Dwg. #44113-A

NEBRASKA PUBLIC POWER DISTRICT

COOPER NUCLEAR STATION

CONTAINMENT PURGE AND VENT VALVE

OPERABILITY REPORT

PREPARED BY: R. W. Zeigler DATE: 11/21/83

CHECKED BY: [signature] DATE: 11/22/83

APPROVED BY: H. L. Goldman DATE: 11/23/83

ALLIS-CHALMERS VALVE OPERATIONS

NOVEMBER 1983

TABLE OF CONTENTS

VALVES COVERED BY THIS REPORT ARE AS FOLLOWS:

TAG NO.	SIZE	OPERATOR	LOCATION
PC-230-MV	24"	MOTOR H2BC/SMB0015 LIMITORQUE	WETWELL
PC-245-AV	24"	AIR-SPRING BETTIS 744A-SRI	WETWELL
PC-233-MV	24"	MOTOR H2BC/SMB0015 LIMITORQUE	WETWELL
PC-237-AV	24"	AIR-SPRING BETTIS 744A-SRI	WETWELL
PC-231-MV	24"	MOTOR H2BC/SMB0015 LIMITORQUE	DRYWELL
PC-246-AV	24"	AIR-SPRING BETTIS T-420B-SRI	DRYWELL
PC-232-MV	24"	MOTOR H2BC/SMB0015 LIMITORQUE	DRYWELL
PC-238-AV	24"	AIR-SPRING BETTIS T-420B-SRI	DRYWELL

ALL VALVE ORIENTATIONS, TORQUE COEFFICIENTS, PRESSURE DROPS, ETC. USED IN THIS REPORT WERE TAKEN FROM ALLIS-CHALMERS REPORT VER-0209 DATED 12/17/79.

CUSTOMER NPPD Cooper Nuclear Station | DATE 11/83 | SHEET 3 OF

SUBJECT Valve Operability Summary | PRELIM. | FINAL

DRAWING NUMBER

LITHO IN U.S.A.-A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY R. J. Cain

Valve Number	230 MV	245 AV
Location	Wetwell	Wetwell
Closing times considered	14 sec.	14 sec.
As Installed Ref. Test No.	29 or 32	30 or 31
As Installed Ref. Fig. No.	9 or 10	11 or 12
Proposed Installation Ref. Test No.	—	—
Proposed Installation Ref. Fig. No.	—	—
As Installed Torque Margin	72 % min.	158 % min.
Proposed Installation Torque Margin	—	—
Comments	Minimum operator torque switch setting should be 1.75 to develop 1300'# output.	

CUSTOMER: NPPD Cooper Nuclear Station | DATE: 11/83 | SHEET 4 OF

SUBJECT: Valve Operability Summary | PRELIM. | FINAL

DRAWING NUMBER

LITHO IN U.S.A.-A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY: R.J.

Valve Number	233 MV	237 AV
Location	Wetwell	Wetwell
Closing times considered	14 sec.	14 sec.
As Installed Ref. Test No.	31 & 32	31 & 32
As Installed Ref. Fig. No.	12 & 10	12 & 10
Proposed Installation Ref. Test No.	—	—
Proposed Installation Ref. Fig. No.	—	—
As Installed Torque Margin	191% min.	159% min.
Proposed Installation Torque Margin	—	—
Comments	Minimum operator torque switch setting should be 1.75 to develop 1300 ft# output.	

CUSTOMER: NPPD Cooper Nuclear Station | DATE: 11/83 | SHEET 5 OF

SUBJECT: Valve Operability Summary | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.-A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS | FORM 6715-1

CALCULATED BY: R.J. Clift

Valve Number	231 MV	246 AV
Location	Drywell	Drywell
Closing times considered	14 sec. & 4 sec.	14 sec. & 9 sec.
As Installed Ref. Test No.	#3	#3
As Installed Ref. Fig. No.	—	—
Proposed Installation Ref. Test No.	29 & 32	29 & 32
Proposed Installation Ref. Fig. No.	9 & 10	9 & 10
As Installed Torque Margin	Valve shaft and operator limits exceeded.	Valve shaft and operator limits exceeded.
Proposed Installation Torque Margin	115 %	45 % min.
Comments	115 % torque margin based on changing valve orientation to match Figs. 9 & 10. Minimum torque switch setting should be 1.75. Torque margin can be increased by setting torque switches to 2.125.	45 % min. torque margin based on torque absorption capability of operator. Valve orientation must be changed to match Figs. 9 & 10.

CUSTOMER NPPD Cooper Nuclear Station | DATE 11/83 | SHEET 6 OF

SUBJECT Valve Operability Summary | PRELIM. | FINAL

DRAWING NUMBER

LITHO IN U.S.A.-A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY R. E. B.

Valve Number	232 MV	233 AV
Location	Drywell	Drywell
Closing times considered	4 sec. & 14 sec.	6, 9 & 14 sec.
As Installed Ref. Test No.	29 & 30	No data
As Installed Ref. Fig. No.	9 & 11	—
Proposed Installation Ref. Test No.	—	30
Proposed Installation Ref. Fig. No.	—	11.
As Installed Torque Margin	37%	No data
Proposed Installation Torque Margin	—	7% momentary min.
Comments	Minimum operator torque switch setting should be 1.75 to develop 1300'# output.	Valve orientation must be changed to match Fig. 11. 7% momentary min. margin is based on operator torque absorption capability and not on ability of operator to close.

Nebraska Public Power District

GENERAL OFFICE
P.O. BOX 499, COLUMBUS, NEBRASKA 68601-0499
TELEPHONE (402) 564-8561

August 15, 1983

Mr. R. H. Zeiders
Allis-Chalmers Corporation
Box M-93
York, Pennsylvania 17405

Dear Mr. Zeiders:

Per our recent discussions, the three purge valves the NRC questioned at CNS have been radiographed. In addition, a field examination of purge valve 238AV was possible by entering the pipeline. The results are as follows:

238AV	-	Curved surface faces flow i.e. seat is downstream.
231MV	-	Flat surface faces flow i.e. seat is upstream.
246AV	-	Flat surface faces flow i.e. seat is upstream.

An updated curve for the CNS drywell and wetwell pressures versus time for a design basis accident is attached. It should be noted that the maximum pressure condition for the drywell is reached around 3 seconds into the accident.

If you should have any questions, please contact either Mark Hillstrom of myself.

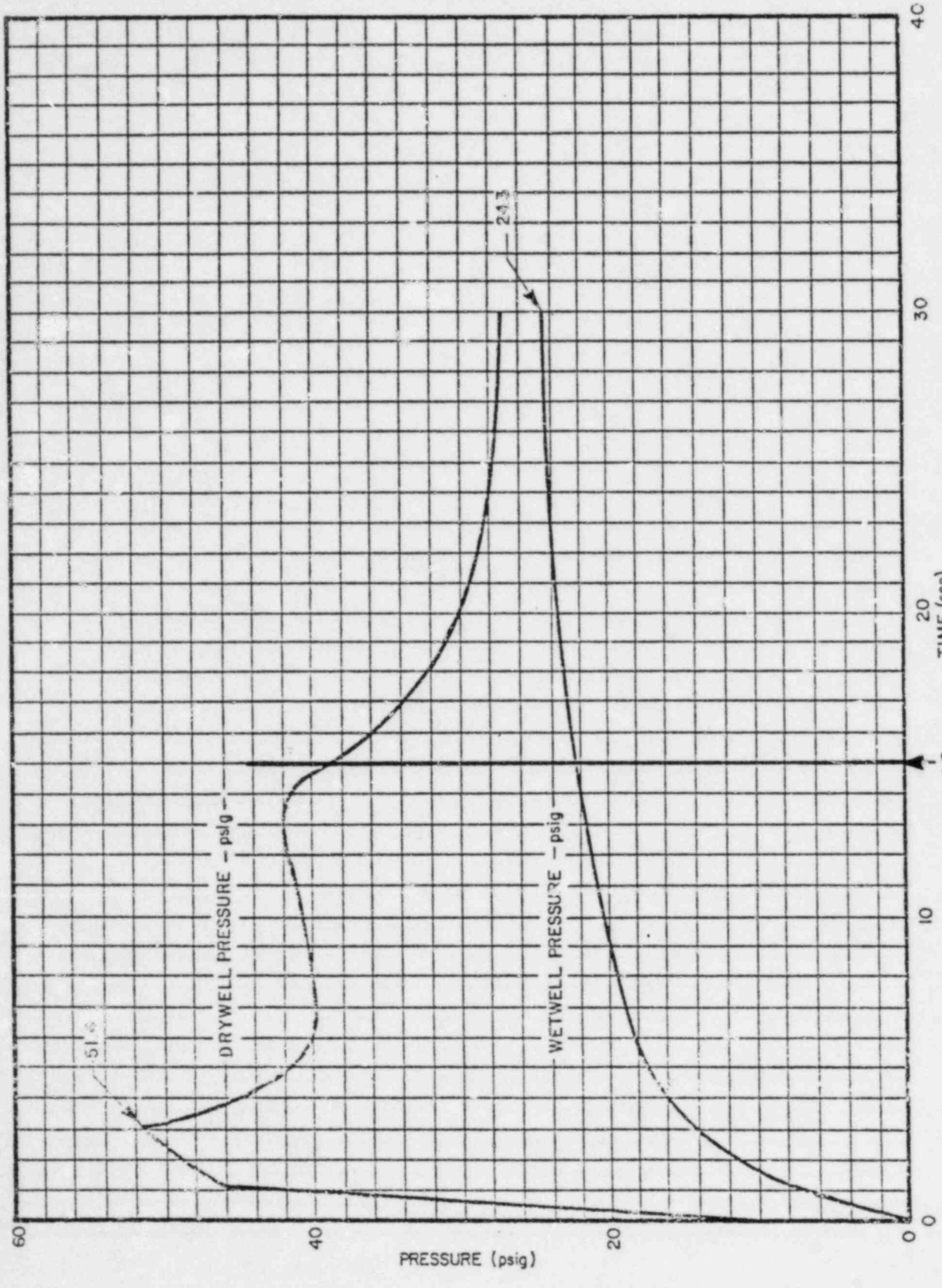
Sincerely,

Mark Hillstrom

For Kenneth J. Done
Senior Mechanical
Engineer

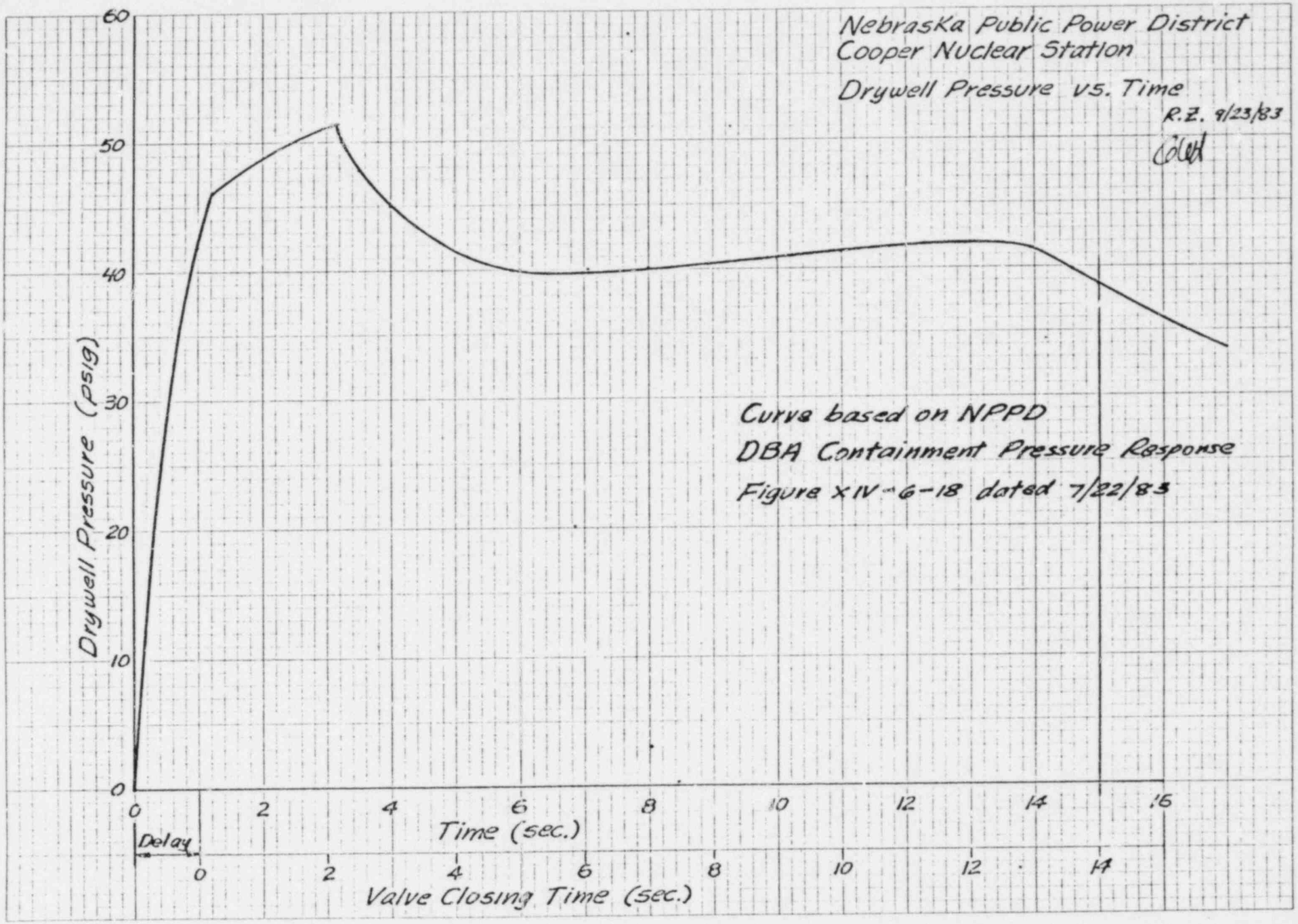
KJD/ck

cc: G. S. McClure w/attachment
J. D. Weaver "
W. H. Rushton "
G. Mace "
M. A. Hillstrom "
File 14(16)1 "



Nebraska Public Power District
COOPER NUCLEAR STATION
UPDATED SAFETY ANALYSIS REPORT (USAR)

DBA Containment
~~Temperature~~ Response
Figure XIV-6-18
7/22/83



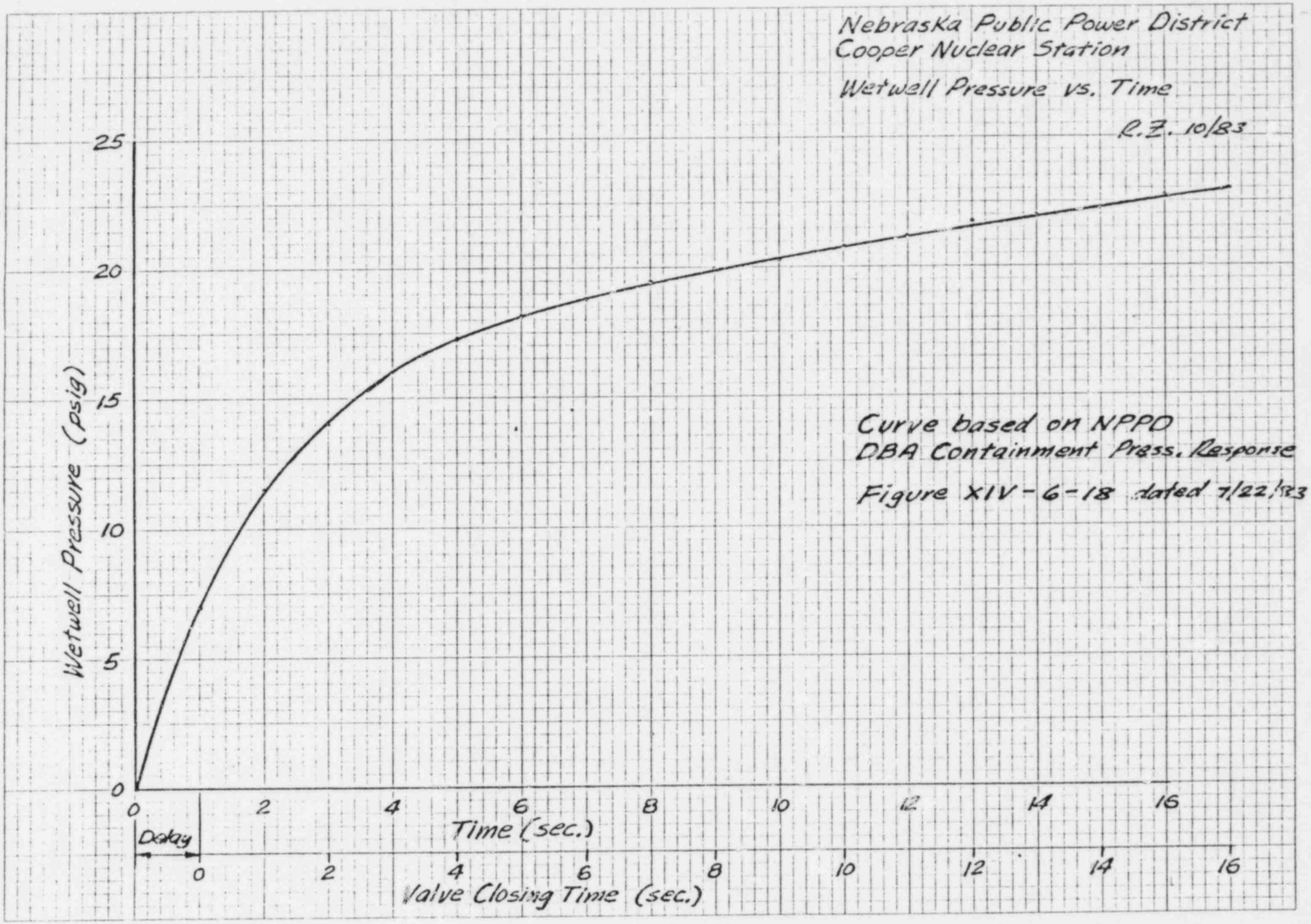
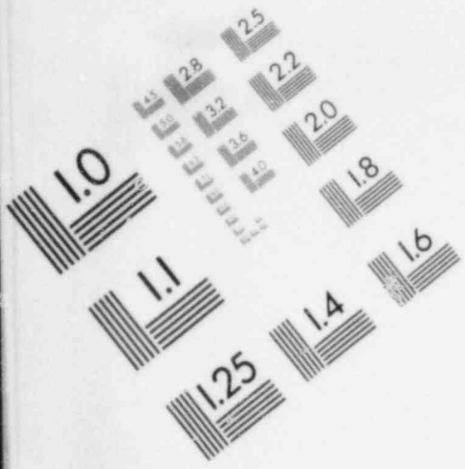
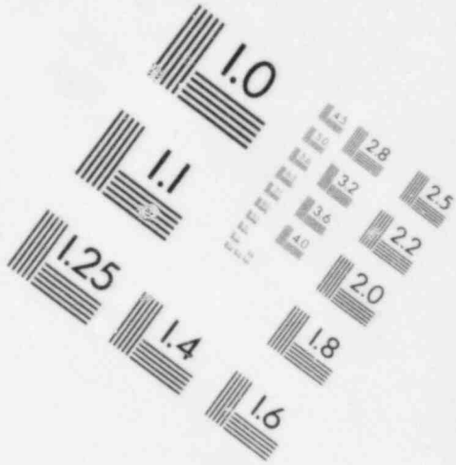
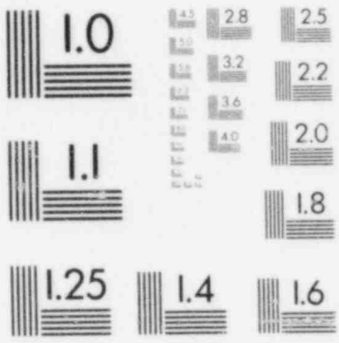
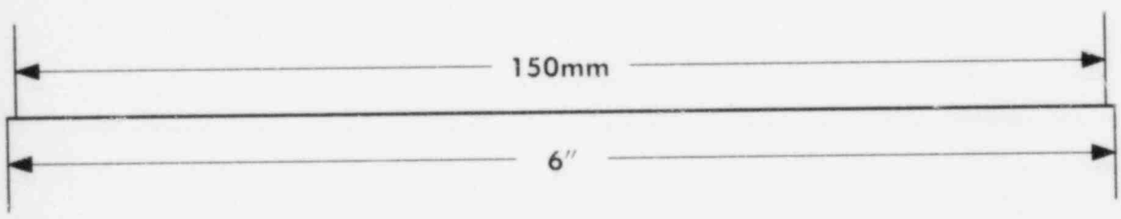


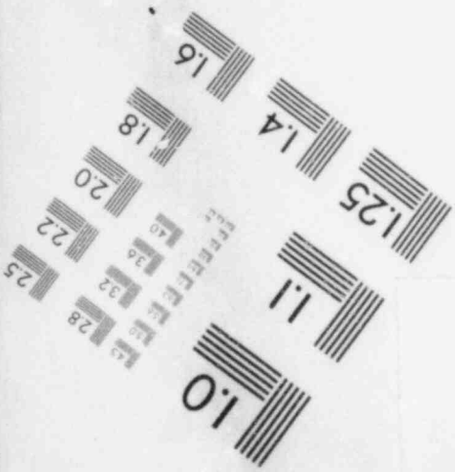
IMAGE EVALUATION
TEST TARGET (MT-3)

