor	TF	0.13	Gear Ratio	OAGR	N/A
			Pullout Effic.	PE	N/A
			Voltage Avail.	Volt	74%

PRESSURE LOCKING CALCULATION

Required Force to overcome pressure locking

F= (Aseat)(VF)(Pb-Pu)+(Aseat)(VF)(Pb-Pd)+Fpo+PL

F= 14,875 lbs

Undervoltage Thrust Available

Tuv = (Torque from Certification Sheet)(Undervoltage)2
Tuv = 192 ft lbs
Tuv_{tf} = Tuv* (1-HighTemp Factor)
Tuv_{tf} = 167 ft lbs
Fuv = (Tuv_{tf})/(SF)
Fuv = 15,755 lbs (Torque to Thrust Conversion)

Where Tuv= torque @ undervoltage, Tuv_{tf}= Tuv w/High Temp Factor and Fuv= thrust @ undervoltage

Comparing the limits of Spring Pack, Valve Structural, Actuator Structural And Undervoltage Thrust

Max Spring Pack Thrust	S_{pack}	=	N/A
Valve Structural Limit	V_{struct}	=	30,120 lbs
Actuat. Structural Limit	A_{struct}	=	30,000 lbs

The Output maximum is 15,755 lbs

The actuator is capable of producing without damage 15,755 lbs of force.

The force required to overcome pressure locking is 14,875 lbs

Actuator Margin is **Margin = (Fmax - Fmin) / Fmin**
= 5.9%

COMMENTS
