Paul H. Kinkel
Vice President

Consolidated Edison Company of New York, Inc.
Indian Point Station
Broadway & Bleakley Avenue
Buchanan, NY 10511
Telephone (914) 734-5340
Fax: (914) 734-5923

November 21, 1997

Re: Indian Point Unit No. 2
Docket No. 50-247

Document Control Desk
US Nuclear Regulatory Commission
Mail Station P1-137
Washington, DC 20555-0001

Subject: Response to Request for Additional Information - Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design Basis Accident Conditions," for Indian Point Unit No. 2. (TAC No. M96822)

Pursuant to 10CFR50.54(f), this letter and attachments provides the response of Consolidated Edison Company of New York, Inc. (Con Edison's) to NRC's request for additional information dated September 22, 1997 on Generic Letter 96-06.

Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions," dated September 30, 1996, requested nuclear utilities to address the susceptibility of 1) containment air cooler cooling water systems to either waterhammer or two-phase flow conditions during postulated accident conditions and 2) piping systems that penetrate containment to thermal expansion of fluid such that overpressurization of piping could occur.

Pursuant to 10CFR50.54(f), Con Edison provided written responses to Generic Letter 96-06 on October 30, 1996, November 18, 1996, January 28, 1997, April 30, 1997, and August 29, 1997.

The attachments to this letter responds to your specific requests for additional information.

A072/1

Should you or your staff have any concerns regarding this matter, please contact Mr. Charles W. Jackson, Manager, Nuclear Safety & Licensing.

Very truly yours,

Paul H. Kinkel

Subscribed and sworn to
before me this 21st day
of November 1997

Karen L. Lancaster
KAREN L. LANCASTER
Notary Public, State of New York
No. 60-4643659
Qualified In Westchester County
Term Expires 9/30/99

Attachments

C: Mr. Hubert J. Miller
Regional Administrator-Region I
US Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Mr. Jefferey F. Harold, Project Manager
Project Directorate I-1
Division of Reactor Projects I/II
US Nuclear Regulatory Commission
Mail Stop 14B-2
Washington, DC 20555

Senior Resident Inspector
US Nuclear Regulatory Commission
PO Box 38
Buchanan, NY 10511

ATTACHMENT A

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
REGARDING RESPONSE TO GENERIC LETTER 96-06

Consolidated Edison Company of New York, Inc.
Indian Point Unit No. 2
Docket No. 50-247
November 1997

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
REGARDING RESPONSE TO GENERIC LETTER 96-06

Request 1:

> "To aid in the completion of the staff's final review, the final results of the evaluations for the pipe line need to be submitted. In addition, please provide a discussion of the corrective actions for these six pipe lines penetrating containment."

Response:

In accordance with our commitments in response to Generic Letter 96-06, modifications consisting of the installation of new thermal relief devices and pipe insulation were completed during the 1997 Indian Point Unit No.2 refueling outage. These modifications restored those pipe lines to their UFSAR design requirements. Of the six pipe lines (#'s 10, 25, 26, 59, 69, and 474) which were determined to have exceeded UFSAR design requirements, new thermal relief devices were installed on lines 26 and 69. New pipe insulation was installed on a portion of line 10 to preclude thermal overpressurization. Sampling lines, 25 and 59, were further evaluated and determined to be within UFSAR design basis stress limits, thus requiring no corrective actions. Line 474 was cut, drained and capped. To prevent the undesirable lifting of Grinnell diaphragm containment isolation valves 1702 and 1705 on line 40, and 1723 and 1728 on line 338, new relief valves were installed. The completion of the above-mentioned actions is intended to address the concerns of Generic Letter 96-06. This information was previously provided to your staff in our letter dated August 29, 1997.

Request 2:

> "Please provide drawings of these valves, the calculations used to determine the lift pressure and discuss any sources of uncertainty associated with the calculated lift pressure."