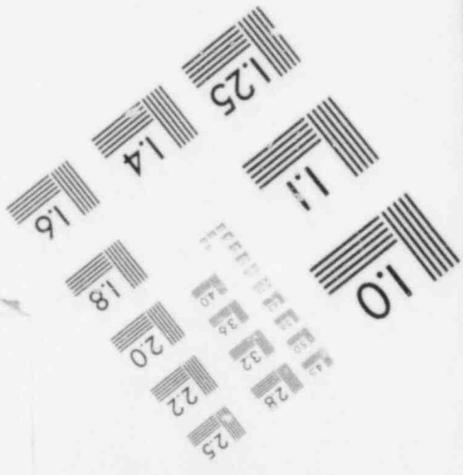












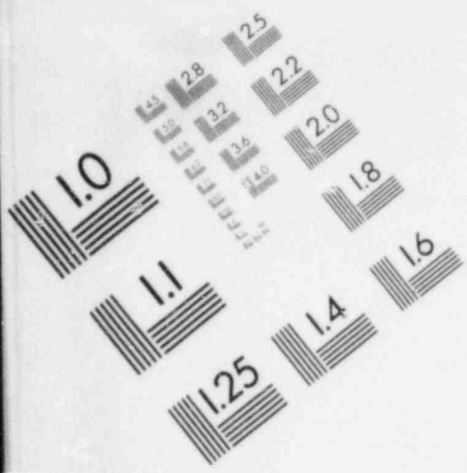
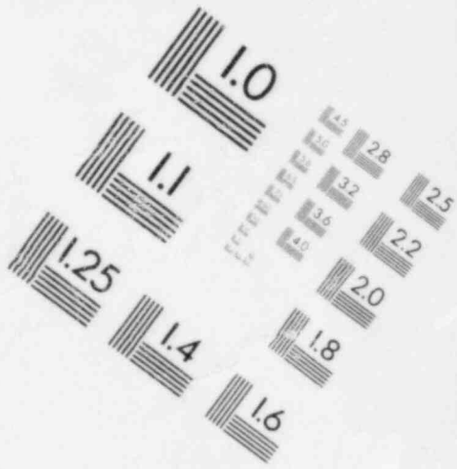
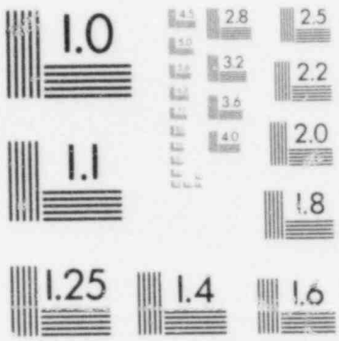
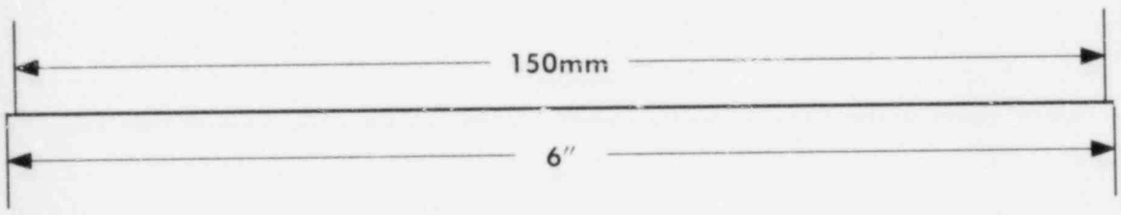
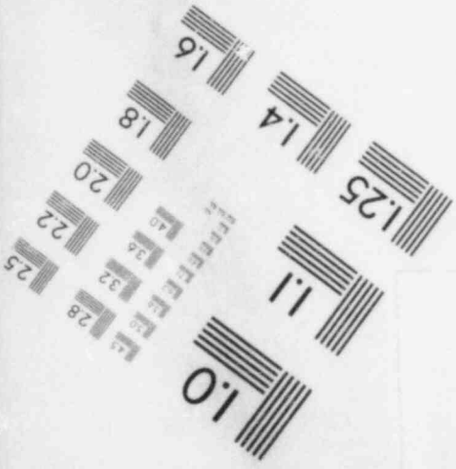


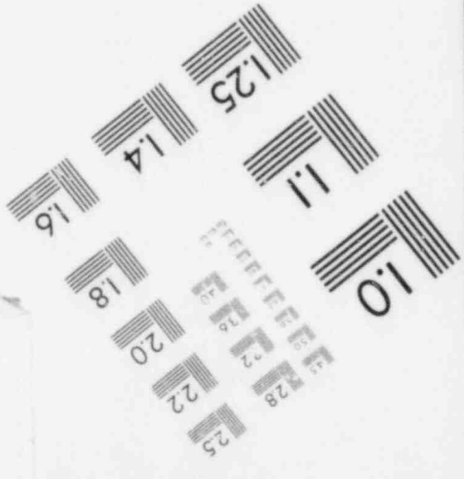
IMAGE EVALUATION TEST TARGET (MT-3)











ALLIS-CHALMERS

BOX M-93 • YORK, PENNSYLVANIA 17405/717-848-1126

YORK PLANT
VALVE DIVISION

Operating Times For Purge & Vent Valves

Several definitions of operating times have been associated with purge and vent valve operation. Some clarification is in order:

a. DELAY TIME

The amount of time between the initiation of an event and the beginning of valve closure. During this time, the event is sensed by appropriate equipment, the valve is signaled to close, and closure just begins.

b. MAXIMUM TECHNICAL SPECIFICATION TIME

For a particular operating plant, the maximum time allowed for all valves to close after the initiation of an event. This includes delay time.

c. NORMAL NO LOAD VALVE OPERATING TIME

Valve closing time with the valve in a no flow - no pressure condition. Delay time is not considered.

d. VALVE OPERATING TIME - LOCA CONDITION

The time it would actually take for a valve to close during a LOCA. This time is affected by the type of operator and the opening or closing tendency of the disc.

The most conservative approach for determining this time is to use: (1) the Technical Spec time plus a factor if the disc tends to open or (2) the normal no load operating time plus a factor if the disc tends to open, whichever is greater.

Longer closing times are conservative, however, only if the valve is closing against an increasing pressure ramp. Each valve must be evaluated on an individual basis considering operator capability and pressure ramp characteristics.

R. H. Zeiders
November, 1983

NPPD Tech. Spec. closing time 15 seconds.

Stroke Time Used In Analysis

Valve 230 MV

Valve closing time used in analysis - 14 seconds
Actual approximate valve closing time - 4 seconds

For closing times longer than 14 seconds, torques could increase about 10% posing no problems for operator or shaft ratings.

Valve 245 AV

Valve closing time used in analysis - 14 seconds
Actual approximate valve closing time considering disc tendency to open - 9 seconds

For closing times as long as 21 seconds, torques could increase by about 10% posing no problems for operator or shaft ratings.

Valve 233 MV

Same conservatism as 230 MW.

Valve 237 AV

Same conservatism as 245 AV.

Valve 231 MV

Valve closing times used in analysis - 4 seconds and 14 seconds
Actual approximate valve disc closing time - 4 seconds

For closing times longer than 14 seconds, torques descrease because of decreasing pressure ramp.

Valve 246 AV

Valve closing time used in analysis - 9 seconds and 14 seconds
Actual approximate disc closing time considering disc tendency to open - 9 seconds

For closing times longer than 14 seconds, torques descrease because of decreasing pressure ramp.

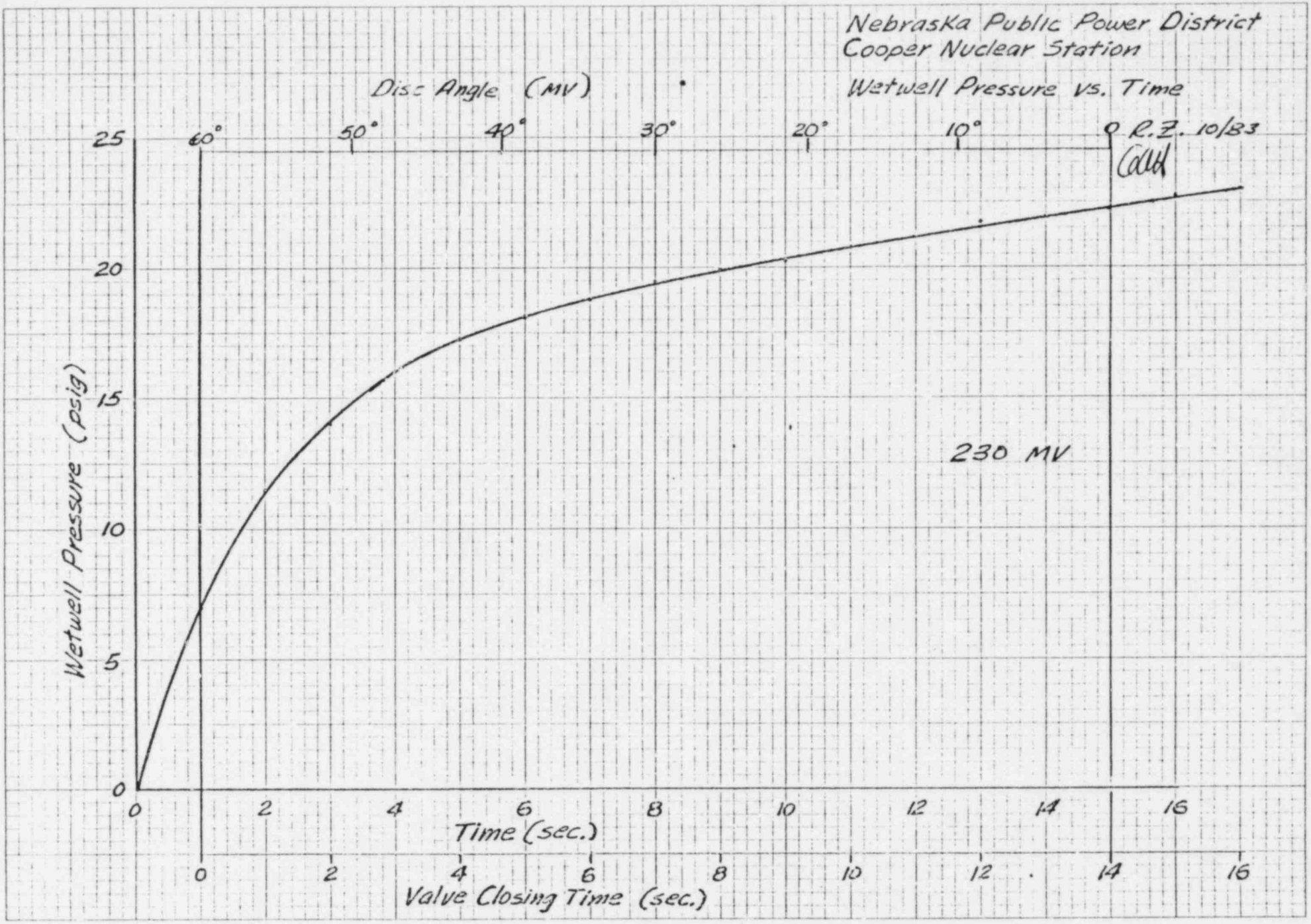
Valve 232 MV

Valve closing time used in analysis - 4 seconds and 14 seconds
Same conservatism as 231 MV.

Valve 238 AV

Valve closing times used in analysis - 6 seconds, 9 seconds, and 14 seconds
Same conservatism as 246 AV.

#230



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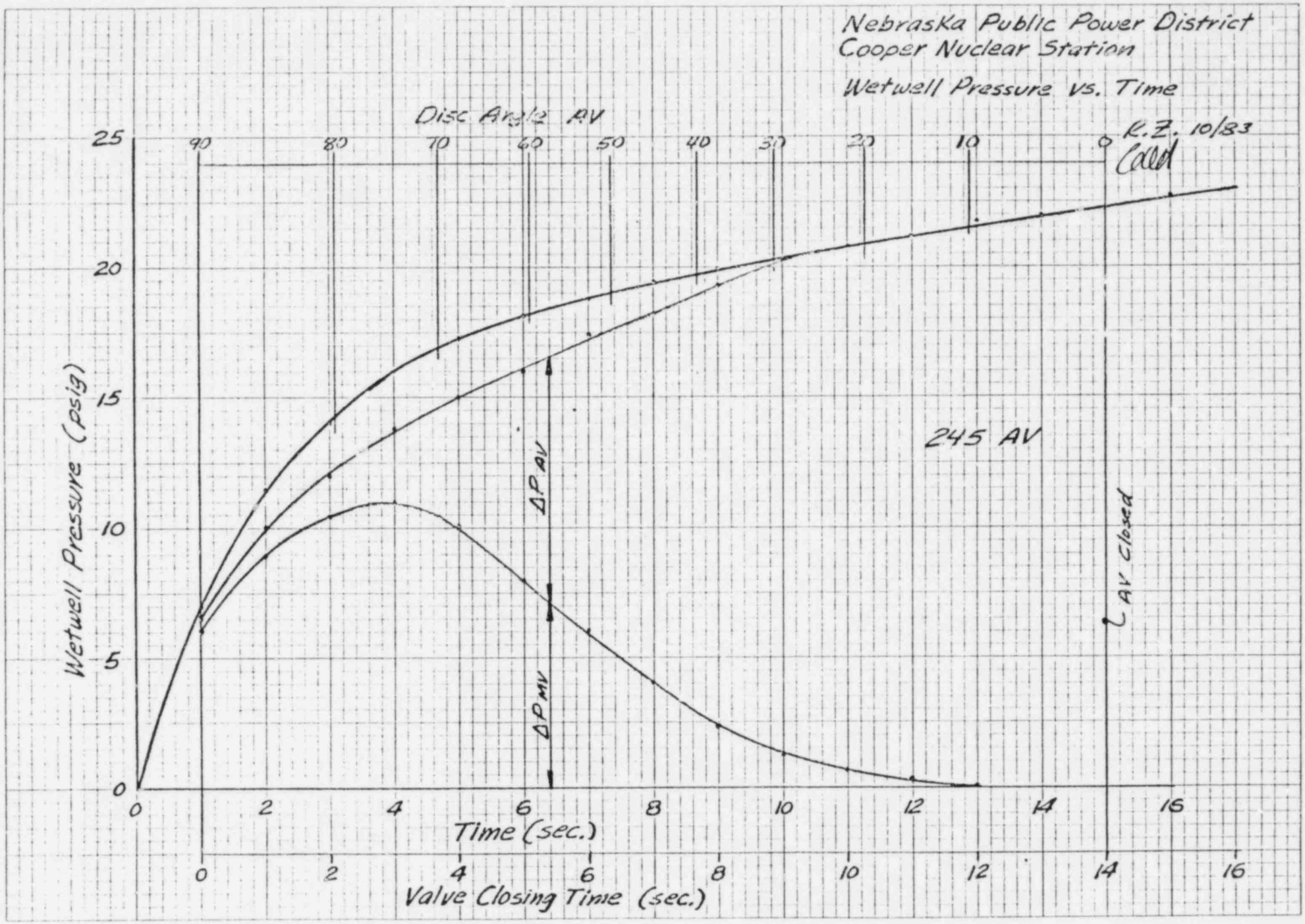

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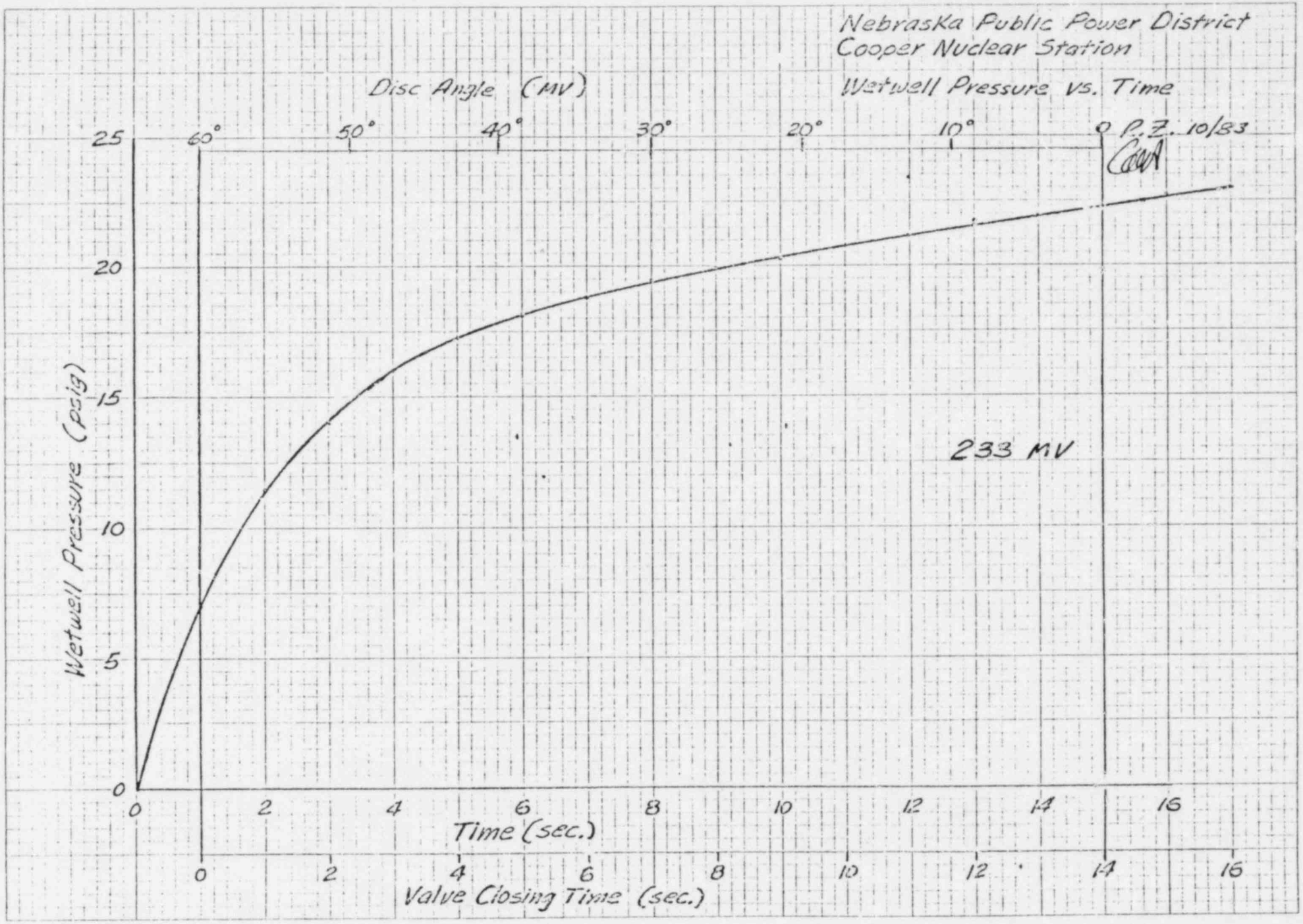

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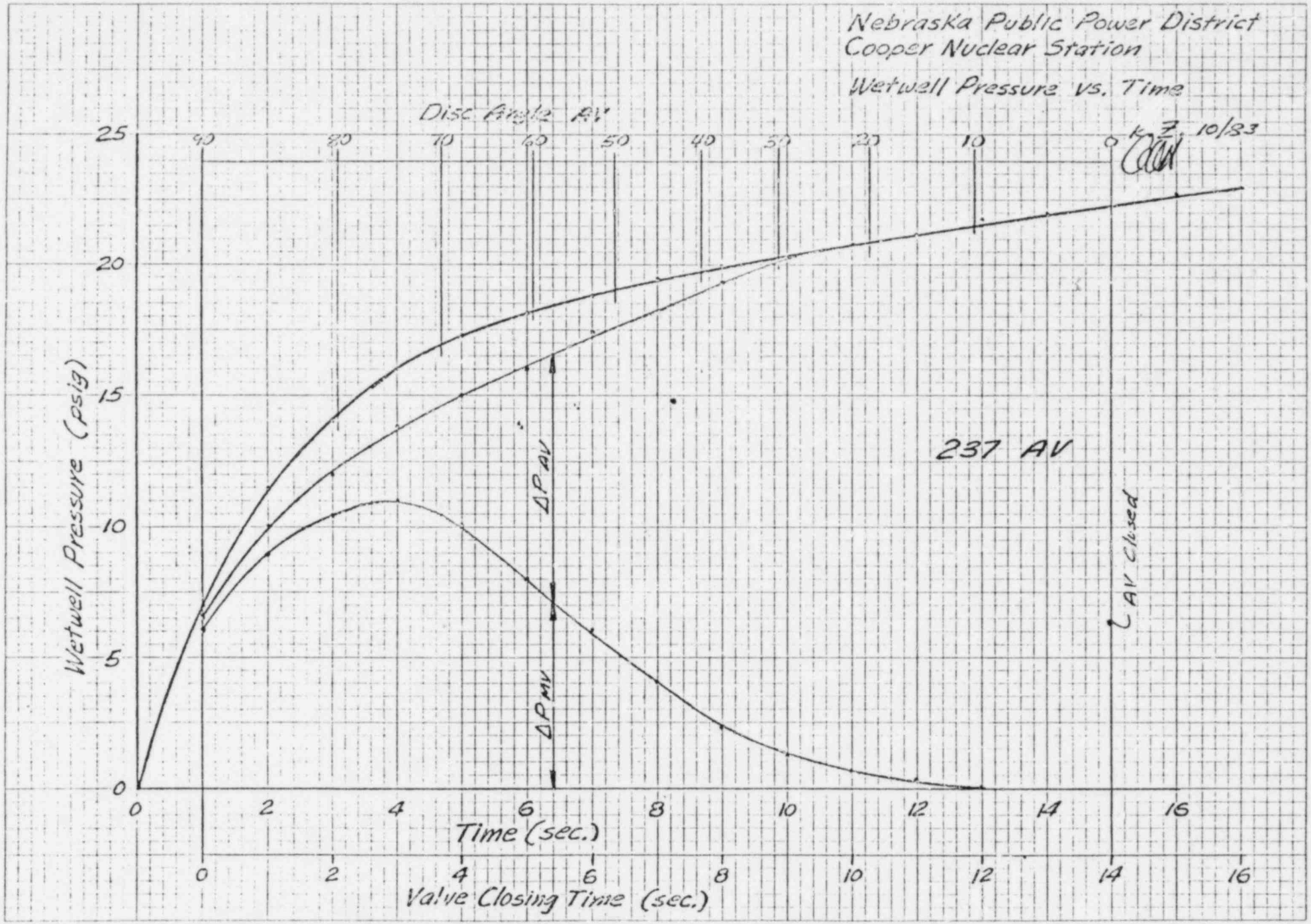