Response:

Attachments 1 and 2 are drawings of the 2" and 3" Grinnell diaphragm valves used on lines 33, 40 and 338 which would lift and prevent internal line pressure from exceeding UFSAR allowable stress limits. For line 33, valve 560 would lift at a minimum line pressure of 207 psig and vent to the pressurizer relief tank. Valve 560 is a 3" Grinnell diaphragm valve as shown on drawing No. WREF-PO-5-SS-1. For line 40, valves 1702 and 1705 would lift at a minimum line pressure of 207 psig and vent any line pressure to the Hold-Up Tanks. Both valves 1702 and 1705 are 3" Grinnell diaphragm valves as shown on drawing No. WREF-PO-5-SS-1. For line 338, valves 1723 and 1728 would lift at a minimum line pressure of 271 psig and vent any line pressure to the Hold-Up Tanks. Both valves 1723 and 1728 are 2" Grinnell diaphragm valves as shown on drawing No. WREP-PO-4-SS-1.

The calculations used to determine the lift pressures for the 2" and 3" Grinnell diaphragm valves were performed by the valve manufacturer, ITT Industries and sent to Con Edison in a letter dated January 10, 1997. A copy of these calculations is provided as Attachment 3.

ATTACHMENT 1

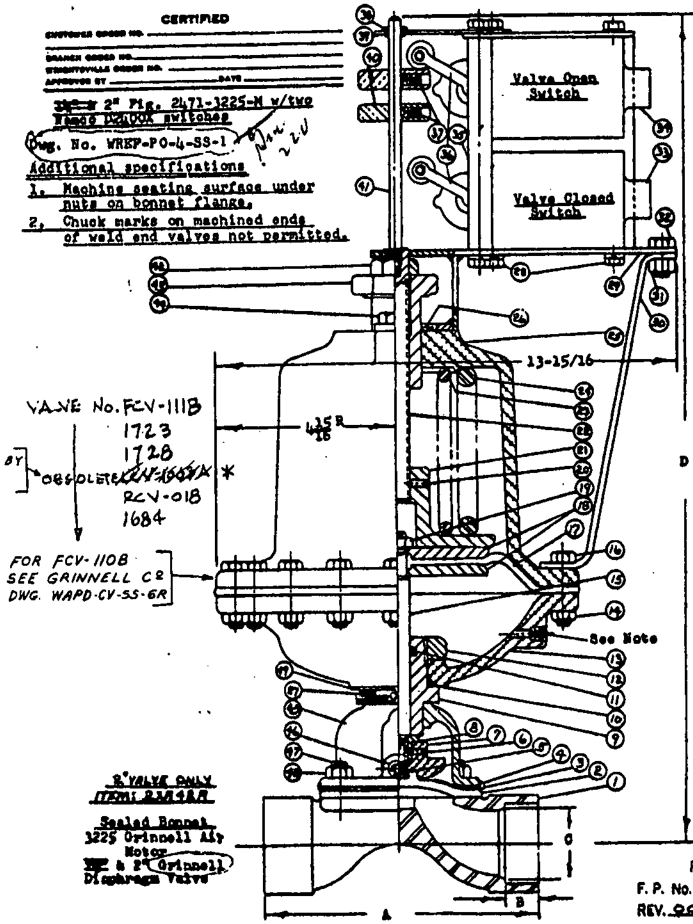
2" GRINNELL DIAPHRAGM VALVE

Drawing No. WREF-PO-4-SS-1

REVISIONS

(1)	4/30/87	O

THIS ISSUE IS "CLASS A" PER CI-240-1. THIS DWG. SUPERSEDES GRINNELL C° DWG. WREF-PO-4-SS-1. UPDATED DWG. TO SHOW WORK DONE ON MOD. PROC. MFI-87-70048, PKG "3694. RELEASE AS CONSTRUCTED. P.N. 70048. E.D./W.F.