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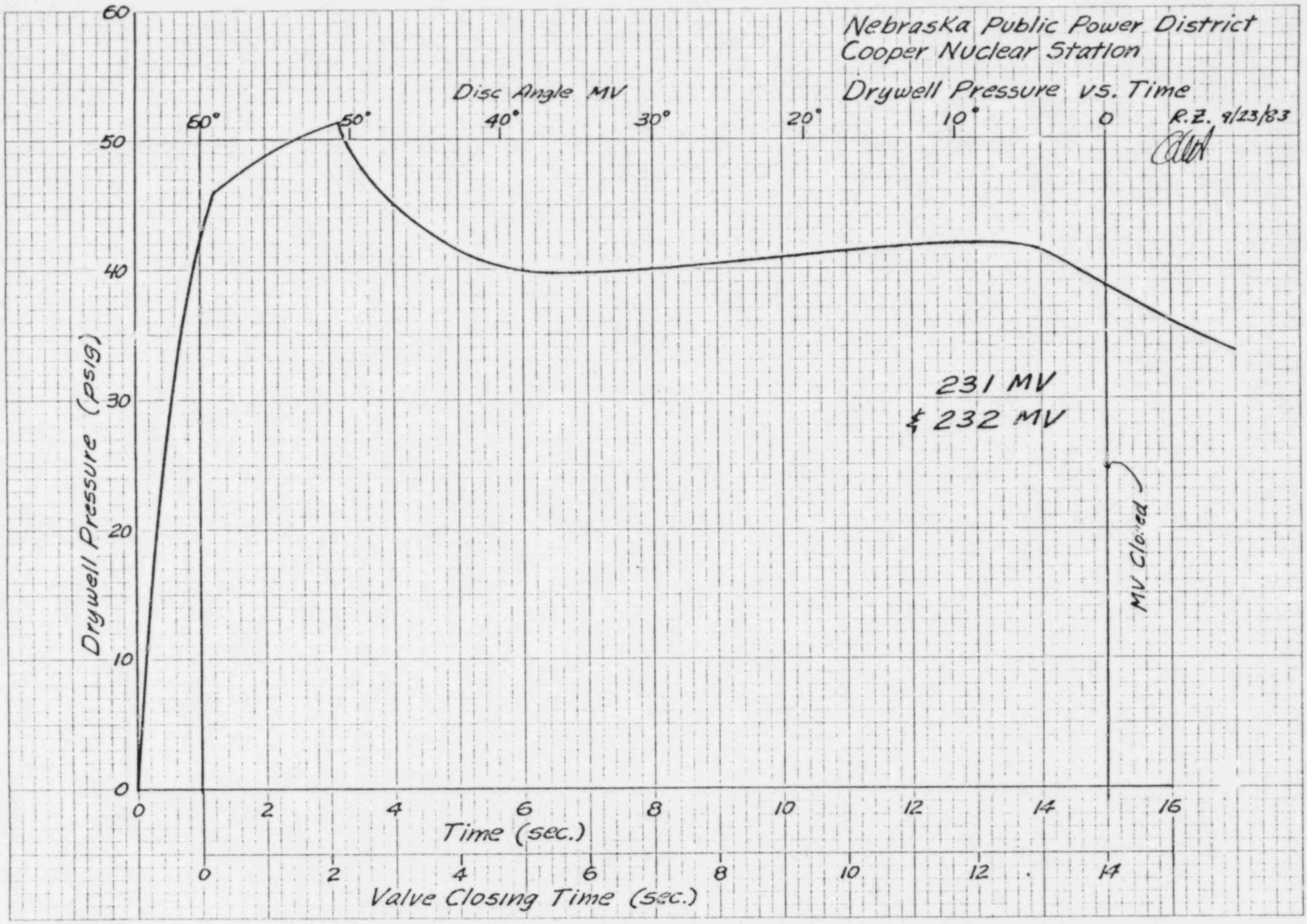
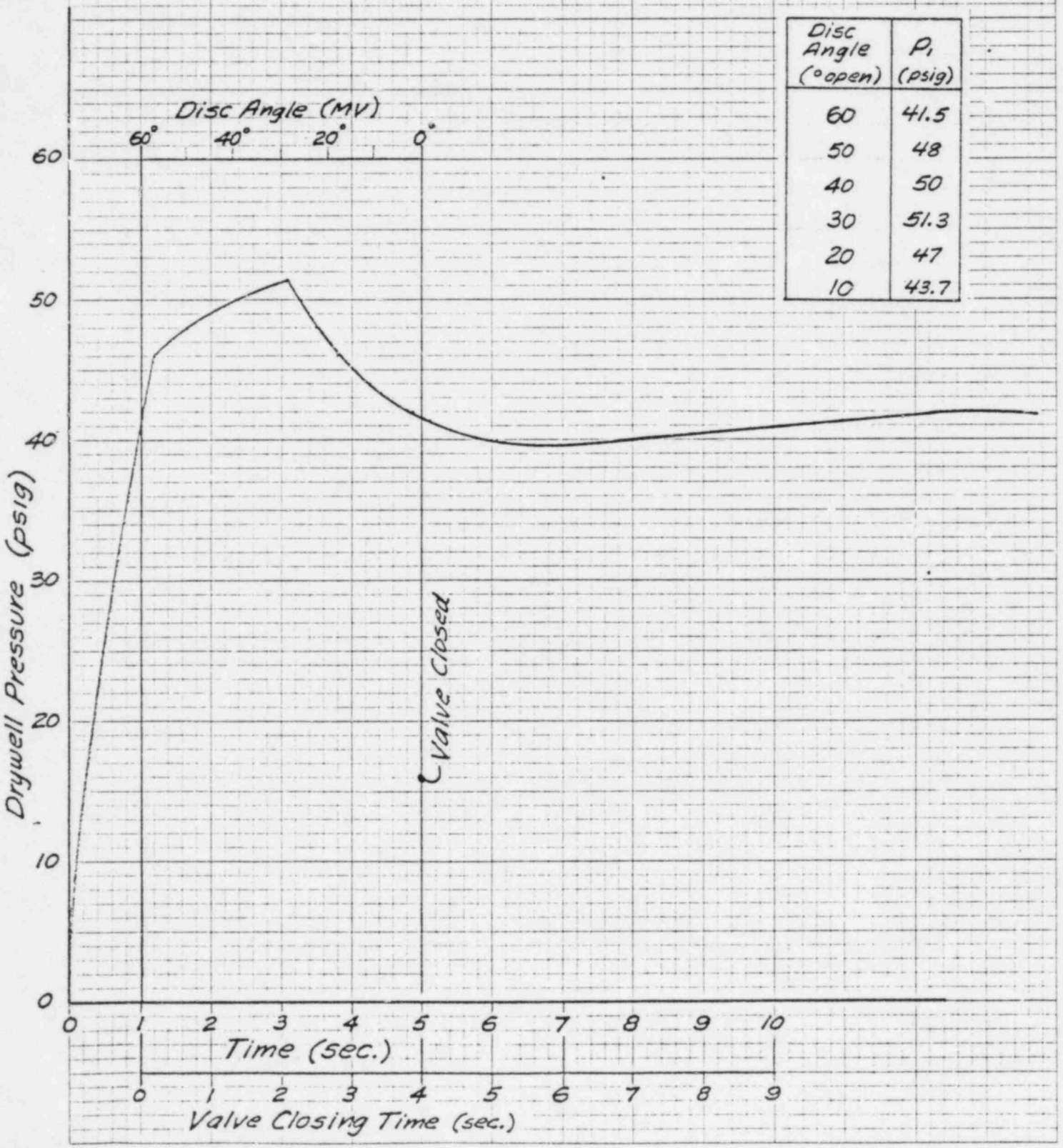


Nebraska Public Power District
Cooper Nuclear Station

Drywell

Valve 231 MV & 232 MV

Disc Angle (°open)	P_1 (psig)
60	41.5
50	48
40	50
30	51.3
20	47
10	43.7



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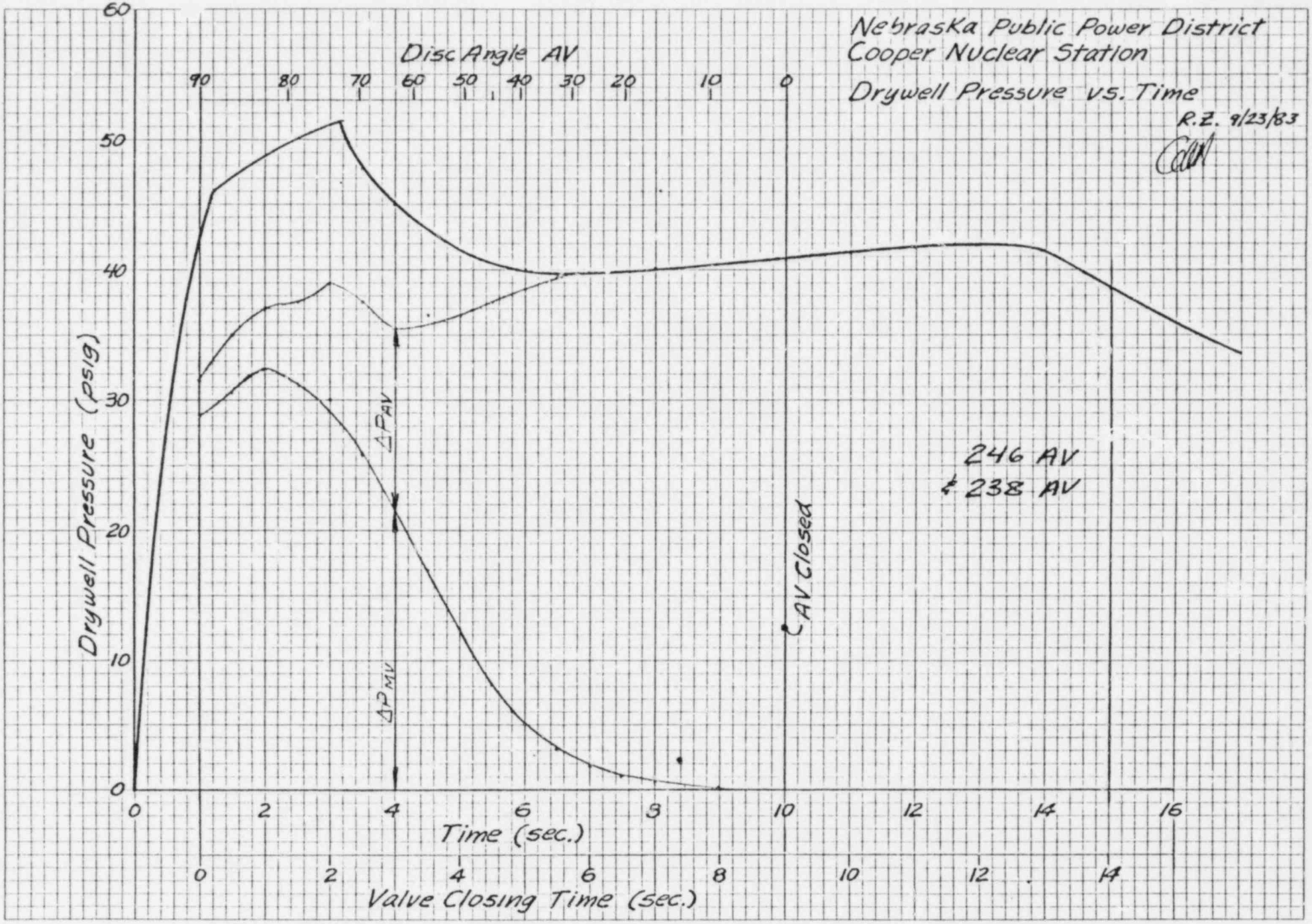

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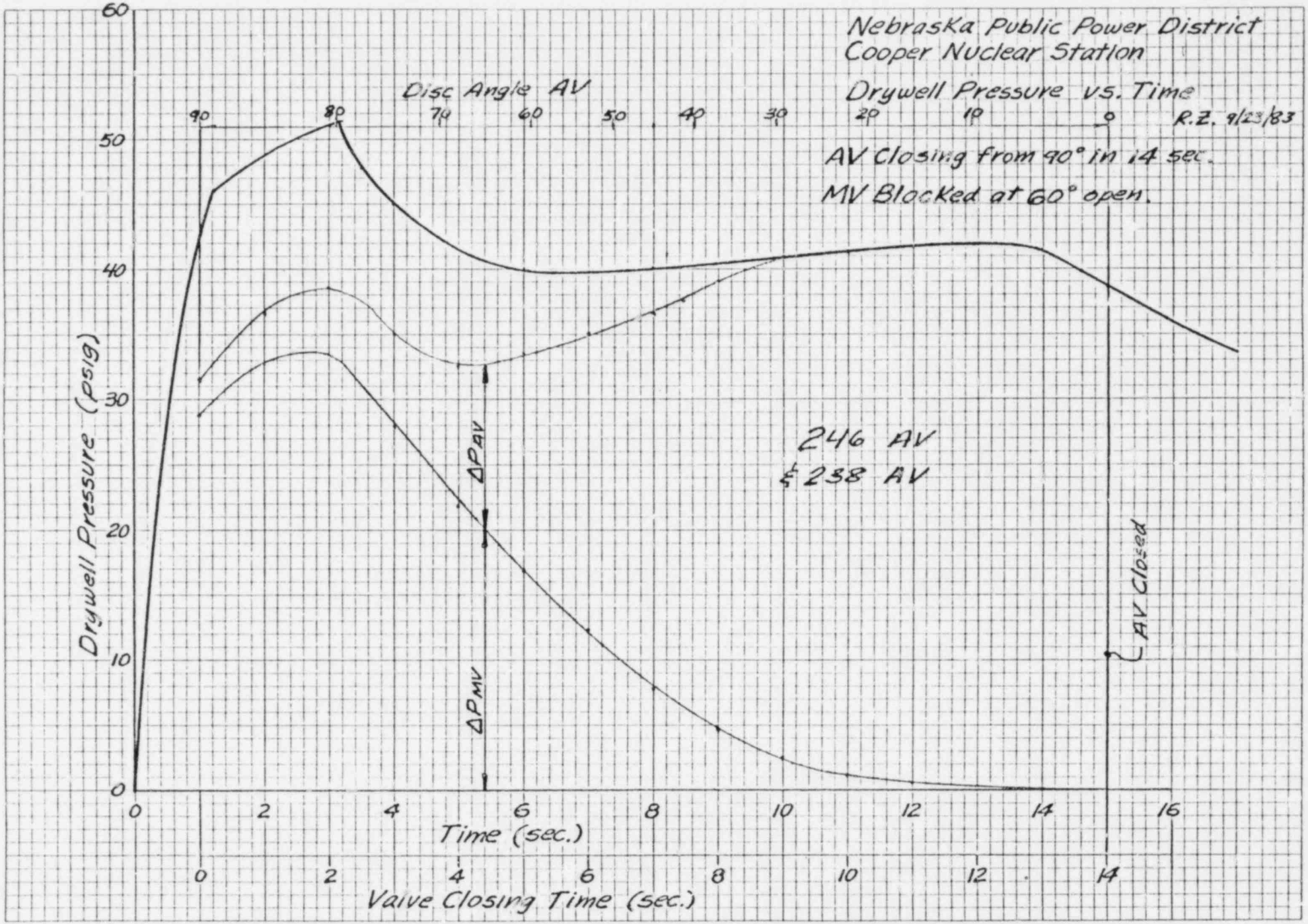
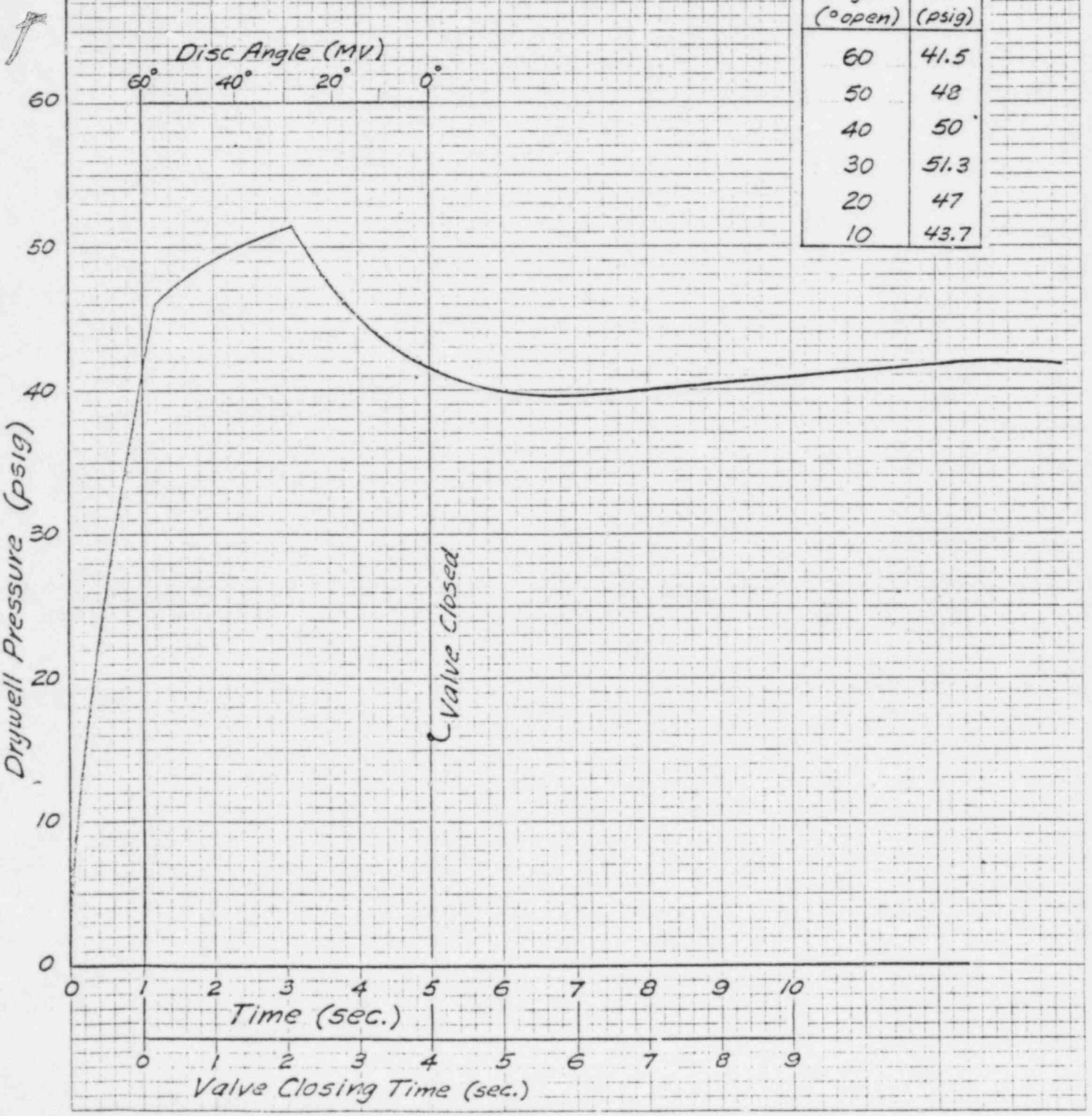