FINAL ISSUE
F.P. No. 0321-01 20641
REV. 00 DATE 9-09-68

LIST OF PARTS			
Item	Description	Material	Quantity
1.	Sock. Weld Body (Sch. 10)	304 St. St. ASTM A-351 (Gr. CF8)	1
* 2.	Diaphragm	EPR Grade "N"	1
3.	Finger Plate	Steel	1
* 4.	Gasket	Neoprene	1
5.	Diaphragm Stud	Brass	1
6.	Spirol Pin	Stainless Steel	1
7.	Compressor	Aluminum	1
8.	Stop Collar	Steel	1
9.	Adapter Bushing	Steel	1
* 10.	"O" Ring #326	Elastomer	1
* 11.	"O" Ring #114	Elastomer	1
12.	Adapter Bushing Nut	M.I.	1
13.	Cover (Lower)	Aluminum	1
14.	Hex Nuts	Steel	18
15.	Spindle	Stainless Steel	1
16.	Hex Cap Screws	Steel	18
* 17.	Air Motor Diaphragm	Elastomer	1
18.	Plates	M.I.	2
19.	Spindle Nut	Steel	1
20.	Spirol Pin	Stainless Steel	1
21.	Spring Seat	M.I.	1
22.	Spring Rod	Steel	1
23.	Spring	Steel	1
24.	Spring	Steel	1
25.	Cover (Upper)	Aluminum	1
26.	Washer	Steel	1
27.	Drive Screws	Steel	2
28.	Hex Hd. Cap Scr.	Steel	6
29.	Switch Mounting Bracket	Steel	1
30.	Support Bracket	Steel	1
31.	Hex Nut	Steel	1
32.	Hex Hd. Cap Scr.	Steel	1
33.	Wamco Switch (D2400X-ST-SR)		1
34.	Wamco Switch (D2400X-ST)		1
35.	Column	Steel	2
36.	Lever Arm		2
37.	Set Scr.	Steel	4
38.	Nyliner Bearing		1
39.	Guide Bracket	Steel	1
40.	Switch Actuator	Brass	2
41.	Operating Rod	Stainless Steel	1
42.	Jam Nut	Steel	1
43.	Adjusting Bushing	M.I.	2
44.	Hex Hd. Cap Scr.	Steel	2
45.	Bonnet	D.I. ASTM-A-445-63T	1
46.	"V" Type Vent Plug	Steel	1
47.	Bonnet Studs	~~[illegible]~~ St. St.	4
48.	Bonnet Nuts	~~[illegible]~~ St. St.	4
49.	Name Plate	Aluminum	1

* Recommended spare parts

Note: All air inlets 1/4" N.P.T., switches shown 90° out of position

Valve Size	A	B	C	D
~~1-1/2~~	~~6-1/2~~	~~1/2~~	1.692 / 1.672	~~20-1/2~~
2	7-1/4	5/8	2.167 / 2.147	30

~~1173 NF 3043~~

20641 (M)

THIS DRAWING CONTAINS ITEMS WHICH MUST BE CONTROLLED WITHIN CON EDISON AS
"CLASS A" ITEMS
PER CI-240-1

B238986

CONSOLIDATED EDISON CO.
OF NEW YORK, INC.

STATION LOCATION: INDIAN POINT
2" GRINNELL DIAPHRAGM VALVE W/ #3225 - SEALED BONNET GRINNELL AIR MOTOR

REPRO
70048

APPROVALS
MJ

ATTACHMENT 2

3" GRINNELL DIAPHRAGM VALVE

Drawing No. WREF-PO-5-SS-1

CERTIFIED

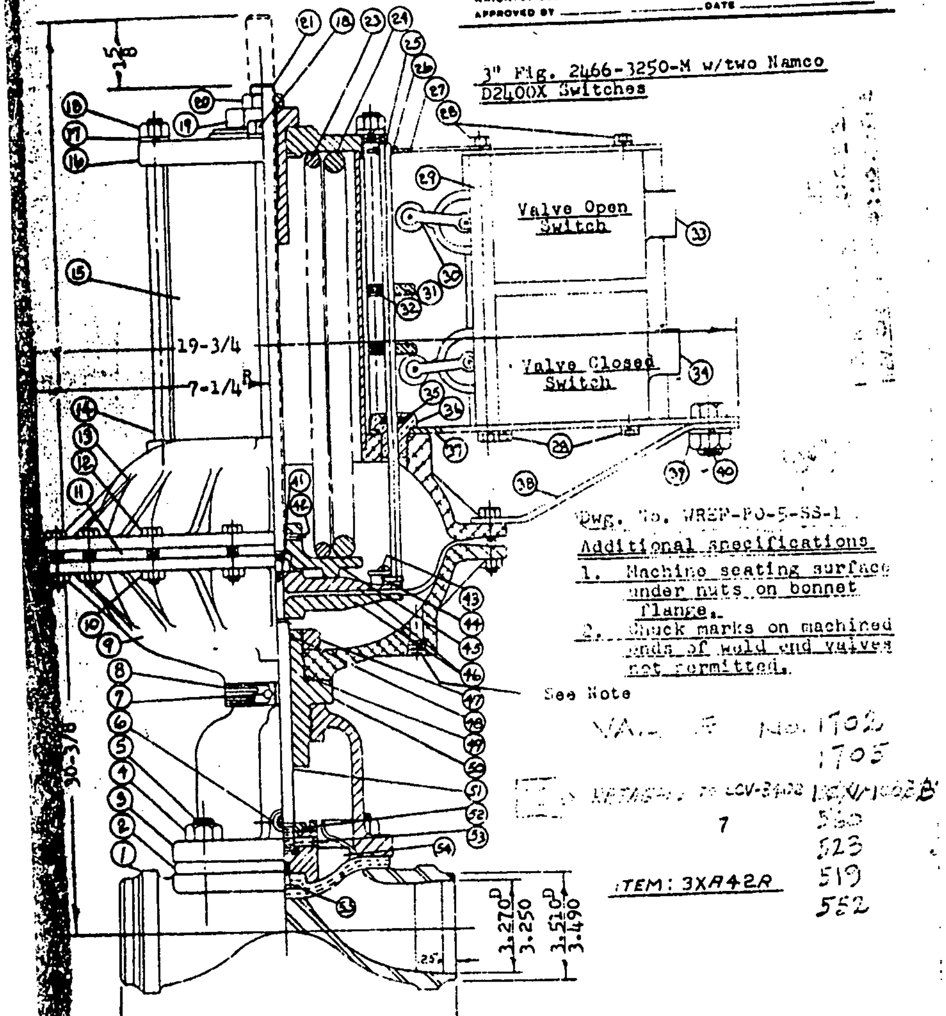
CUSTOMER ORDER NO. ____________

BRANCH ORDER NO. ____________

WRIGHTSVILLE ORDER NO. ____________

APPROVED BY ____________ DATE ____________

3" Fig. 2466-3250-M w/two Namco D2400X Switches



Sealed Bonnet
3250 Grinnell Air Motor
3" Grinnell Diaphragm Valve

Item	Description	Material	Quantity
			1
1.	Butt. Weld Body (Sch. 40)	304 St. St. ASTM-A-351 (Gr. CF8)	1
2.	Diaphragm	EPR Grade "M"	1
3.	Bonnet	D.I. ASTM-A-445-63T	4
4.	Bonnet Nuts	~~Steel ASTM-194~~ St. St.	4
5.	Bonnet Studs	~~Steel ASTM-193~~ St. St.	1
6.	"V" Type Vent Plug	Steel	2
7.	Drive Screws	Steel	1
8.	Name Plate	Aluminum	1
9.	Cover (Lower)	Aluminum	16
10.	Hex Nuts	Steel	1
* 11.	Air Motor Diaphragm	Elastomer	16
12.	Hex Cap Screws	Steel	1
13.	Cover (Upper)	Aluminum	4
14.	Column	Steel	1
15.	Spring Housing	Steel	1
16.	Spring Cover	M.I.	4
17.	Lock Washer	Steel	4
18.	Hex Nuts	Steel	1
19.	Adjusting Bushing	M.I.	1
20.	Jam Nut	Steel	1
21.	Spring Rod	Steel	1
23.	Spring (Inner) #97	Steel	1
24.	Spring (Outer) #96	Steel	1
25.	Operating Rod	Stainless Steel	1
26.	Nylinder Bearing		1
27.	Guide Bracket	Steel	6
28.	Hex Hd. Cap Scr.	Steel	1
29.	Column	Steel	2
30.	Lever Arm		2
31.	Switch Actuator	Steel	4
32.	Soc. Hd. Set Scr.	Steel	1
33.	Namco Switch D2400X-ST		1
34.	Namco Switch D2400X-ST-SR		1
* 35.	"O" Ring #110	Elastomer	1
36.	Rod Guide	Brass	1
37.	Switch Mounting Bracket	Steel	1
38.	Support Bracket	Steel	1
39.	Hex Nut	Steel	1
40.	Hex Hd. Cap Scr.	Steel	1
41.	Spindle Nut	Steel	1
42.	Spirol Pin	Stainless Steel	2
43.	Rd. Hd. Mach. Scr.	Steel	1
44.	Anchor Plate	Steel	1
45.	Spring Seat	M.I.	2
46.	Plates	C.I.	1
47.	Adapter Bushing Nut	M.I.	1
* 48.	"O" Ring #214	Elastomer	1
* 49.	"O" Ring #326	Elastomer	1
50.	Adapter Bushing	Steel	1
51.	Spindle	Stainless Steel	1
52.	Stop Collar	Steel	1
53.	Spirol Pin	Stainless Steel	1
54.	Compressor	C.I.	1
55.	Diaphragm Stud	Brass	