Nebraska Public Power District
Cooper Nuclear Station

Drywell

Valve 231 MV & 232 MV

Disc Angle (° open)	P_1 (psig)
60	41.5
50	48
40	50
30	51.3
20	47
10	43.7



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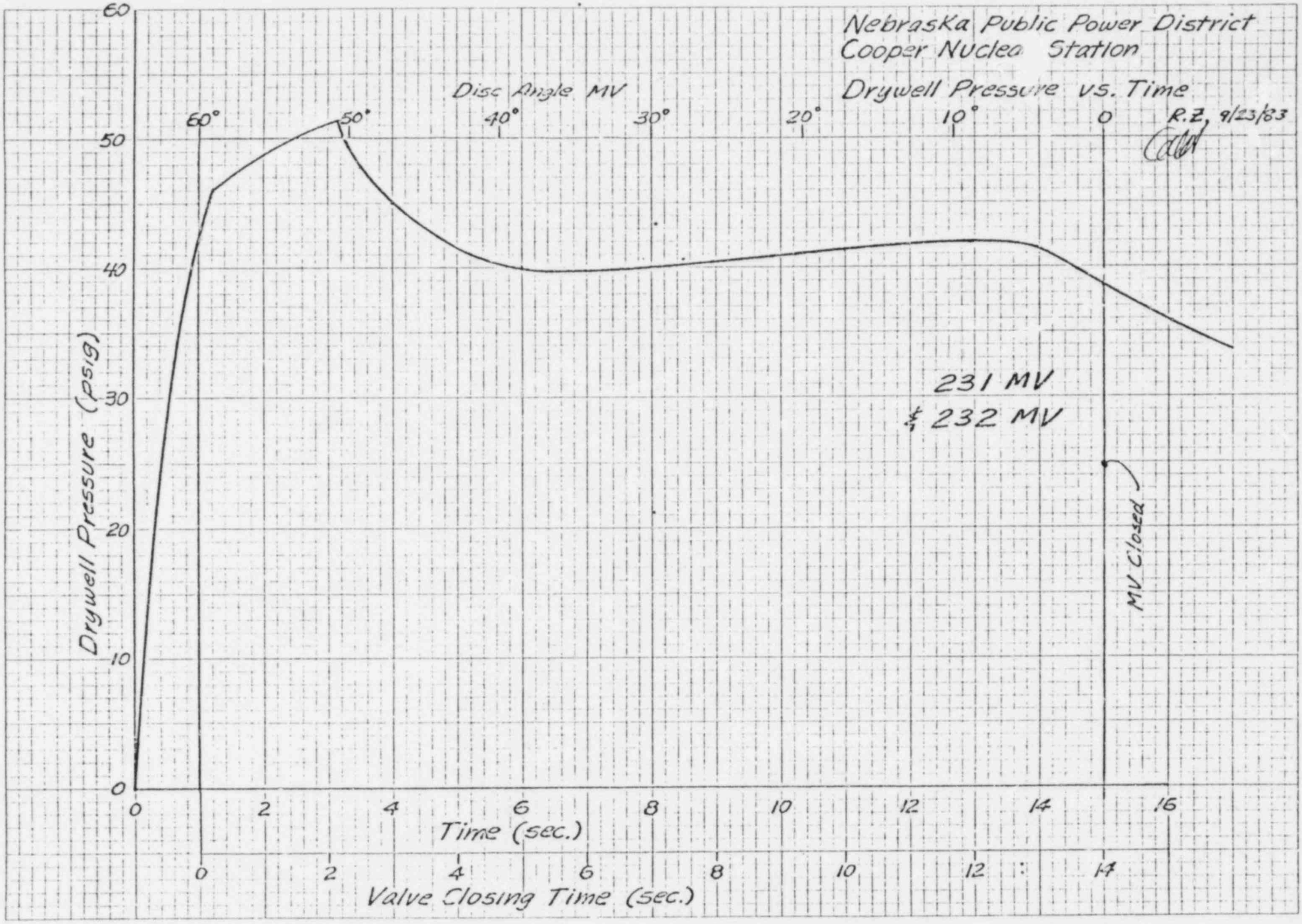
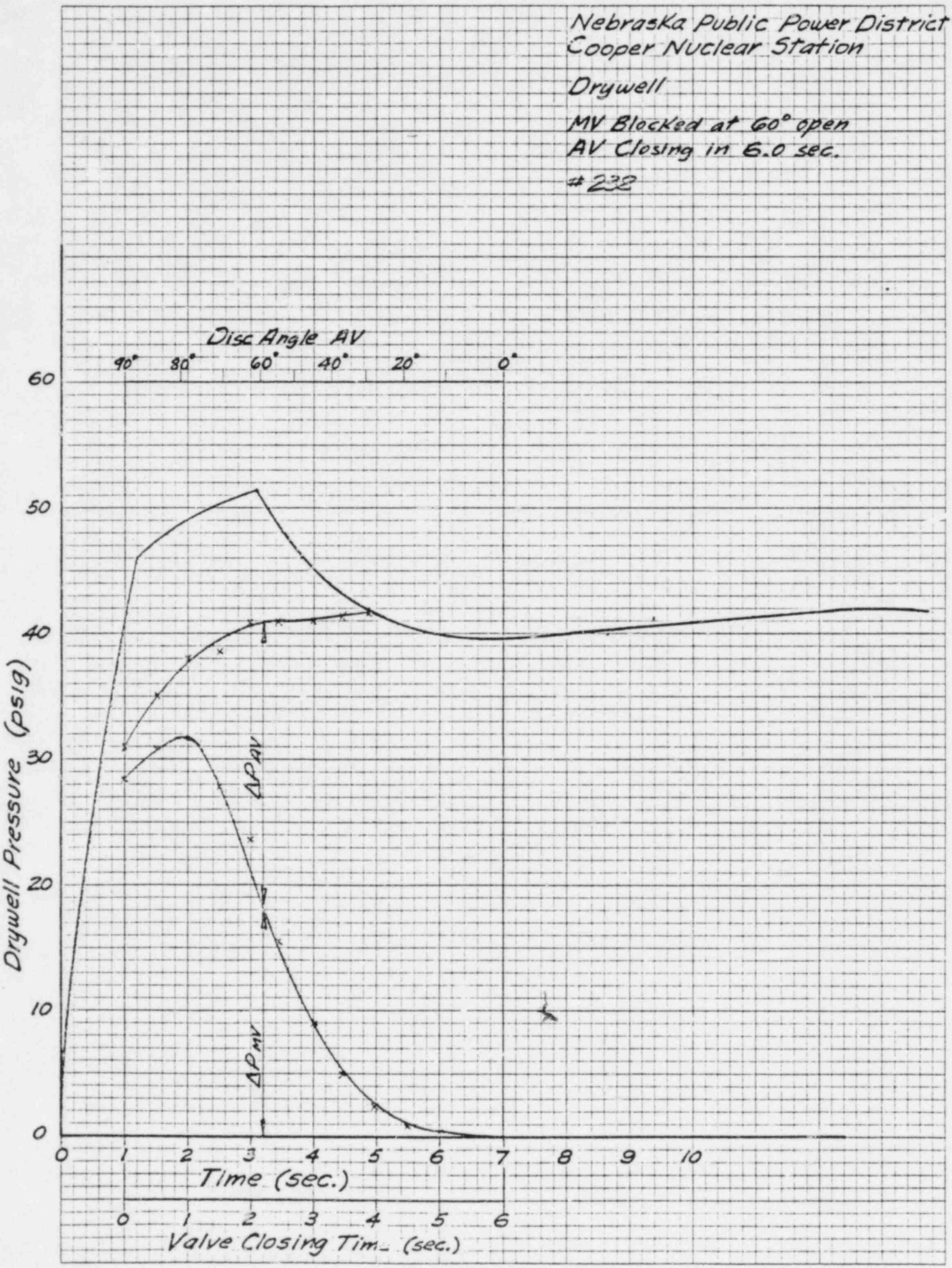
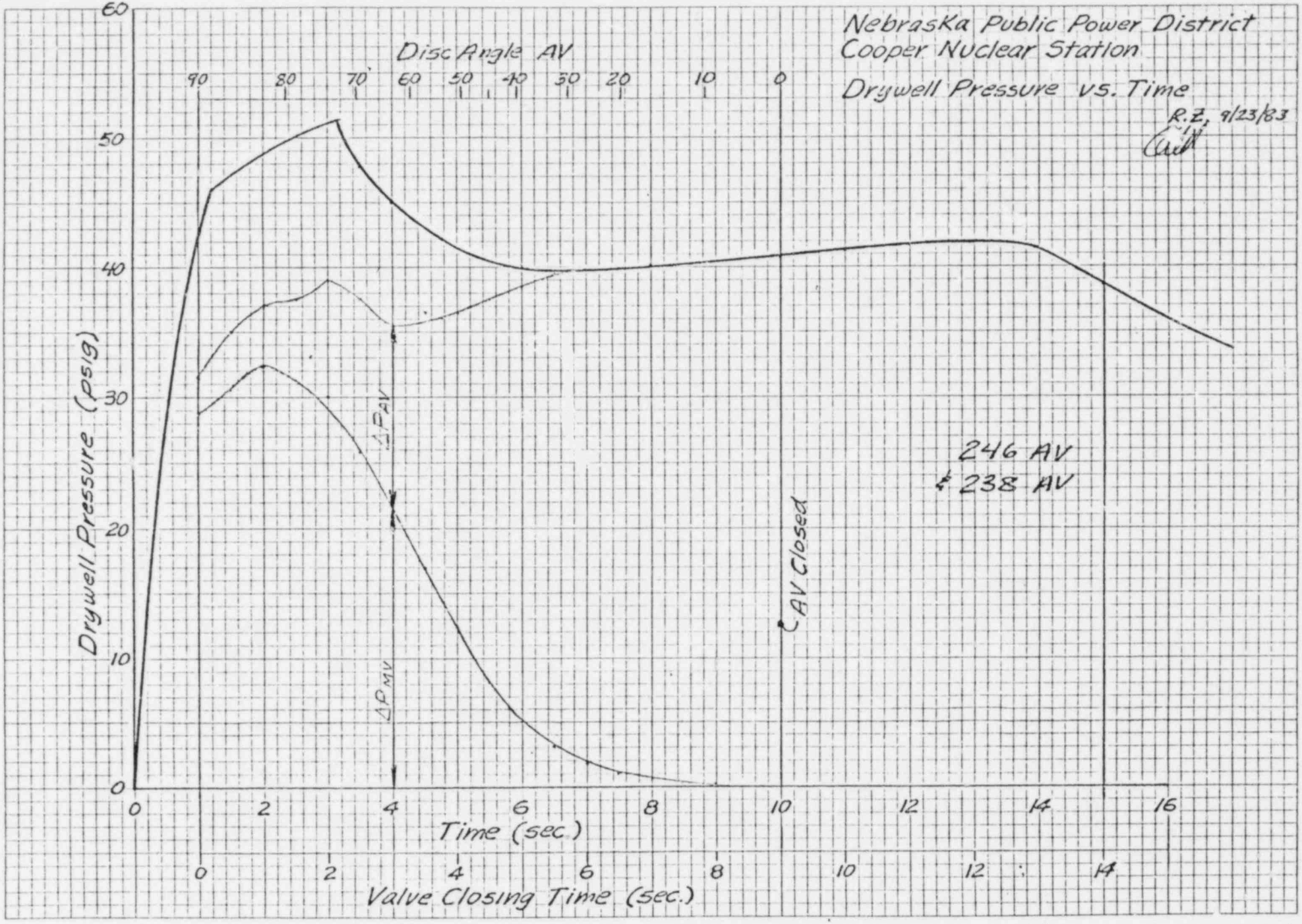



Nebraska Public Power District
Cooper Nuclear Station
Drywell
MV Blocked at 60° open
AV Closing in 6.0 sec.
#232
Disc Angle AV
90° 80° 60° 40° 20° 0°
Drywell Pressure (psig)
0 10 20 30 40 50 60
ΔP AV
ΔP MV
0 1 2 3 4 5 6 7 8 9 10
Time (sec.)
0 1 2 3 4 5 6
Valve Closing Time (sec.)
DIETZGEN CORPORATION
MADE IN U.S.A.
NO. 341-10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH

246



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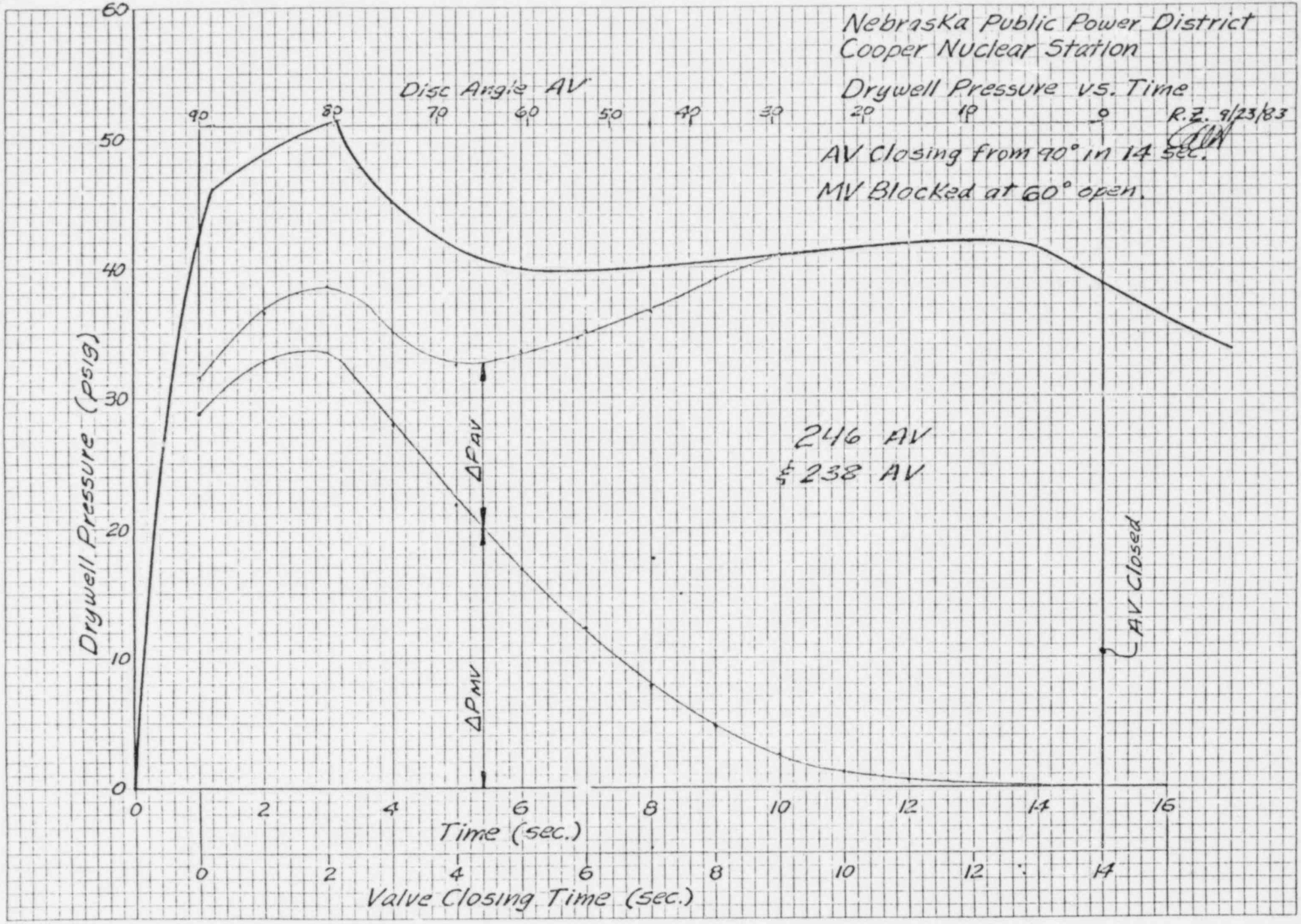
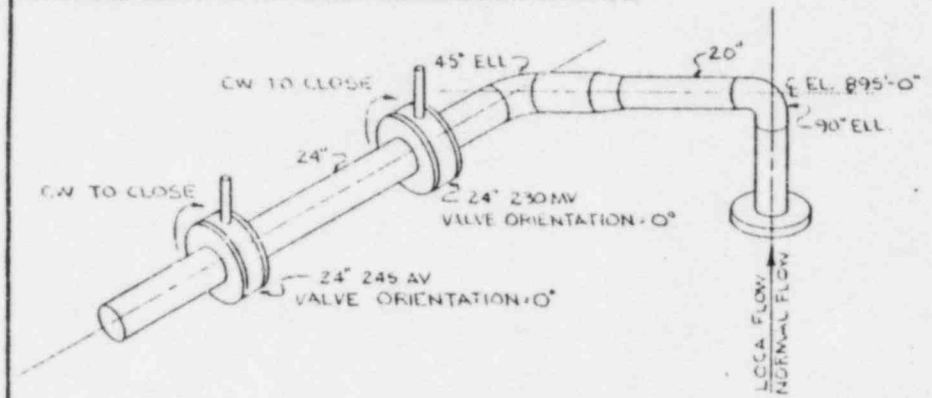
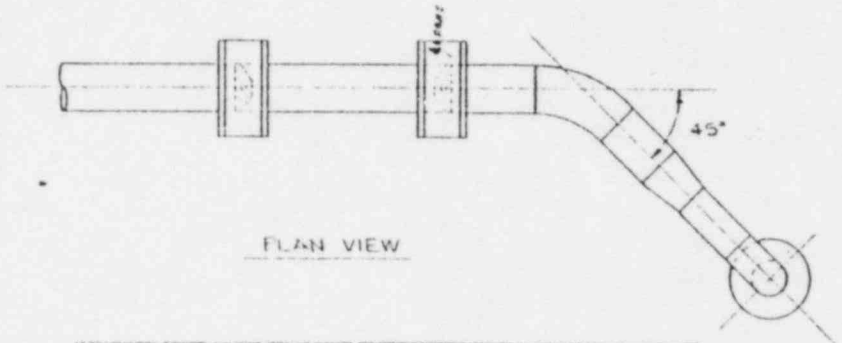


SUMMARY OF COMPARISON 230MV

ITEM	TEST CONDITION	FIELD CONDITION	COMMENTS
DISC FLATFACE	UPSTREAM	UPSTREAM	OK
ELBOW PLANE	IN SHAFT PLANE & 90° FROM SHAFT PLANE	45° ELBOW 90° FROM SHAFT PLANE	OK - ASSUME 45° ELBOW IN 90° ELBOW
FLOW FORCE ON DISC	TENDS TO OPEN VALVE	TENDS TO OPEN VALVE	OK



FIELD CONFIGURATION THAT EXISTS FOR
230MV & 245AV

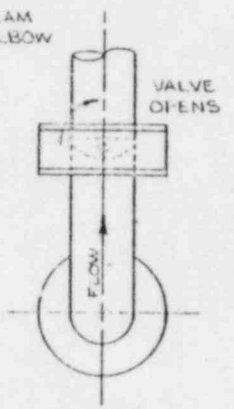


PLAN VIEW

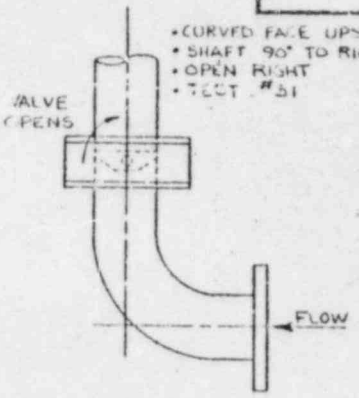
SUMMARY OF COMPARISON 245AV

ITEM	TEST CONDITION	FIELD CONDITION	COMMENTS
DISC FLATFACE	DOWNSTREAM	DOWNSTREAM	OK
ELBOW PLANE	IN SHAFT PLANE & 90° FROM SHAFT PLANE	45° ELBOW 90° FROM SHAFT PLANE	OK
FLOW FORCE ON DISC	TENDS TO OPEN VALVE	TENDS TO OPEN VALVE	OK

- CURVED FACE UPSTREAM
- SHAFT IN PLANE W/ELBOW
- OPEN RIGHT
- TEST #30

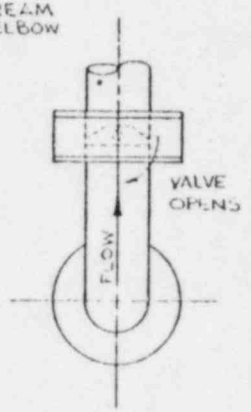


- CURVED FACE UPSTREAM
- SHAFT 90° TO RIGHT
- OPEN RIGHT
- TEST #31

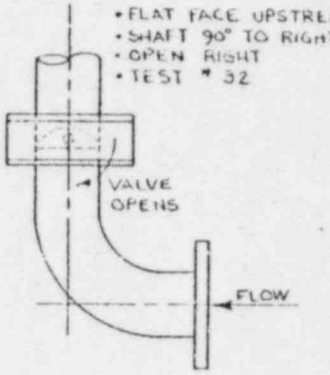


A-C TEST CONFIGURATIONS 30 OR 31
APPLY FOR 245AV

- FLAT FACE UPSTREAM
- SHAFT IN PLANE W/ELBOW
- OPEN RIGHT
- TEST #29



- FLAT FACE UPSTREAM
- SHAFT 90° TO RIGHT
- OPEN RIGHT
- TEST #32



INFORMATION ONLY

A-C TEST CONFIGURATIONS (29) OR (32)
APPLY FOR 230 MV

REVISIONS							
SIGNIFICANT NUMBER							
GROUP	1	2	3	4	5	6	

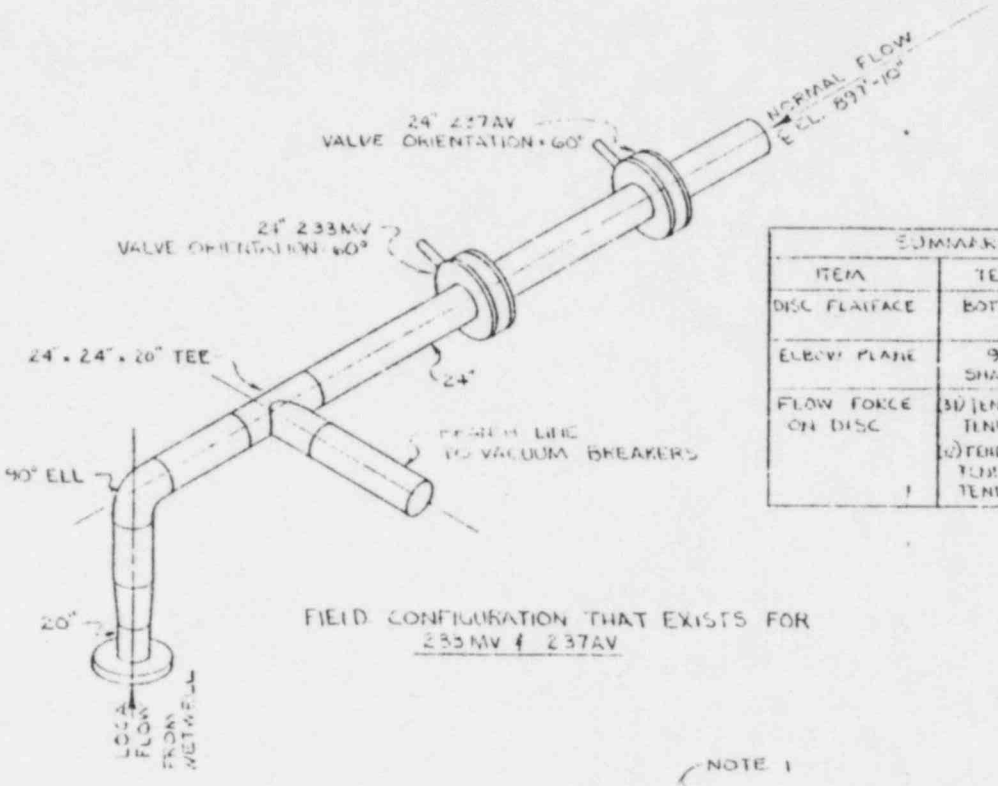
DRAWN SGH DATE 9-13-85
CHECKED DATE
APPROVED DATE
FILMED