* Recommended spare parts

Body per WAPD Dwg. 498B932

Note: All air inlets 1/4" N.P.T.
Switches shown 90° out of position

20638

ATTACHMENT 3

ITT Industries Letter Dated 1/10/97

FAX COVER SHEET

ITT Industries
AUTOMOTIVE
DEFENSE & ELECTRONICS
FLUID TECHNOLOGY

ITT Engineered Valves
33 Centerville Road
P. O. Box 6164
Lancaster, PA 17603
Telephone (717) 291-1901

DATE: January 10, 1997

TO: Lisa Cona

FROM: Ed Foulke

SUBJECT: Diaphragm Valves

If there are problems with transmission of this fax, please call P. Iovale at 717-291-1901
If there are questions about this fax, please contact the writer at 717-291-1901

MESSAGE:

The following information is a regards to your discussion with Kathy Yohn.

1. The maximum temperature for EPDM is 300° F.

1. Diaphragms have never been tested above 300 psig; therefore, there is no data at exactly what pressure the diaphragms will fail. Also, the failure point of the diaphragm will depend on length of service and irradiation and thermal aging. The makes it even more difficult to predict when a diaphragm will fail. Also, it is possible that there could be body/bonnet joint leakage before the diaphragm fails. The maximum design pressure for the valves listed below is 200 psig.

2. For the 3" diaphragm valve with 3250L air motor, 96 & 97 springs (drawing WREF-PO-5-SS-1), the valve line pressure to open the valves is 207 psig. This is not a conservative number and the actual opening pressure is probably higher. O-ring friction was considered but lubrication, cycle frequency and tolerances could not be taken into account. Also the spring rate has a tolerance of ± 10%.

3. For the 2" valve with 3225 air motor, 101 and 102A springs (drawing WREF-PO-4-SS-1), the minimum valve line pressure to open the valve was found to be ~~282~~ 271 psig KAM. psig. The comments concerning the analysis and variables apply to this configuration as well. The 102A spring, which is the spring we would use if the valve was being supplied today, was used for calculations since no data on the 102 spring could be found. The 102 spring has not been used for many years and the only information we can find on it is that for sizing an actuator, the maximum line pressure for the 102 and 102A springs are the same.

Please contact Kathy Yohn (717-291-1901, ext. 317) if you have any additional questions.

TOTAL PAGES IN THIS FAX ~~1~~ 8 (INCLUDING COVER SHEET)

File AM3225_A.MCD, 1/9/97 KAY 1/9/97

3225 air motor - determination of valve line pressure required to begin opening valve, o-ring friction considered for 2" only - not conservative
K. A. Yohn 1/8/97

nominal dimensions used
layout sketch for air motor - SK-D-607 dated 2/29/72
reference drawings
spring seat 5475 rev. K
AM diaphragm 3891 Rev. P
upper cover 3533 Rev. W
actuator plate 2842 Rev. E2
catalog DV-96
spring drawing 2127 rev. GG

CASE A. FRICTION NEGLECTED

actuator will begin to open when force due to fluid line pressure equals force due to spring compression

spring free length $fl\_101 := 10.12 \cdot in$

$fl\_102a := 10.37 \cdot in$

reference spring rate $sr\_101 := 260 \cdot \frac{lbf}{in}$

$sr\_102a := 140 \cdot \frac{lbf}{in}$

height of springs when valve open (set point for all am's)

overall am height $h_1 := 3.25 \cdot in + 0.19 \cdot in + 8.31 \cdot in$

$h_1 = 11.75 \cdot in$

$h_o := 3.75 \cdot in + 0.19 \cdot in + 2 \cdot \left(\frac{5}{16} \cdot in\right) + 0.50 \cdot in + 1.00 \cdot in$

$h_o = 6.065 \cdot in$

spring height when valve open $h := h_1 - h_o$

$h = 5.685 \cdot in$

valve stoke - 2 & .75" $h_2 := 1.12 \cdot in$

$h_{75} := 0.38 \cdot in$

for 2" valve

spring height when valve closed $hs\_2 := h + h_2$

$hs\_2 = 6.805 \cdot in$

initial compression $c2\_101 := fl\_101 - hs\_2$ $c2\_102a := fl\_102a - hs\_2$

$c2\_101 = 3.315 \cdot in$ $c2\_102a = 3.565 \cdot in$

force to overcome to begin opening valve

$open\_2 := sr\_101 \cdot c2\_101 + sr\_102a \cdot c2\_102a$

$open\_2 = 1361 \cdot lbf$

for 100% pressure drop condition - only one half diaphragm exposed to working fluid before valve begining to open, assume diaphragm bead diameter area is area in contact with fluid, valve will open when force due to line pressure equals initial compression force from springs

$$dia_2 := \left(3 + \frac{11}{16}\right) \cdot in$$

$$dia_2 = 3.688 \cdot in$$

Pressure*diaphragm area = initial compression force

$$Pressure\_2 := \frac{open\_2}{0.5 \cdot \left(\frac{\pi}{4} \cdot dia_2^{\,2}\right)}$$

$$Pressure\_2 = 255 \cdot psi$$

for 0.75" valve

spring height when valve closed $hs\_75 := h + h_{75}$

$hs\_75 = 6.065 \cdot in$

initial compression $c75\_101 := fl\_101 - hs\_75$ $c75\_102a := fl\_102a - hs\_75$

$c75\_101 = 4.055 \cdot in$ $c75\_102a = 4.305 \cdot in$

force to overcome to begin opening valve

$$open\_75 := sr\_101 \cdot c75\_101 + sr\_102a \cdot c75\_102a$$

$$open\_75 = 1657 \cdot lbf$$

for 100% pressure drop condition - only one half diaphragm exposed to working fluid before valve beginning to open, assume diaphragm bead diameter area is area in contact with fluid, valve will open when force due to line pressure equals initial compression force from springs

$$dia_{75} := 1.88 \cdot in$$

Pressure*diaphragm area = initial compression force

$$Pressure\_75 := \frac{open\_75}{0.5 \cdot \left(\frac{\pi}{4} \cdot dia_{75}^{\,2}\right)}$$

$$Pressure\_75 = 1194 \cdot psi$$

CASE B - Line pressure for valve opening when considering friction - 2" ONLY

This is not very exact. Friction can depend upon many factors including: time period since last operation, condition of o-rings, lubrication, base metal corrosion, thermal expansion of metal. This calculation is only an approximation and does not account for these factors which can increase friction.

From the Parker catalog ORD 5700
assume breakout friction = 3* running friction (page A6-5)
when considering o-ring friction two components - seat compression & fluid pressure

#116 o-ring used with 3225 air motors, for yoke mounted configurations 4 used and for close coupled 2 are used, assume yoke mounted - worst case WAPD-CV-SS-6R has 4 o-rings.

a. friction due to seal compression

spindle-bushing o-ring
o-ring #116 dimensions

spindle diameter - dwgs. 4474 & 101448

$id\_o := 0.737 \cdot in$

$od\_b \quad 0.750 \cdot in$

thickness
$w := 0.103 \cdot in$

adapter bushing groove - dwg. 101281 Rev. K

$od\_g \ - 0.926 \cdot in$

adapter bushing bore dia $\quad d_{bore} \quad 0.755 \cdot in$

% stretch of 116 o-ring o-ring installed so that it is stretched to the spindle OD

$$s = \frac{od\_b \quad id\_o}{id\_o} \cdot 100$$

$s = 1.764$

reduction in cross sectional area due to the initial stretching - from Parker Catalog ORD-5700, page A4-7