Nebraska Public Power District

PURGE VALVES 230MV & 245AV
FIELD CONDITION vs. TEST CONDITION

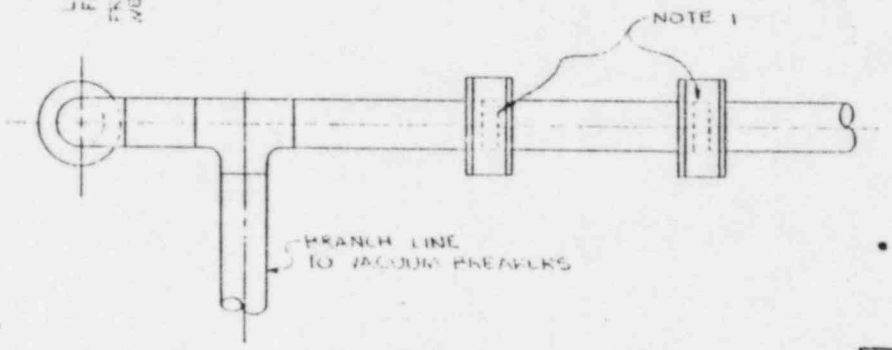
NB

REVISION



FIELD CONFIGURATION THAT EXISTS FOR
233MV & 237AV

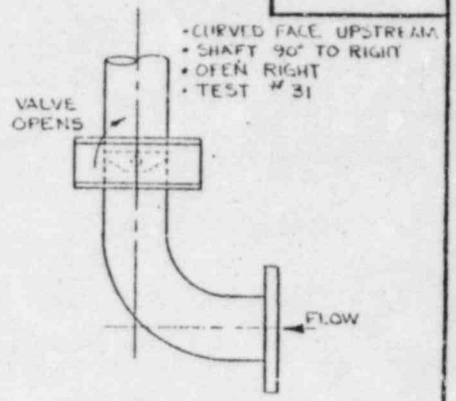
SUMMARY OF COMPARISON 233MV & 237AV			
ITEM	TEST CONDITION	FIELD CONDITION	COMMENTS
DISC FLATFACE	BOTH DIRECTION	UNKNOWN	OK
ELBOW PLANE	90° FROM SHAFT PLANE	60° FROM SHAFT PLANE	ASSUME 60° IS 90°
FLOW FORCE ON DISC	(a) TENDS TO CLOSE 90-35° TENDS TO OPEN 35°-0°	TENDS TO OPEN	OK
	(b) TENDS TO OPEN 90°-75° TENDS TO CLOSE 75°-25° TENDS TO OPEN 25°-0°		

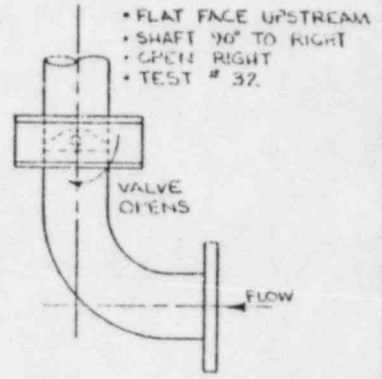


PLAN VIEW

NOTE 1: DIRECTION OF FLAT OR CURVED FACE UNKNOWN

INFORMATION ONLY





A-C TESTS 31 & 32
APPLY FOR
233MV & 237AV
(SEAT DIRECTIONS UNKNOWN)

REVISIONS
NO.

DRAWN	DATE
SGH	9-6-83
CHECKED	DATE
APPROVED	DATE
FILMED	

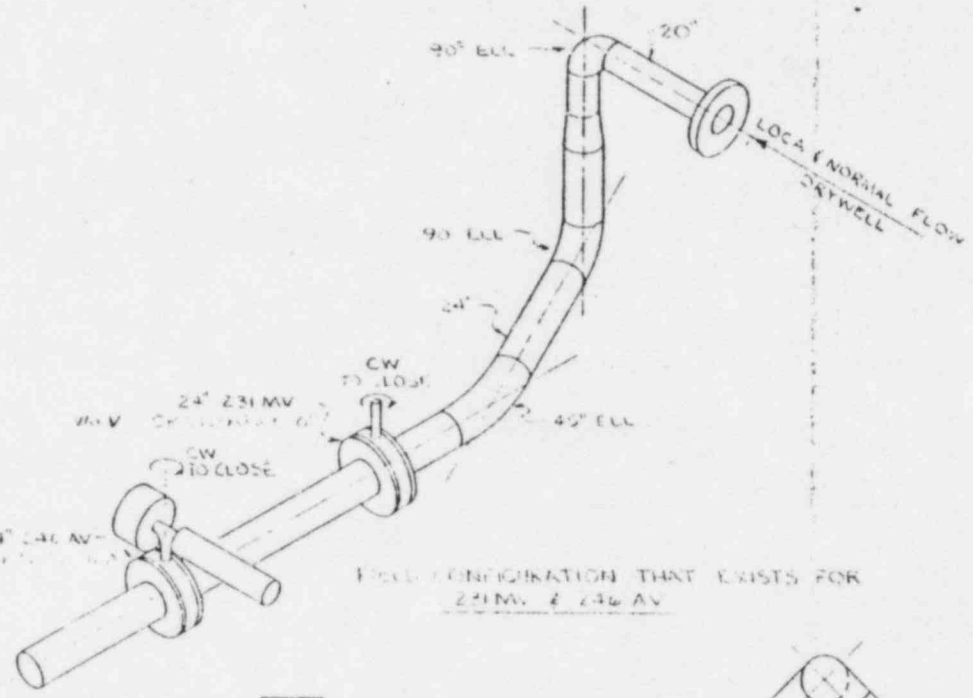
Nebraska Public Power District

NB

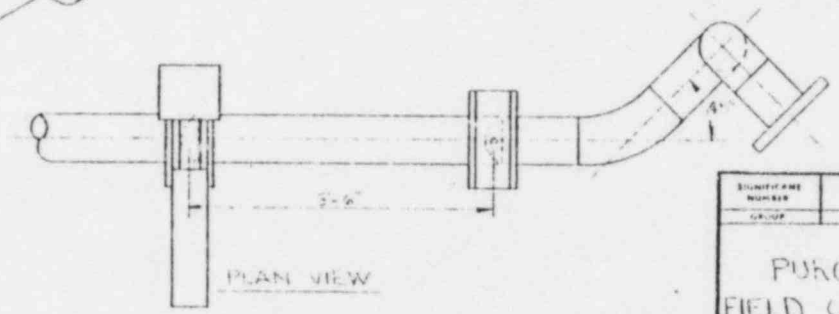
PURGE VALVES 233MV & 237AV
FIELD CONDITION vs. TEST CONDITION

SUMMARY OF COMPARISON 231MV & 246AV

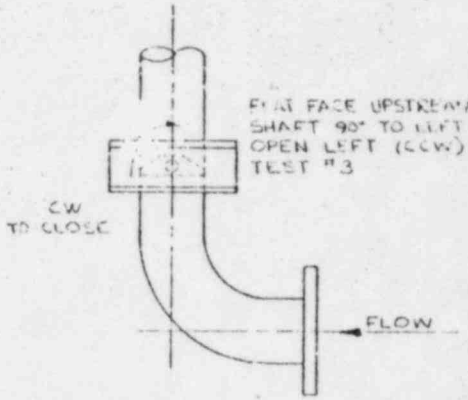
ITEM	TEST CONDITION	FIELD CONDITION	COMMENTS
DISC FLAT FACE	UPSTREAM	UPSTREAM	SAME
ELBOW PLANE	90° FROM SHAFT PLANE	45° ELBOW 90° FROM SHAFT PLANE	ASSUME 45° ELBOW IS 90° ELBOW
FLOW FORCE ON DISC	FLOW TENDS TO OPEN VALVE	FLOW TENDS TO OPEN VALVE	TEST SHOWS IT TENDS TO OPEN



FIELD CONFIGURATION THAT EXISTS FOR 231MV & 246 AV



PLAN VIEW



A-C TEST CONFIGURATION THAT APPLY FOR 231AV & 246 AV

INFORMATION ONLY

REVISIONS

NO.

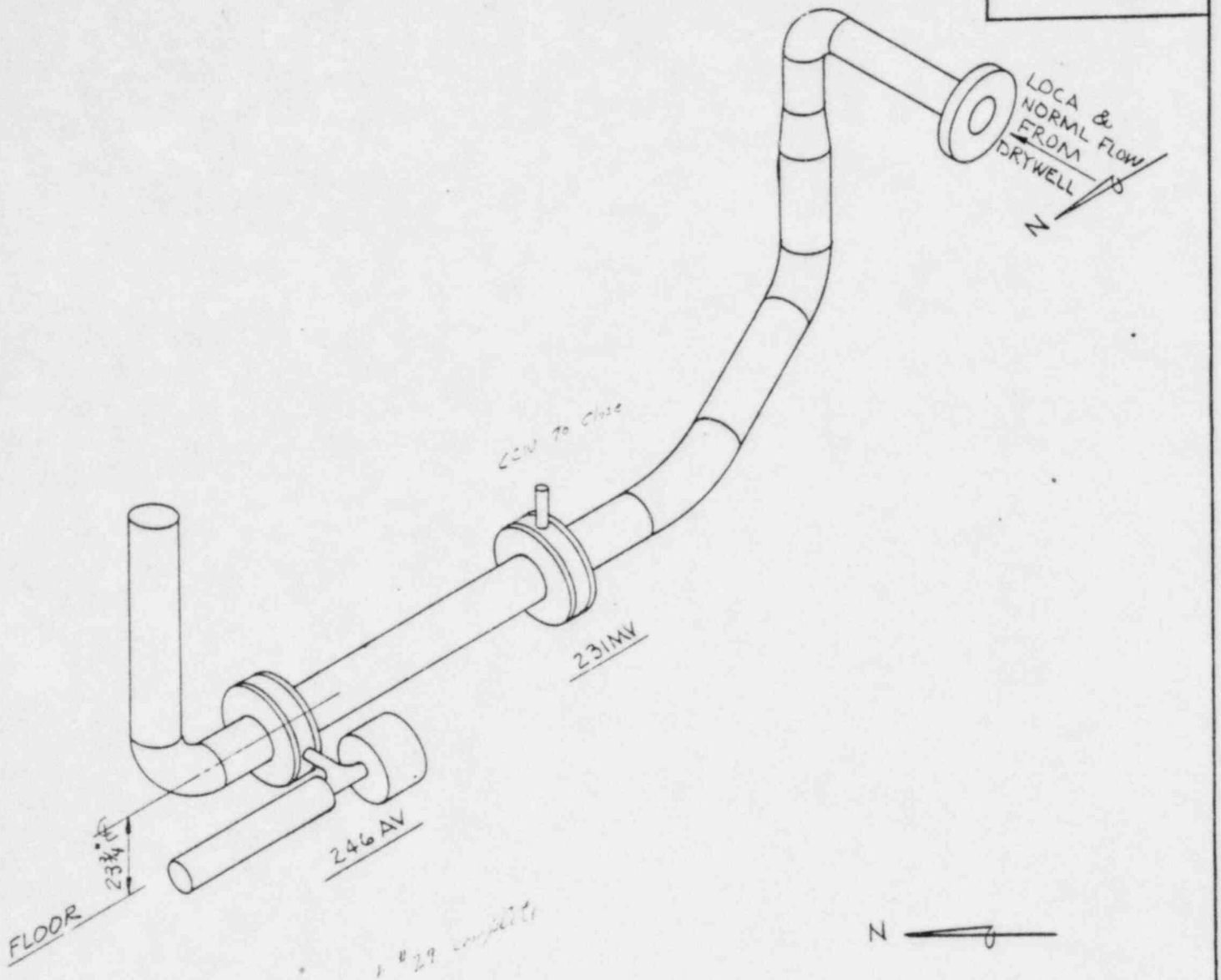
DRAWN | DATE
SGH 9-6-83
CHECKED | DATE
APPROVED | DATE
FINISH

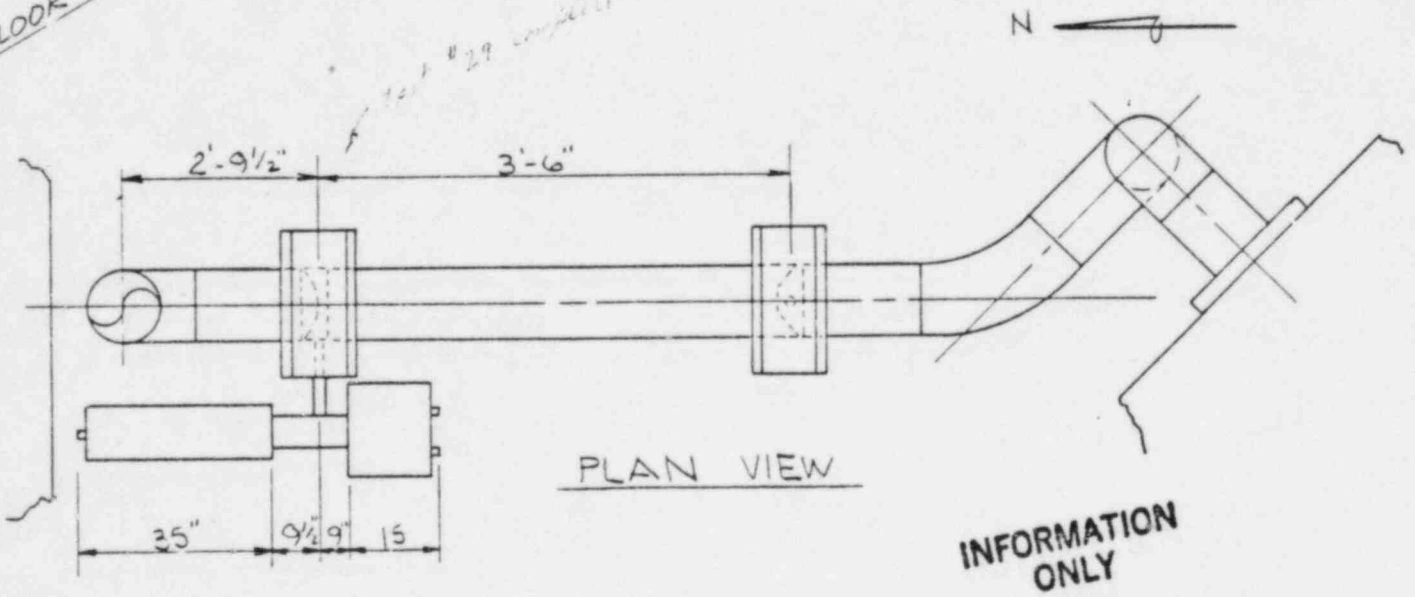
Nebraska Public Power District

NB

REVISION

PURGE VALVES 231MV & 246AV
FIELD CONDITION VS. TEST CONDITION





PLAN VIEW

INFORMATION ONLY

NO.	REVISION

PROPOSED PURGE VALVE 246AV INSTALLATION

DRAWN	DATE
SGH	10.12.83
CHECKED	DATE
APPROVED	DATE
FILMED	NA

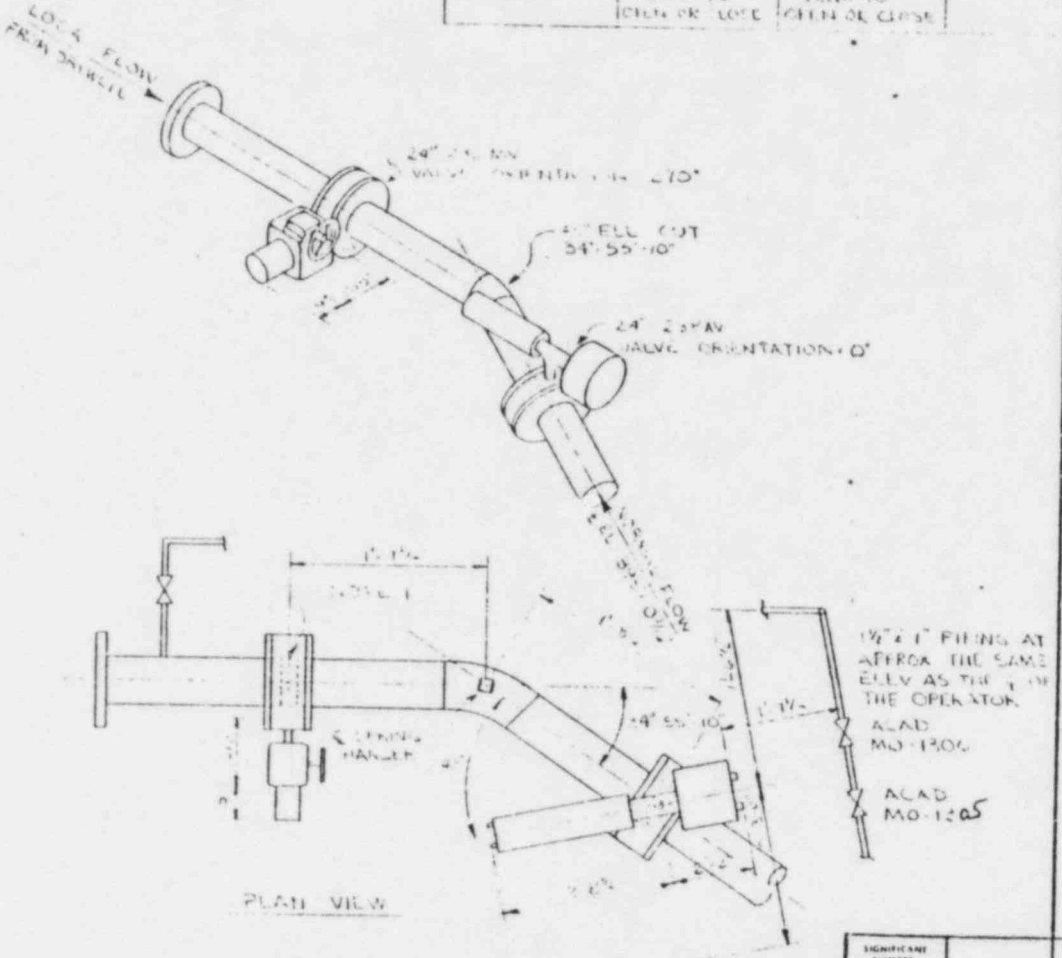
Nebraska Public Power District

REVISION

STANDARDBLUE, OMAHA 23307

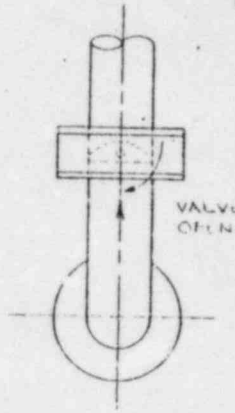
ITEM	TEST CONDITION	FIELD CONDITION	
FLAT FACE	FLOW DIRECTION	UNKNOWN	OK
ELBOW PLANE	IN SHAFT PLANE	NO ELBOW	OK
FLOW FORCE ON DISC	DOES NOT TEND TO OPEN OR CLOSE	DOES NOT TEND TO OPEN OR CLOSE	OK

FIELD CONFIGURATION
THAT EXISTS FOR
232MV & 238AV



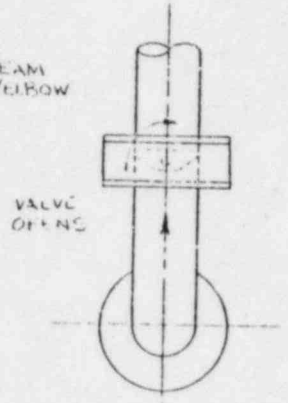
NOTE 1: ORIENTATION OF FLAT OR CURVED FACES UNKNOWN

(1) A.C. TEST DATA APPLY FOR 232MV (SEAT POSITION UNKNOWN)



- FLAT SURFACE UPSTREAM
- SHAFT IN PLANE W/ELBOW
- OPEN RIGHT
- TEST #29

- CURVE FACE UPSTREAM
- SHAFT IN PLANE W/ELBOW
- OPEN RIGHT
- TEST #30



INFORMATION ONLY

(2) NO A.C. TEST DATA APPLY FOR 238AV (SEAT DOWNSTREAM)

NO.	REVISIONS

SIGNIFICANT NUMBER							
GROUP	1	2	3	4	5	6	

PURGE VALVES 232MV & 238AV
FIELD CONDITION VS. TEST CONDITION

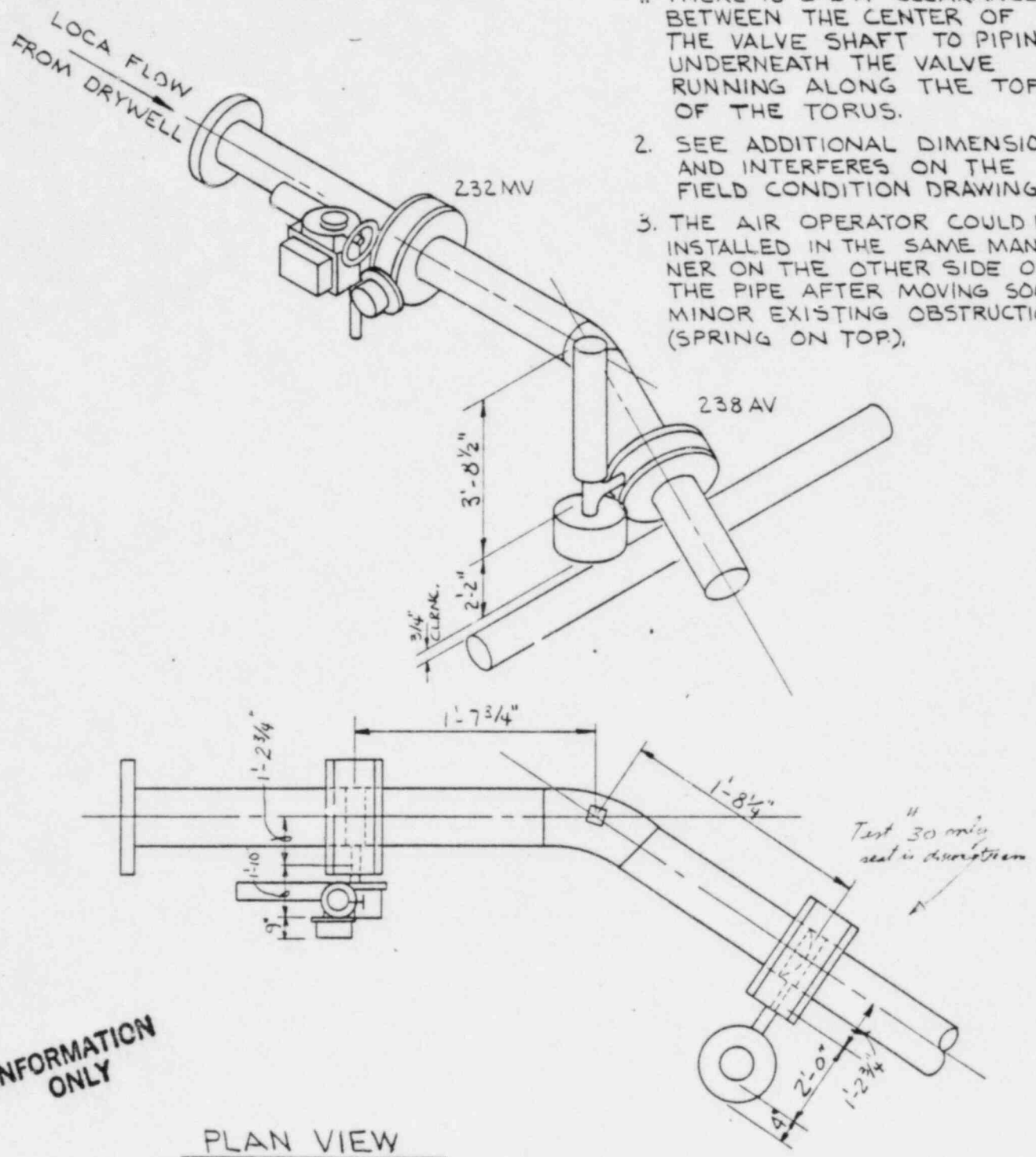
DRAWN	DATE
EGH	9-12-85
CHECKED	DATE
APPROVED	DATE
FILMED	NB

Nebraska Public Power District

REVISION

NOTES:

1. THERE IS 2'-2¾" CLEARANCE BETWEEN THE CENTER OF THE VALVE SHAFT TO PIPING UNDERNEATH THE VALVE RUNNING ALONG THE TOP OF THE TORUS.
2. SEE ADDITIONAL DIMENSIONS AND INTERFERES ON THE FIELD CONDITION DRAWING.
3. THE AIR OPERATOR COULD BE INSTALLED IN THE SAME MANNER ON THE OTHER SIDE OF THE PIPE AFTER MOVING SOME MINOR EXISTING OBSTRUCTIONS (SPRING ON TOP).



INFORMATION ONLY

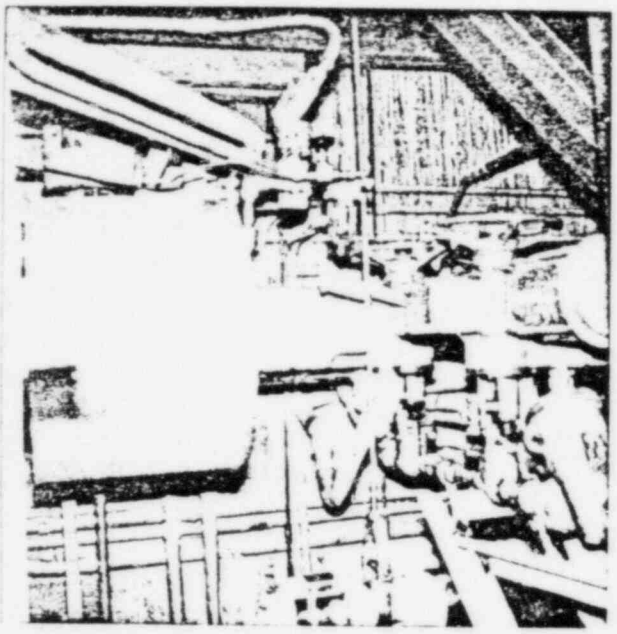
PLAN VIEW

NO.	REVISION

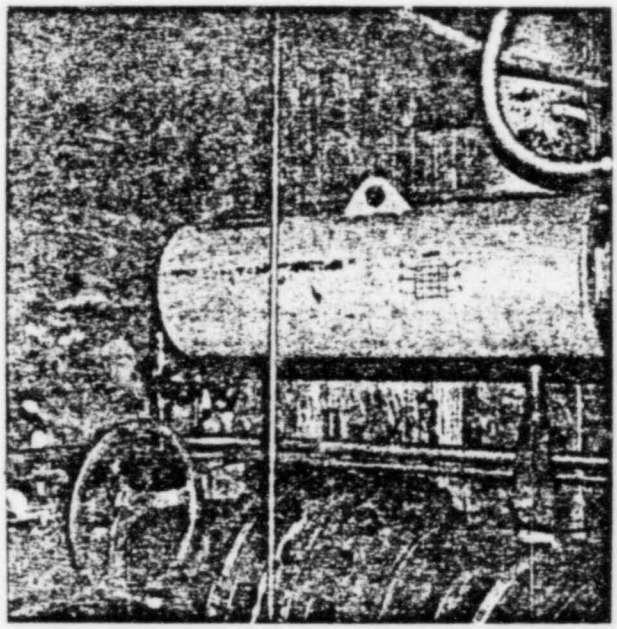
PROPOSED PURGE VALVE
238 AV
INSTALLATION

DRAWN	DATE
SGH	10.10.83
CHECKED	DATE
APPROVED	DATE
FILMED	REVISION
NA	

Nebraska Public Power District



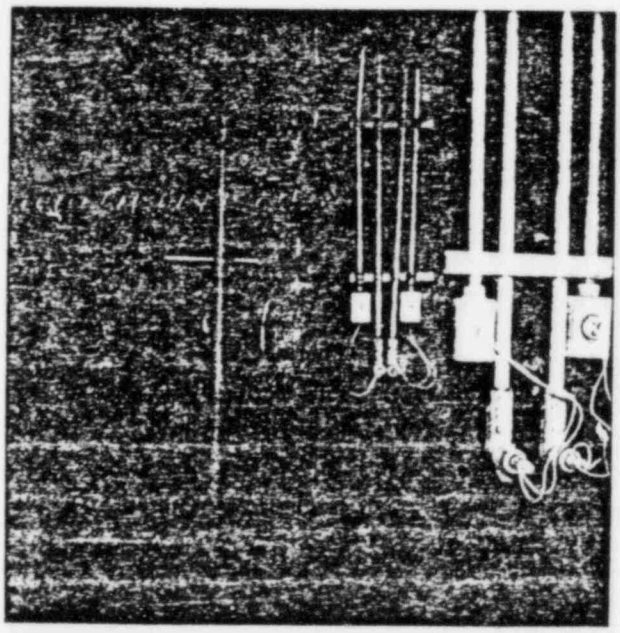
Shows small motor operated
A...valves 15 & 130



232MV

Shows 232 MV
spray cylinder for
232A1

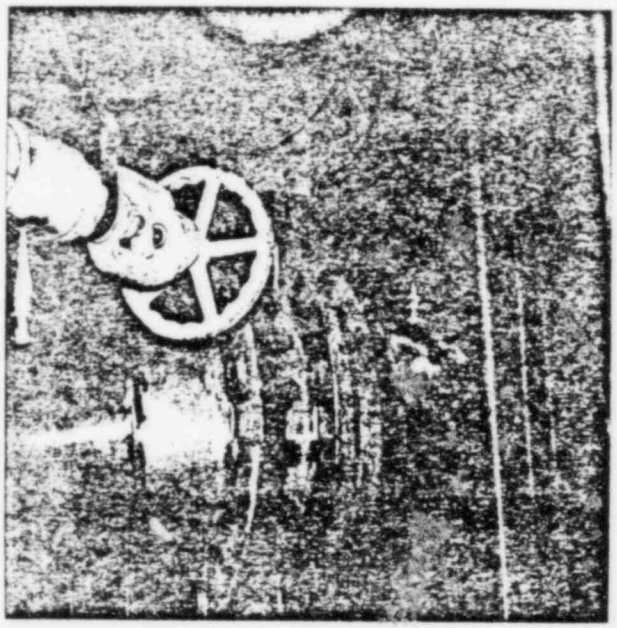
Shows small line obstructions
behind 232AV



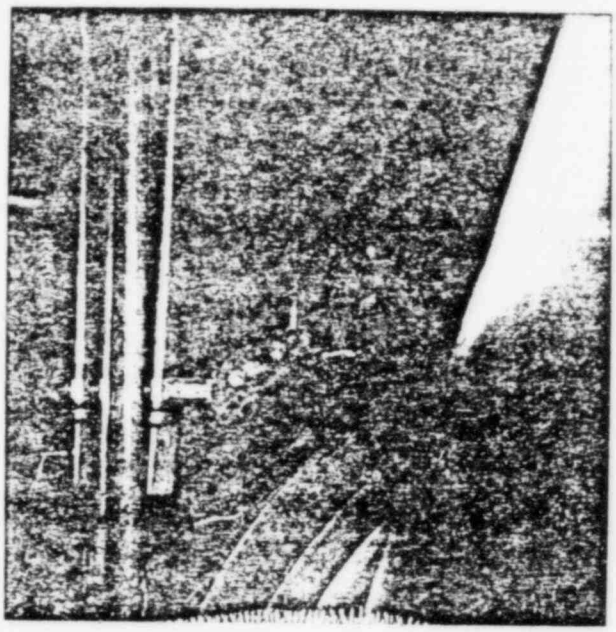
232MV

232AV

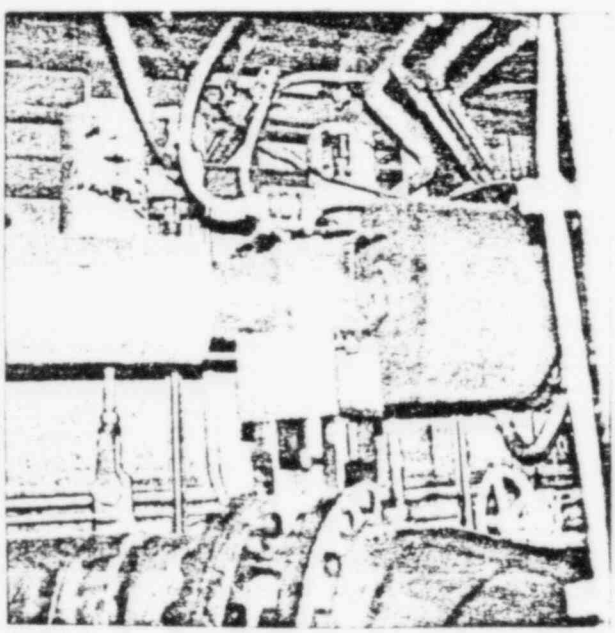
...shown



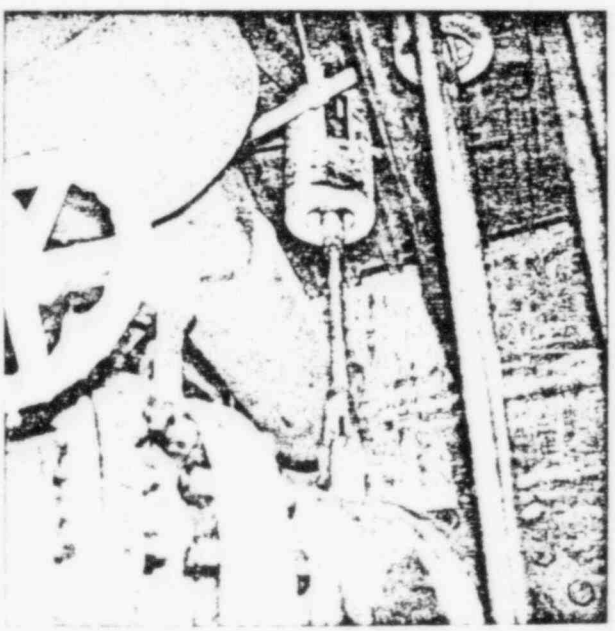
View of 238th



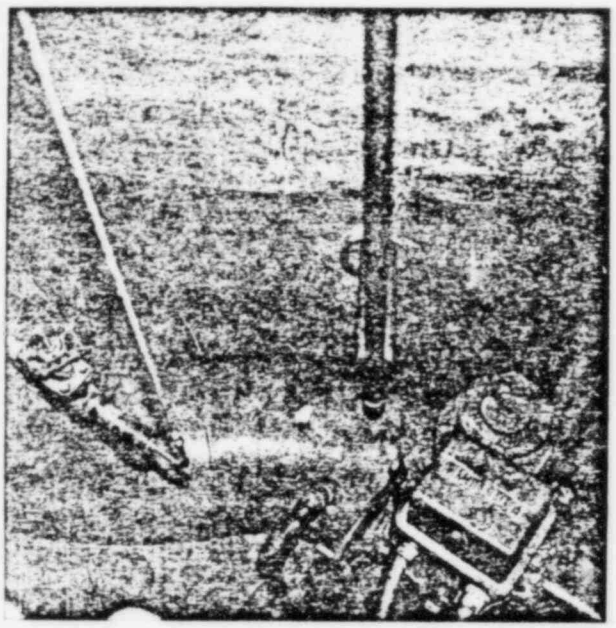
Entrance of 238th



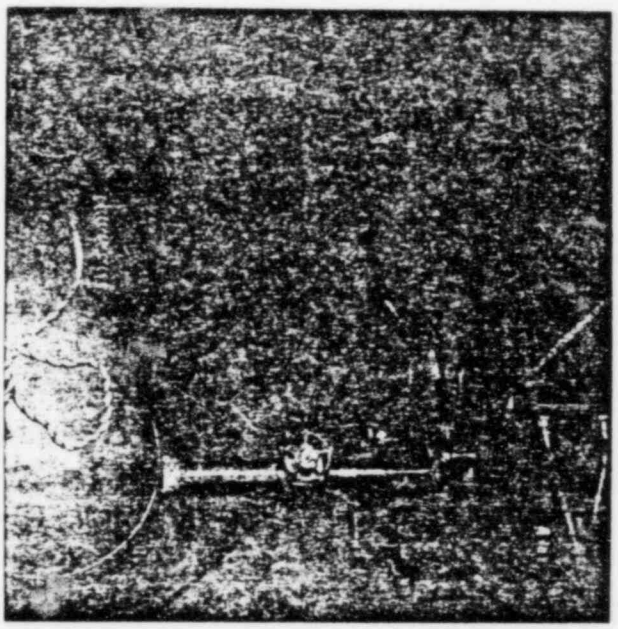
238th View of 239th Av



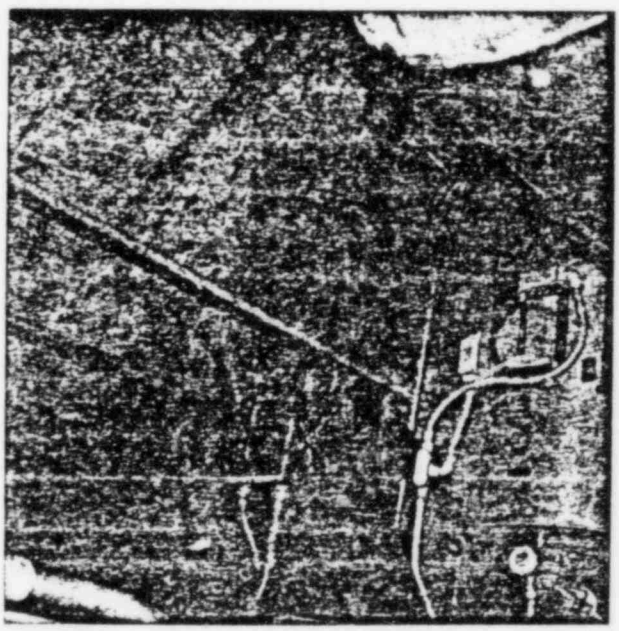
Looking at 238th
in this manner



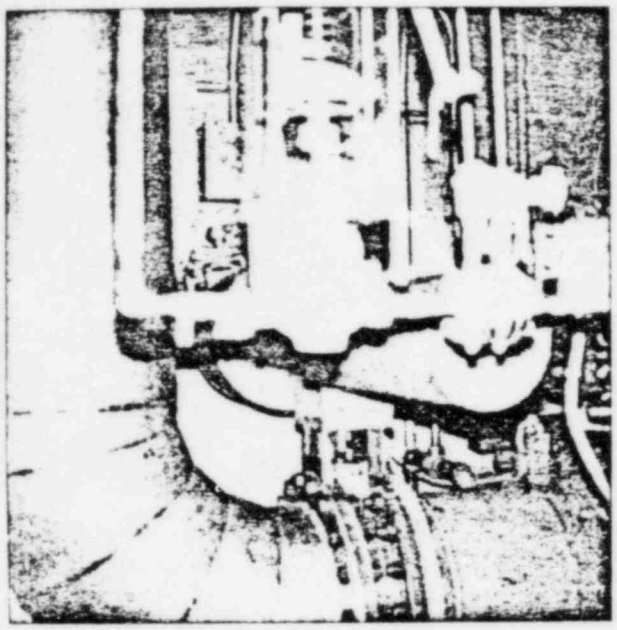
Double Elbow configuration
for 231MV & 246AV



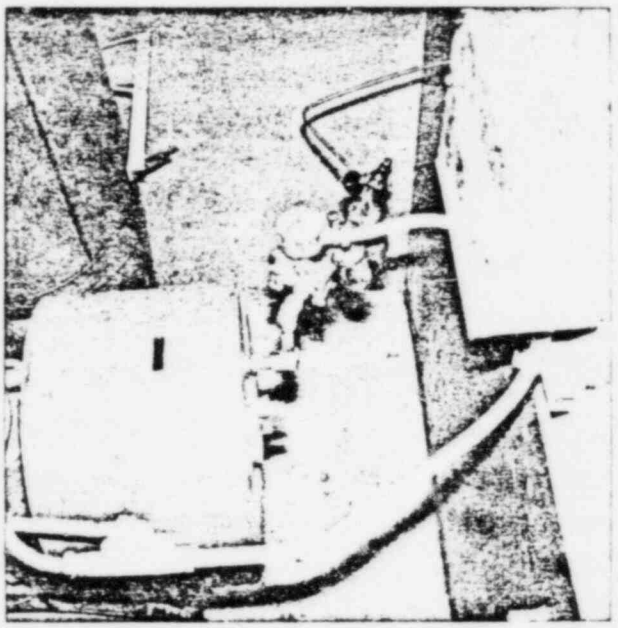
Elbow configuration for 231MV



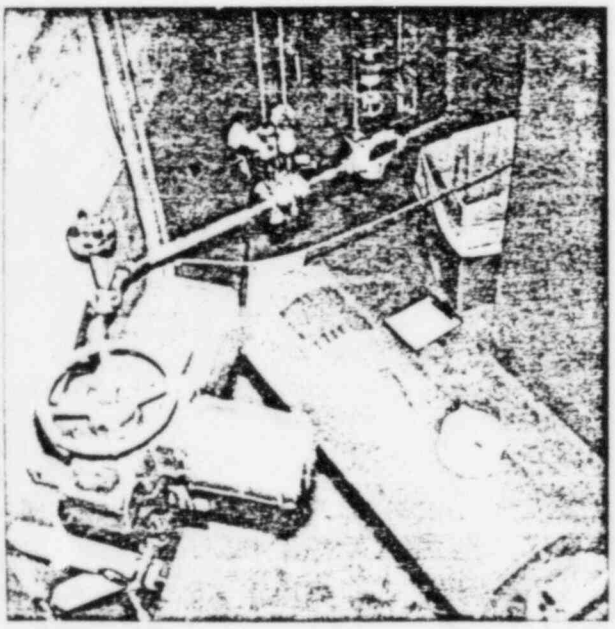
231MV & 246AV viewed
from top of shield wall



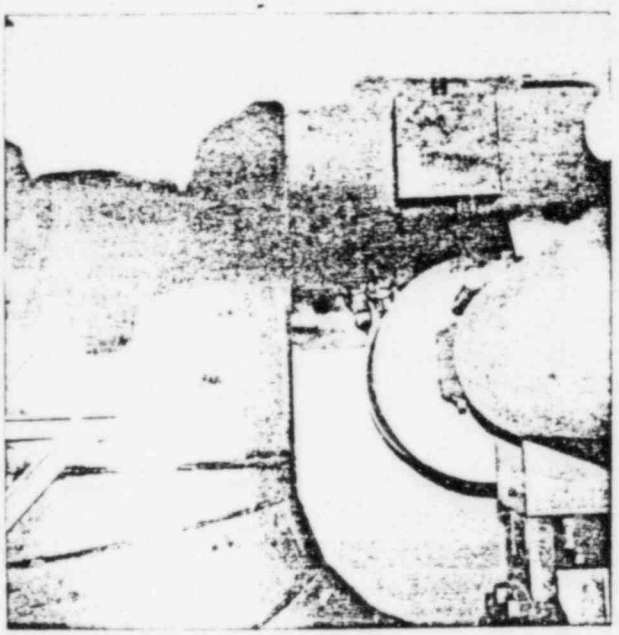
Air Operator 246AV looking toward vessel