$Y := 1.3$ for s graph on page A4-7 used for observed data for s, equation does not produce possible results

new cross sectional areas

$w\_str := w - (.01 \cdot Y) \cdot w$

$w\_str = 0.102 \cdot in$

new OD

$OD := od\_b + 2 \cdot (w\_str)$

$OD = 0.953 \cdot in$

groove depth $g := \frac{od\_g - d_{bore}}{2}$

$g = 0.086 \cdot in$

$sq_1 := w\_str - g$

$sq_1 = 0.016 \cdot in$

%squeeze $sq_{1p} := \frac{sq_1}{w\_str} \cdot 100$

$sq_{1p} = 16$

from figure A6-5

$f_c := 1.2 \cdot \frac{lbf}{in}$

$F_c := f_c \cdot l_r$

$F_c = 2.82 \cdot lbf$

from table A6-2

$l_r := 2.35 \cdot in$

$a_r := 0.24 \cdot in^2$

Friction due to line pressure - This is from a graph and is dependent on a graph based upon line pressure, but if it is assumed that the line pressure is approximately 300 psig (conservative) then f_h equals 18 lb/in^2 and if the line pressure is 250 psig then f_h equals approx. 17 lb/in^2.

$f_h := 18 \cdot \frac{lbf}{in^2}$

$F_h := f_h \cdot a_r$

$F_h = 4.32 \cdot lbf$

o-ring breakout friction = 3*(F_c+F_h)* no. of o-rings

$open\_2f := open\_2 + 3 \cdot (F_c + F_h) \cdot 4$

$open\_2f = 1.447 \cdot 10^3 \cdot lbf$

$Pressure := \frac{open\_2f}{0.5 \left(\frac{\pi}{4} \cdot dia_2^{\,2}\right)}$ $Pressure = 271 \cdot psi$

In real life the friction is probably considerable greater

information note - if f_h of 17 psig used pressure changes to 270 psig - negligible

3250 air motor - determination of valve line pressure required to begin opening valve,
o-ring friction included in final calculations, case A does not include friction, case B includes friction

by K. A Yohn 12/27/96
nominal dimensions used
layout sketch for air motor - SK-D-610
reference drawings
spring seat 5475 Rev. K
AM diaphragm 3543 Rev. AA
upper cover 1869 Rev. F3
actuator plate 4456 Rev. G
spring case 4460 Rev. F
spring case cover 4463 Rev. K1
catalog DV-96
spring drawing 2127 rev. GG

CASE A - neglecting o-ring friction

The actuator will begin to open when the force due to fluid line pressure equals force due to spring initial compression, when o-ring friction neglected.

spring free length $fl\_96 := 17.38 \cdot in$ reference spring rate $sr\_96 := 237 \cdot \frac{lbf}{in}$

$fl\_97 := 17.38 \cdot in$ $sr\_97 := 135 \cdot \frac{lbf}{in}$

height of springs when valve open (set point for all air motors)

spring height = spring case height + spring distance below case when open (x)

$h_c := 9.38 \cdot in$

$x := (4.16 \cdot in + 0.12 \cdot in + 2.94 \cdot in) - (4.97 \cdot in + 0.69 \cdot in + 0.12 \cdot in + 0.53 \cdot in + 0.50 \cdot in)$

$x = 0.41 \cdot in$

spring height when open $h := h_c + x$

$h = 9.79 \cdot in$

stroke for 3" valve $h_3 := 1.62 \cdot in$

spring height when valve closed

$hs\_3 := h + h_3$

$hs\_3 = 11.41 \cdot in$

initial compression $c3\_96 := fl\_96 - hs\_3$ $c3\_97 := fl\_97 - hs\_3$

$c3\_96 = 5.97 \cdot in$ $c3\_97 = 5.97 \cdot in$

force to overcome to begin opening valve

$open\_3 := sr\_96 \cdot c3\_96 + sr\_97 \cdot c3\_97$

$open\_3 = 2340 \cdot lbf$

For 100% pressure drop condition - only one half diaphragm exposed to working fluid before valve begins to open. One half the diaphragm bead diameter area is assumed to be the area in contact with fluid, valve will open when force due to line pressure equals initial compression force from springs

$dia_3 = 5.5 \cdot in$

Pressure * diaphragm area = initial compression force

$$Pressure := \frac{open\_3}{0.5 \cdot \left(\frac{\pi}{4} \cdot dia_3^2\right)} \qquad Pressure = 197 \cdot psi$$

CASE B - Line pressure for valve opening when considering friction

This is not very exact. Friction can depend upon many factors including: time period since last operation, condition of o-rings, lubrication, base metal corrosion, thermal expansion of metal. This calculation is only an approximation and does not account for these factors which can increase friction.

From the Parker catalog ORD 5700
assume breakout friction = 3* running friction (page A6-5)
when considering o-ring friction two components - seat compression & fluid pressure

#214 o-ring used with 3250L air motors, for yoke mounted configurations 4 used and for close coupled 2 are used, assume yoke mounted - worst case WAPD-CV-SS-8R has 4 o-rings.

a. friction due to seal compression
spindle ~~bonnet~~ bushing o-ring CA 1/13/97
o-ring #214 dimensions

spindle diameter - dwgs. 102601 & 102610

$id\_o := 0.984 \cdot in$

$od\_b := 1.000 \cdot in$

thickness
$w := 0.139 \cdot in$

adapter bushing groove - dwg. 101282 Rev. K

$od\_g := 1.240 \cdot in$

adapter bushing bore dia $d_{bore} := 1.005 \cdot in$

% stretch of 214 o-ring o-ring installed so that it is stretched to the spindle OD

$$s := \frac{od\_b - id\_o}{id\_o} \cdot 100$$

$s = 1.626$

reduction in cross sectional area due to the initial stretching - from Parker Catalog ORD-5700, page A4-7

$Y := 1.2$ for s graph on page A4-7 used for observed data for s, equation does not produce possible results

new cross sectional areas

$w\_str := w - (.01 \cdot Y) \cdot w$

$w\_str = 0.137 \cdot in$

new OD

$OD := od\_b + 2 \cdot (w\_str)$

$OD = 1.275 \cdot in$

File AM3250_2.MCD, 1/2/97

groove depth

$$g := \frac{od\_g - d_{bore}}{2}$$

$$g = 0.117 \cdot in$$

$$sq_1 := w\_str - g$$

$$sq_1 = 0.02 \cdot in$$

%squeeze

$$sq_{1p} := \frac{sq_1}{w\_str} \cdot 100$$

$$sq_{1p} = 14$$

from figure A6-5

$$f_c := 0.95 \cdot \frac{lbf}{in}$$

$$F_c := f_c \cdot l_r$$

$$F_c = 2.983 \cdot lbf$$

from table A6-2

$$l_r := 3.14 \cdot in$$

$$a_r := 0.43 \cdot in^2$$

Friction due to line pressure - This is from a graph and is dependent on a graph based upon line pressure, but if it is assumed that the line pressure is approximately 250 psig (conservative) then f_h equals 17.5 lb/in² and if the line pressure is 200 psig then f_h equals approx. 15 lb/in².

$$f_h := 17 \cdot \frac{lbf}{in^2}$$

$$F_h := f_h \cdot a_r$$

$$F_h = 7.31 \cdot lbf$$

o-ring breakout friction = 3*(F_c+F_h)* no. of o-rings

$$open\_3f := open\_3 + 3 \cdot (F_c + F_h) \cdot 4$$

$$open\_3f = 2.464 \cdot 10^3 \cdot lbf$$

$$Pressure := \frac{open\_3f}{0.5 \cdot \left(\frac{\pi}{4} \cdot dia_3^{\,2}\right)} \qquad Pressure = 207 \cdot psi$$

In real life the friction is probably considerable greater

information note - if f_h of 15 psig used pressure changes to 207 psig - negligible