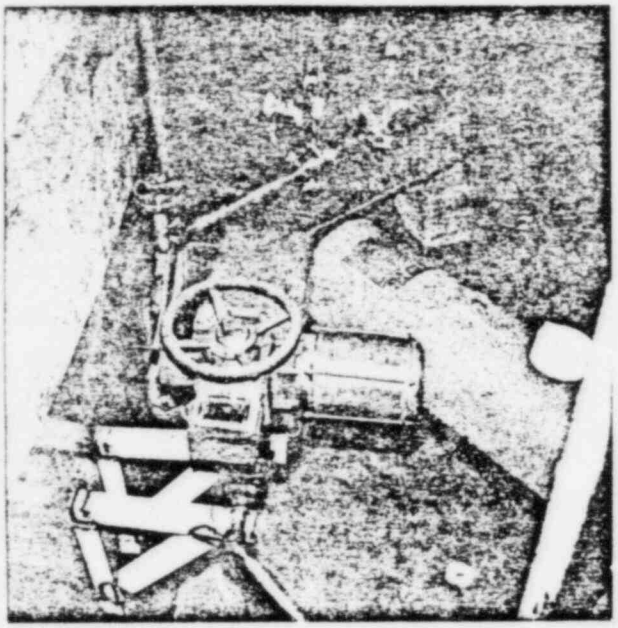
Air cylinder 246AV



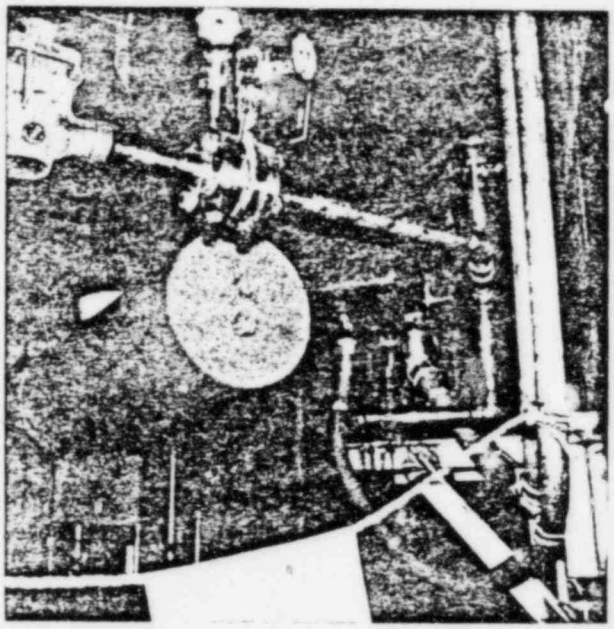
246AV



Air Operator For 246 AV shows exhaust riser

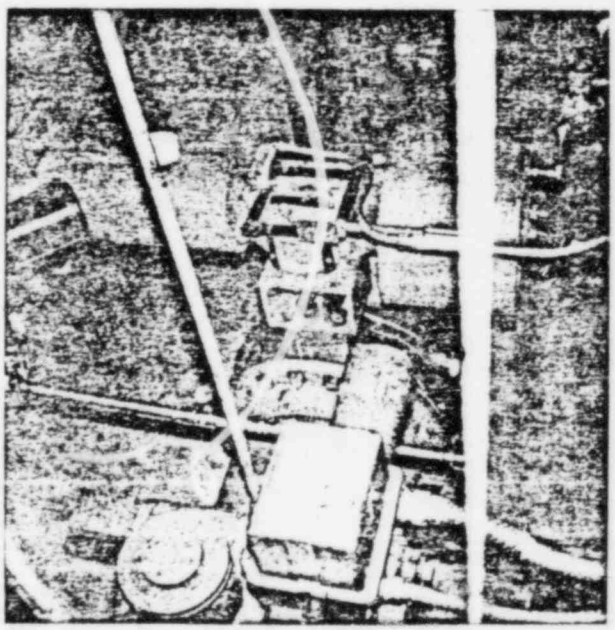


Spray cylinder 1st st. 1



Spray cylinder 2nd st. 1

Shows the side the valve is bolted to the frame with bolts 246 AV



Viewed from Top of Pipe

= Electric pipe
= 246 AV
= 231 MV

ALLIS-CHALMERS

BOX M-93 • YORK, PENNSYLVANIA 17405/717-848-1126

YORK PLANT
VALVE DIVISION

TORQUE ABSORPTION RATING OF VALVE OPERATORS

Operators for quarter turn rubber seated valves in air service must be sized to overcome the greatest combination of bearing friction torque (T_b), rubber seating torque (T_s) and dynamic torque (T_d).

Bearing friction torque is usually expressed as:

$T_b = 4.71\ D^2dfP$ where

T_b = bearing friction torque (ft-lb) which acts to oppose valve shaft rotation

D = valve diameter in feet

d = valve shaft diameter in inches

f = bearing friction coefficient between the valve shaft and bearing surface

P = pressure drop across the valve in psi

Rubber seating or unseating torque is expressed as:

$T_s = C_sD^2$ where

T_s = seating or unseating torque in foot-pounds

C_s = coefficient of seating or unseating torque from test data

Dynamic torque is expressed as:

$T_d = C_TD^3P$ where

T_d = dynamic torque in foot pounds

C_T = coefficient of dynamic torque from test data

As the valve reaches the seated position going from opened to closed (approximately the last 5°-8° of travel) the operating torque is the sum of the seating torque and bearing torque. This is a maximum at the closed position: $T_{os} = T_s + T_b$. Dynamic torque has little or no influence at this point since flow is essentially stopped.

During the initial part of the closing stroke (from 90° to 10°) dynamic torque and bearing torque determine the operating requirements. Depending on valve geometry, orientation and upstream piping and flow conditions, the valve disc may tend to close or tend to open. This can cause the following conditions:

1. The disc tends to close because of dynamic torque and bearing torque opposes this tendency.

   $T_{od} = T_d - T_b$ is the torque that must be overcome by the valve operator. If $T_b > T_d$, the operator must be able to overcome the absolute value of $T_d - T_b$. If $T_d > T_b$, the operator then acts like a brake and lets the disc close at a certain rate.

2. The disc tends to open because of dynamic torque and bearing torque opposes this tendency. If the operator is acting to close the valve then:

   $T_{od} = T_d + T_b$ The operator must overcome the dynamic torque and the friction torque.

Electric motor operators used to open or close butterfly valves typically supply torque to the valve shaft at a speed ranging from 0.1 to 3 RPM. These operators can be broken into 3 basic parts:

1. An electric motor usually 1,800 RPM.

2. An intermediate gear set (spur gears and a worm set) that decreases motor speed and increases torque.

3. A final worm gear set that is "self-locking" and further reduces speed and increases torque. This is the part of the operator that attaches to the valve shaft.

The torque absorption capability of this type of electric motor operator is the output torque rating of the unit which is based on the capability of the "weakest link" in the train (i.e. the electric motor, the intermediate gear box or the final worm gear set). The direction of the torque that must be applied to the valve shaft has little effect on the gears or motor. If the valve shaft torque opposes the direction that the operator is running, the gears and motor are loaded in a normal manner which is, in fact, how these operators are sized.

If the valve shaft torque acts in the same direction that the operator is running, the operator is then acting as a brake letting the disc close in a specified amount of time. When this situation occurs, the load actually seen by each gear set and the motor is less than for the reverse condition. This reduction of load is caused by the reversal of the friction component in the gearing. A good analogy is the difference in torque required to raise a scissor type jack as compared to lowering it. The electric motor operator only develops torque as required to overcome external loads applied through the valve shaft. Except for slight friction loads, the internal components of the electric motor operator are not preloaded and only build-up loading in proportion to external torques applied.

The same condition is not true for an air cylinder spring return operator such as the Bettis T-series. This type of operator (with spring to close) stores energy in the form of a compressed spring or springs during the opening stroke. The air cylinder, piston rod, and various other components must be designed to overcome the increasing spring force and produce an additional specified operating torque during the opening stroke. In the open position these components remain loaded because the spring is compressed. When closing, stored energy from the compressed spring can be converted into torque if there is resistance to the closing motion from the valve shaft. If there is no resistance from the valve shaft, no torque is produced and the internal parts that connect the spring to the piston are gradually unloaded over the full stroke to some preload point.

If, during the closing stroke, the valve shaft applies a torque in the direction of closing, this torque is additive in the form of additional force to the components between the spring and the piston. The torque absorption rating of this type of operator is the sum of the spring torque plus the additional specified torque developed during the opening stroke. All components in the operator are designed to withstand the forces developed by this combined torque. These torques can be seen graphically in Figure TA-1.

R. H. Zeiders
Oct. 1983

CUSTOMER: NPPD Cooper Nuclear Station | DATE: 10/27/83 | SHEET 40 OF

SUBJECT: Operator Torque Absorption Capability Bettis T-420B-SR1 | PRELIM. | FINAL

DRAWING NUMBER

LITHO IN U.S.A. - A-C

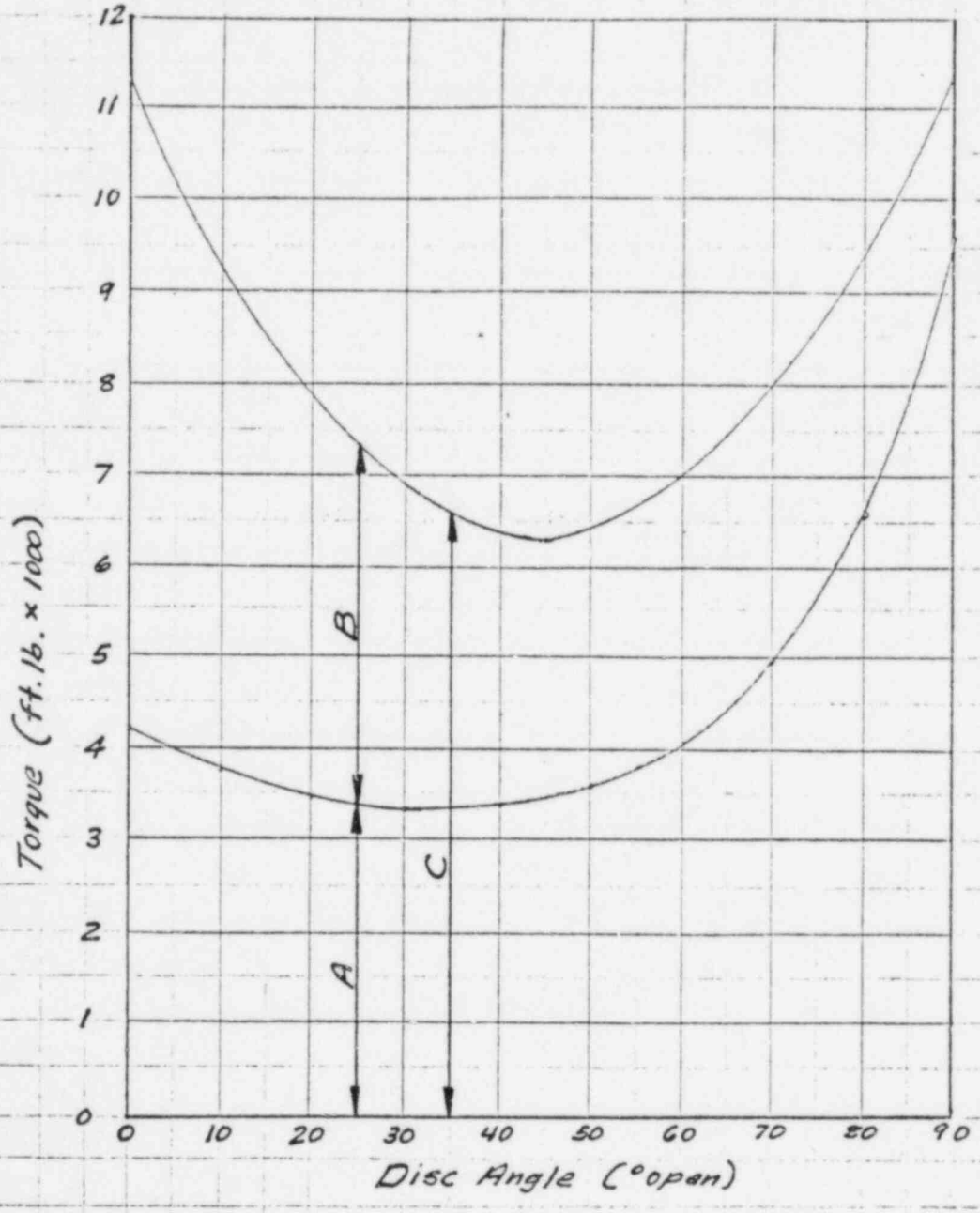
ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY: Zeiders

Valve: Ref. A-C Test # Fig.

Closing time:



A = torque available to valve shaft during closing stroke

B = torque available to valve shaft during opening stroke

C = rated torque absorption capability of operator

FIG. TA-1

CUSTOMER

DATE 5/23/21.

SHEET 8 OF 8

SUBJECT PARTIAL OPERATOR T-1170 B-GB1.

PRELIM.

FINAL —

DRAWING NUMBER

LITHO IN U.S.A.-A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS

FORM 6715-1

CALCULATED BY C. ALLEN.

VALVE ANGLE	Δ	T (IN-LB)	T (FT-LB).
(CLOSE) 90	45	115480	9623
80	35	78806	6567.
70	25	59761	4980
60	15	49165	4097
50	5	43274	3606
40	-5	40415	3369
30	-15	39852	3321
20	-25	41352	3446.
10	-35	44969	3747
CLOSED 0	-45	50628	4219

CUSTOMER | DATE | SHEET 1 OF 5

SUBJECT: BETTS OPERATOR - 7444-2SR-41 | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.-A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS | FORM 6715-1

CALCULATED BY: C. ALLEN

SPRING PRE-LOAD = 3220 LBF
SPRING CONSTANT, k = 402 LBF/IN.
MOMENT ARM, MA = 4.125"
EFFECIENCY = 72%

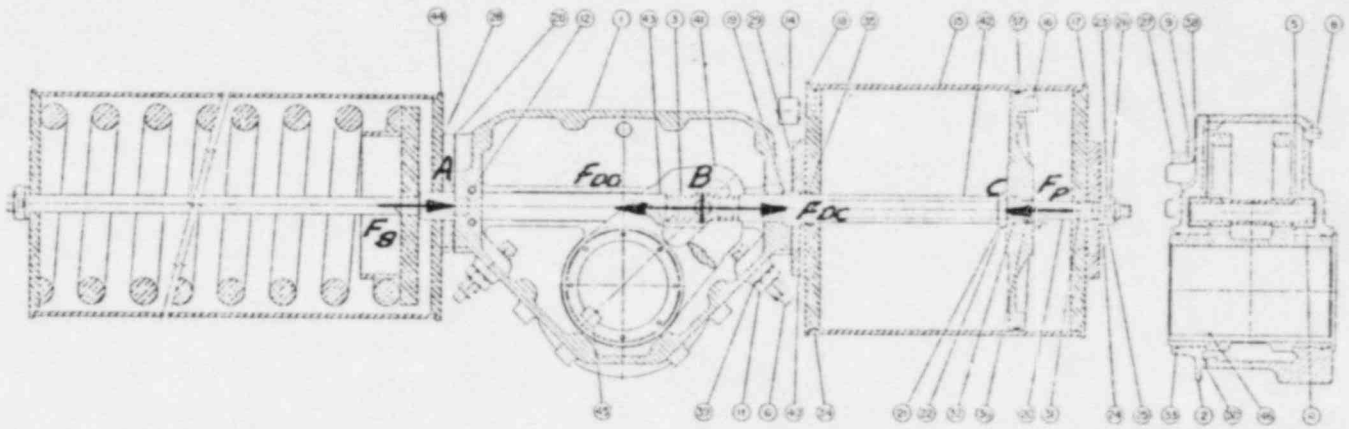
ANALYSIS FROM ~~TED~~ RODNEY'S BETTS PROCEDURE.
SEE PGS 14 TO 12.

VALVE ANGLE	Δ	T(IN-LB).	T(FT-LB)
OPEN 90	45	39420	3285
80	35	27174	2264
70	25	20796	1733
60	15	17261	1438
50	5	15333	1277
40	-5	14464	1205
30	-15	14433	1202
20	-25	15204	1267
10	-35	16295	1358
CLOSED 0	-45	19331	1611

T-4B-SR

ALWAYS FURNISH SERIAL NUMBER OF ACTUATOR WHEN ORDERING PARTS

PARTS LIST T-3458B
MAY I, 1979



	T-410B SR	T-412B SR	T-416B SR	T-420B SR	MODEL NO. T-4B-SR BETTIS ACTUATOR				
Item	Part No.	Part No.	Part No.	Part No.	Description	Material	Quan	Spare Parts	Price Each
1	19848	19848	19848	19848	HOUSING	DUCT IRON	1		
2	19861	19861	19861	19861	COVER	DUCT IRON	1		
3	19840	19840	19840	19840	NUT, YOKE PIN	STEEL	1		
4	19836	19836	19836	19836	PIN, YOKE	STEEL	1		
5	19837	19837	19837	19837	ROLLER, YOKE	STEEL	4		
6	19841	19841	19841	19841	STOP SCREW	STEEL	2		
7	28884	28884	28884	28884	FITTING, GREASE (NS)	STN. STEEL	2		
8	13243	13243	13243	13243	PIPE PLUG	STEEL	1		
9	12421	12421	12421	12421	SCREW, HEX CAP COVER	STEEL	8		
10	19956	19956	19956	19956	SCREW, DRIVE (NS)	STEEL	4		
11	11335	11335	11335	11335	JAM NUT, STOP SCREW	STEEL	2		
12	16778	16778	16778	16778	PIN, COVER	STEEL	4		
13	3294	3294	3294	3294	TAG, SERIAL NUMBER (NS)	STN. STEEL	1		
14	29198	29198	29198	29198	BREATHER	ALUMINUM	1		
15	27560	16844	16840	22572	CYLINDER	STEEL	1		
16	31897	31898	31899	31900	PISTON	DUCT IRON	1		
17	22547	21515	21517	22568	END CAP, OUTER	STEEL	1		
18	22551	21514	21516	22573	END CAP, INNER	STEEL	1		
19	31930	31930	31930	31930	BUSHING, ROD	BRONZE	1		
20	19842	19842	19842	19842	TIE BAR	STEEL	2		
21	24434	24434	24434	24434	RING, PISTON SPLIT	STEEL	2		
22	25034	25034	25034	25034	RETAINER, SPLIT RING	STEEL	2		
23	16084	16084	16084	16084	NUT, HVY HEX TIE BAR	STEEL	2		
24	22501	22501	22501	22501	RETAINER, NUT	STEEL	1		
25	11171	11171	11171	11171	LOCKWASHER, RETAINER SCR	STEEL	1		
26	11914	11914	11914	11914	SCREW, SOC HD CAP	STEEL ALLOY	5		
27	11967	11967	11967	11967	SNUBBER VALVE ASSY		1		

	T-410B SR	T-412B SR	T-416B SR	T-420B SR	MODEL NO. T-4B-SR BETTIS ACTUATOR				
Item	Part No.	Part No.	Part No.	Part No.	Description	Material	Quan	Spare Parts	Price Each
28	28848	28848	28848	28848	GASKET, END CAP	ASBESTOS	3	2	
29									
30	19855	19855	19855	19855	GASKET, COVER	ASBESTOS	1	1	
31	5115	5115	5115	5115	SEAL, TIE BAR	NITRILE	4	4	
32	5123	5123	5123	5123	SEAL, PISTON HEAD	NITRILE	1	1	
33	5256	5256	5256	5256	SEAL, YOKE	NITRILE	2	2	
34	5274	5276	5281	5288	SEAL, END CAP	NITRILE	2	2	
35	31472	31472	31472	31472	SEAL SET, PISTON ROD	NITRILE & NYLON	1	1	
36	20269	20269	20269	20269	SEAL, TIE BAR PISTON	NITRILE & TEFLON	2	2	
37	31481	29723	29726	29725	SEAL, PISTON	NITRILE & TEFLON	1	1	
38	29289	25289	25289	29269	GASKET, COVER SCREW	COPPER	8	8	
39	28980	28980	28980	28980	GASKET, STOP SCREW	COPPER	2	2	
40	31936	31936	31936	31936	SPRING WASHER	STEEL	1	1	
41	19835	19835	19835	19835	YOKE	DUCT IRON	1		
42	19843	19843	19843	19843	ROD, PISTON	STEEL	1		
43	20881	20881	20881	20881	ROD, PUSH	STEEL	1		
44		SEE BELOW			SPRING CARTRIDGE ASSY		1		
45	19853	19853	19853	19853	KEY, YOKE	STEEL	1		
46	20643	20643	20643	20643	PIN, YOKE KEY	STEEL	1		
47	19874	19874	19874	19874	INDICATOR, POSITION (NS)	STEEL	1		
	Part No	Cart No							
	20875	1							
	20967	2							
	20945	3							
	20946	4							
	20947	5							

☐ PARTS IN SHADED AREA ARE NOT INTERCHANGEABLE
(NS) NOT SHOWN

If disc tends to close:

$F_S + F_{OC} = F_P$

Force in rod A-B = F_S

Force in rod B-C = $F_P + F_{OO} = F_S$

If disc tends to open:

$F_S = F_{OO} + F_P$

Force in rod A-B = $F_{OO} + F_P = F_S$

Force in rod B-C = $F_P = F_S - F_{OO}$

SEAL KITS T-410B-#32080
T-412B-#32081
T-416B-#32082
T-420B-#32083

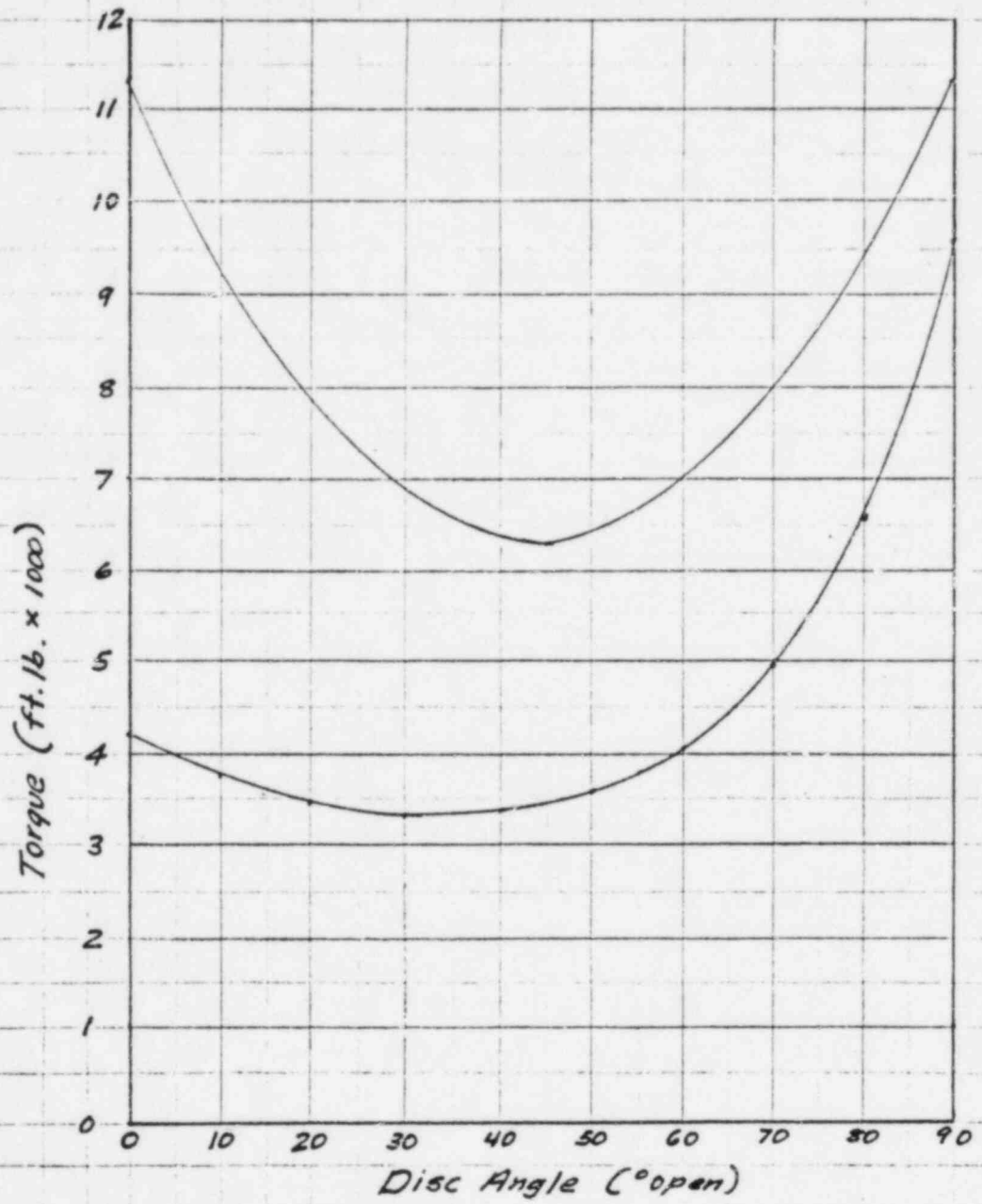
CUSTOMER	DATE	SHEET
NPPD Cooper Nuclear Station	10/27/83	44 OF

SUBJECT	PRELIM.	FINAL
Operator Torque Absorption Capability Bettis T-420B-SRI		

DRAWING NUMBER		CALCULATED BY
	LITHO IN U.S.A.—A-C ENGINEERING CALCULATION SHEET ALLIS-CHALMERS FORM 6715-1	Zeiders

Valve : Ref. A-C Test # Fig.

Closing time :



CUSTOMER: NPPD Cooper Nuclear Station | DATE: 11/2/83 | SHEET 45 OF

SUBJECT: Operator Torque Absorption Capability Bettis 744A-SR1-41 | PRELIM. | FINAL

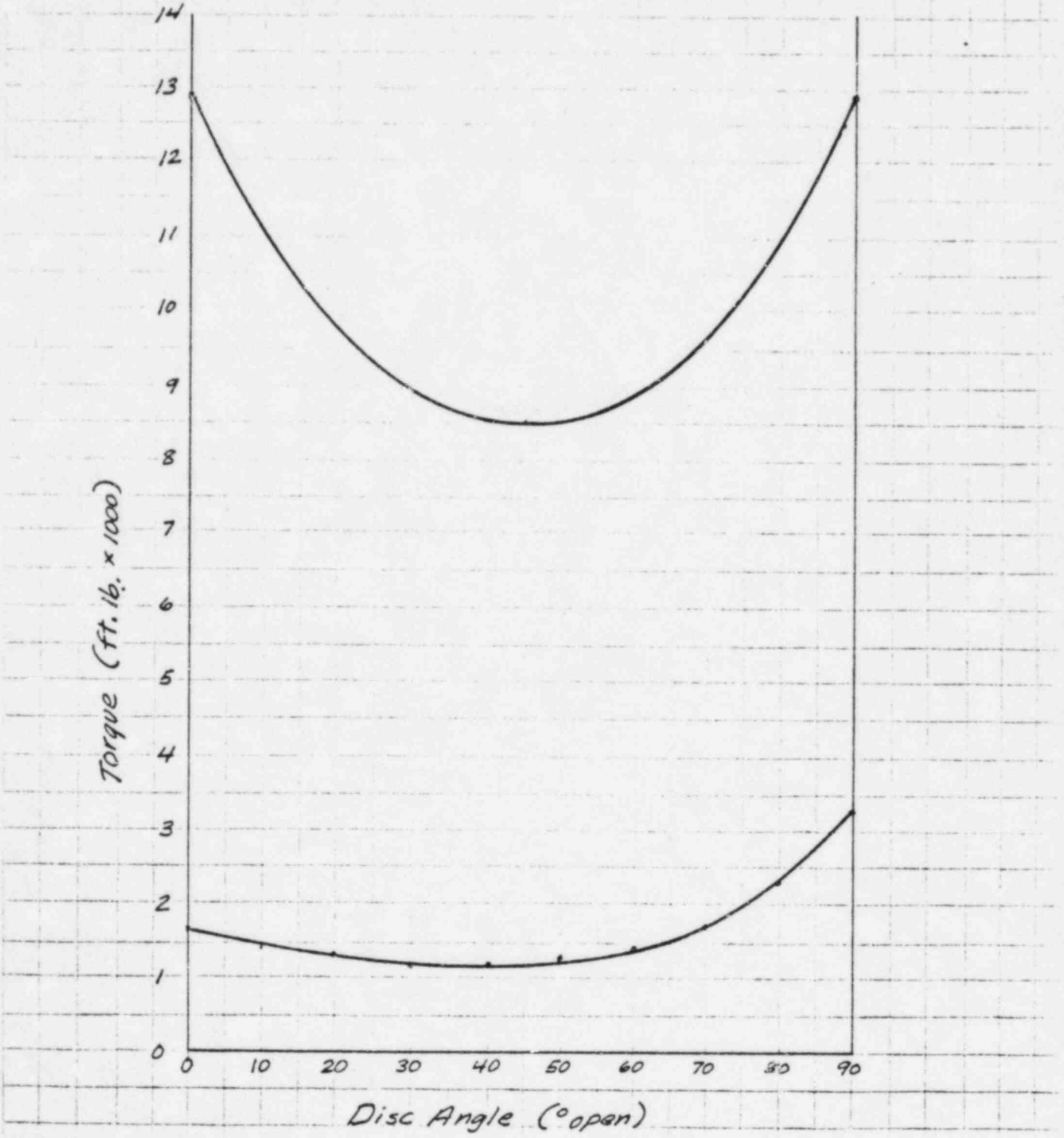
DRAWING NUMBER

LITHO IN U.S.A.-A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY: R. Zeiders



LOAD STRESS ANALYSIS

CRITICAL VALVE PARTS

The following shows a worst case condition of LOCA torques imposed on critical valve parts. Note that all stresses are well below allowable.

Stress calculations as a result of seismic loads were submitted for these valves in the form of Allis-Chalmers Report VER-0093 in 1972.

Although LOCA and seismic loads and stresses have not been combined in this report, examination of the separate reports indicate very conservative results.

CUSTOMER: Nebraska Public Power District | DATE | SHEET 1 OF

SUBJECT: S+B #44113; Mfg #'s 78402 thru 78406 | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.-A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS | FORM 6715-1

CALCULATED BY: G W Anderson

Critical Valve Part - Load/Stress Analysis

24" Drywell Valve LOCA Torque = 1239 ft-lbs.
Bettis Operator Model 744-1SR wt. = 611*

I Analysis of Adapter To Body Bolts

Bolt material = A276 Ty 304 Allowable stress = use 15000 psi
Bolt size = 1"-8 x 2 1/2" Stress area = .551 in² (shear)
Equivalent radius of bolt location = 4.42 in No. bolts = 4

Shear force due To LOCA dynamic Torque =

$$\frac{1239 \text{ ft-lbs}}{\frac{4.42}{12.00 \text{ in}}} = 3364 \text{ lbs}$$

$$\frac{3364 \text{ lbs}}{4} = 841 \text{ lbs per bolt.}$$

Shear stress due to LOCA Torque = $\frac{(841)}{(.551)} = 1526$ psi

Shear Stress due To extended weight and horizontal shaft: $\frac{681^*}{4(551)} = 312$ psi.

* This includes bracket wt (76#)

CUSTOMER | DATE | SHEET 2 OF

SUBJECT | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.-A-C | CALCULATED BY

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS | FORM 6715-1

II Analysis of Bracket to Operator Bolts

Bolt material = A276 ty 304
Bolt size = 3/4-10 x 1 3/4 lg no. bolts = 8
Bolt circle = 12.375" shear stress area = .302 in²

Shear force due to LOCA dynamic Torque =

$$\frac{1239 \text{ ft-lbs}}{12.375} = 1201 \text{ lbs.}$$

$12.$

load per bolt = $\frac{1201}{8} = 150$ lbs per bolt.

Shear stress due to LOCA Torque = $\frac{150}{.302} = 497$ psi

Shear stress due to extended weight and horizontal shaft =

$$\frac{611}{8(.302)} = 253 \text{ psi}$$

CUSTOMER | DATE | SHEET 3 OF

SUBJECT | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.-A-C | CALCULATED BY C.W. Andzulis

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS | FORM 6715-1

III Valve Shaft Torsional Analysis

Ref: Table 20, case I
Formulas for Stress + Strain
Roark + Young - Fifth edition

Valve shaft = 2.5" dia
material = S. Steel Ty 304

Maximum Torsional Shear Stress, ref case I above, = τ

$$\tau = \frac{2T}{\pi r^3}$$ where T = Torque (in lbs)
r = radius (in.)
τ = shear stress (psi)

$$\tau = \frac{2(1259)(12)}{\pi(1.25^3)} = 4846 \text{ psi}$$

Maximum Torsional shear stress allowed
= 11 500 psi (AWWA C504)

IV Analysis of Disc Pins

In accordance with the standard criteria of AWWA C504, the pin connection shall be capable of transmitting a minimum of 75% of the torsional strength of the valve shaft.

Since the above Analysis shows that the dynamic Torque is well below that equivalent to 75% of the shaft capability, the disc pins are suitable for the intended load.

CUSTOMER Nebraska Public Power District | DATE | SHEET 4 OF

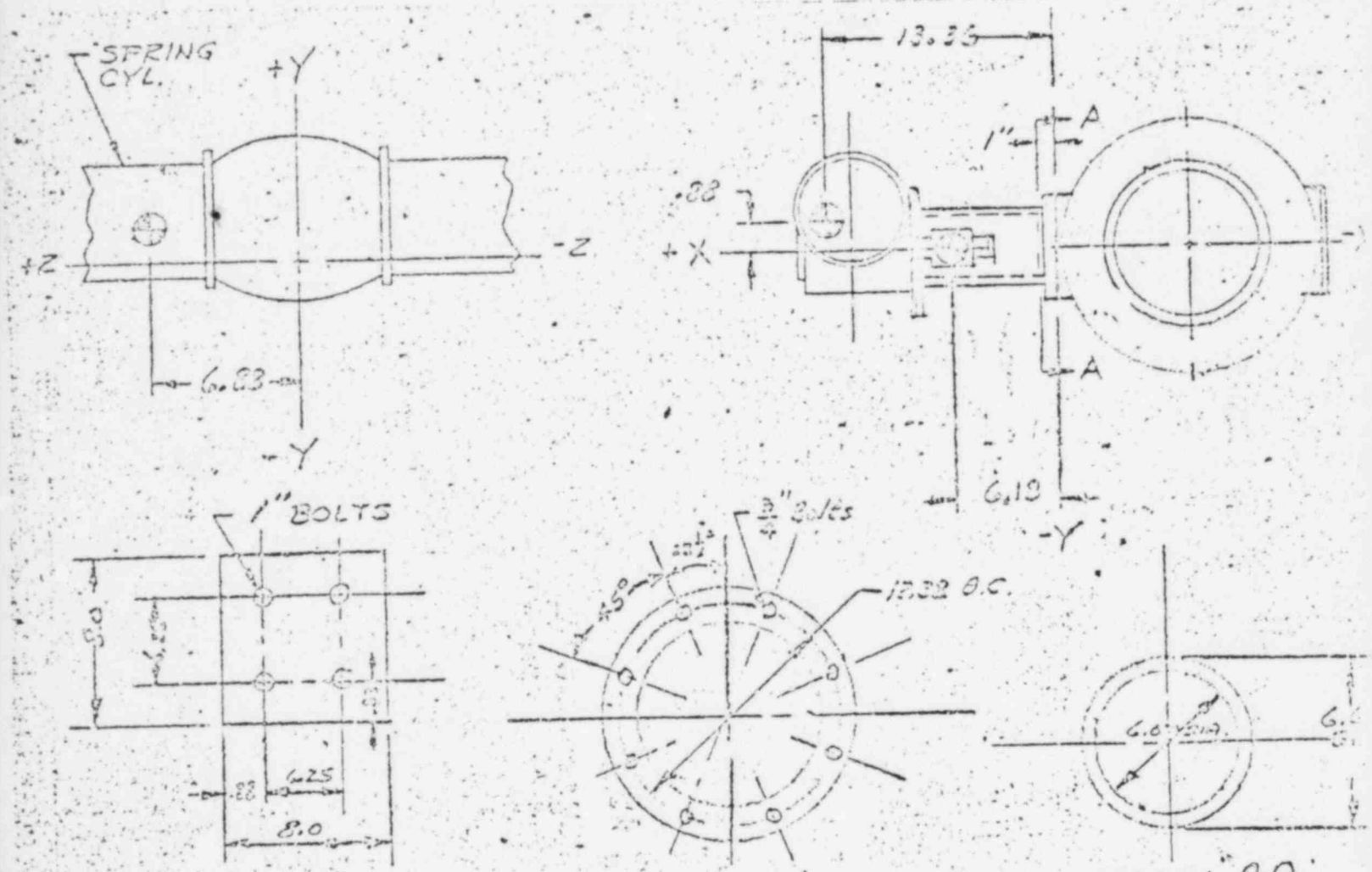
SUBJECT S+B 44113, Mfg #'s 78402 Thru 78406 | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A. - A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS | FORM 6715-1 | CALCULATED BY Cdk

Dimensions of Operator + Bracket Mounting
(pg 6 of original VER 0093)



ADAPTER TO BODY MTG. ADAPTER TO OPERATOR SECTION A-A

WEIGHTS #

OPERATOR	611
ADAPTER	76
TOTAL	687 #

CUSTOMER	DATE	SHEET 51 OF
NPPD Cooper Nuclear Station		

SUBJECT	PRELIM.		FINAL
Dynamic Torque Analysis - Closing Stroke			

DRAWING NUMBER		CALCULATED BY
	ENGINEERING CALCULATION SHEET	R. Zeiders
		CHKD. BY

LITHO IN U.S.A.-A-C

ALLIS-CHALMERS FORM 6715-1

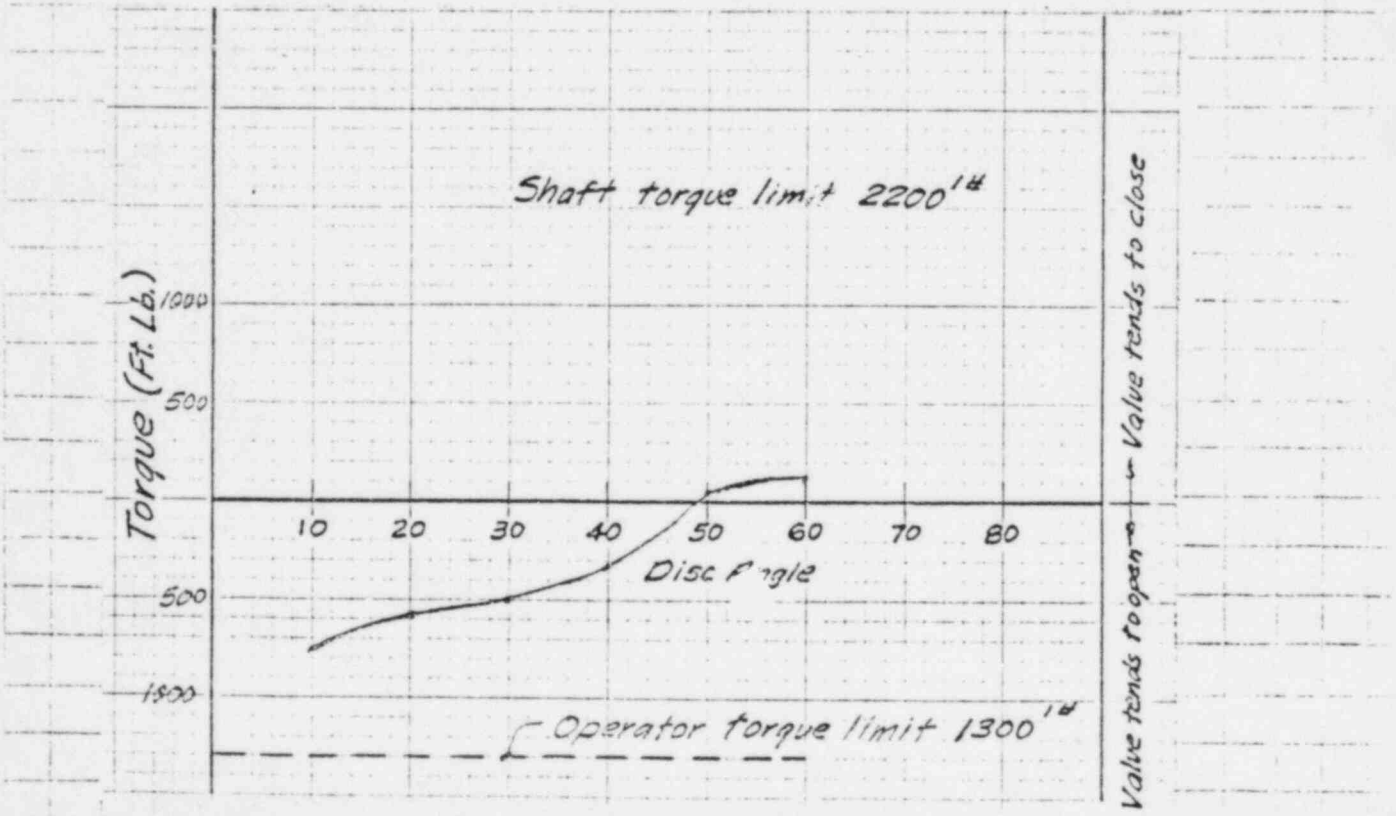
Analysis for Valve 230 MV Location: Wetwell

Valve Seat Location Upstream A-C Test # 29 Fig. # 9

Upstream Piping: Preceded by 45° elbow, shaft 90° out of plane, preceded by 90° elbow shaft in plane

Closing time: 14 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°						
80						
70	Valve is blocked at 60° open.					
60	7	6	3	144	34	110
50	14.8	13.5	1.1	119	76	43
40	17.8	16.8	-1.7	-228	95	-323
30	19.4	19.4	-2.5	-388	110	-498
20	20.5	20.5	-2.8	-459	116	-575
10	21.4	21.4	-3.7	-633	121	-754



CUSTOMER	DATE	SHEET
NPPD Cooper Nuclear Station	10/24/83	52 OF

SUBJECT	PRELIM.		FINAL
Dynamic Torque Analysis - Closing Stroke			

DRAWING NUMBER		CALCULATED BY
	ENGINEERING CALCULATION SHEET	R. Zeiders
		CHKD. BY

LITHO IN U.S.A. - A-C

ALLIS-CHALMERS FORM 6715-1

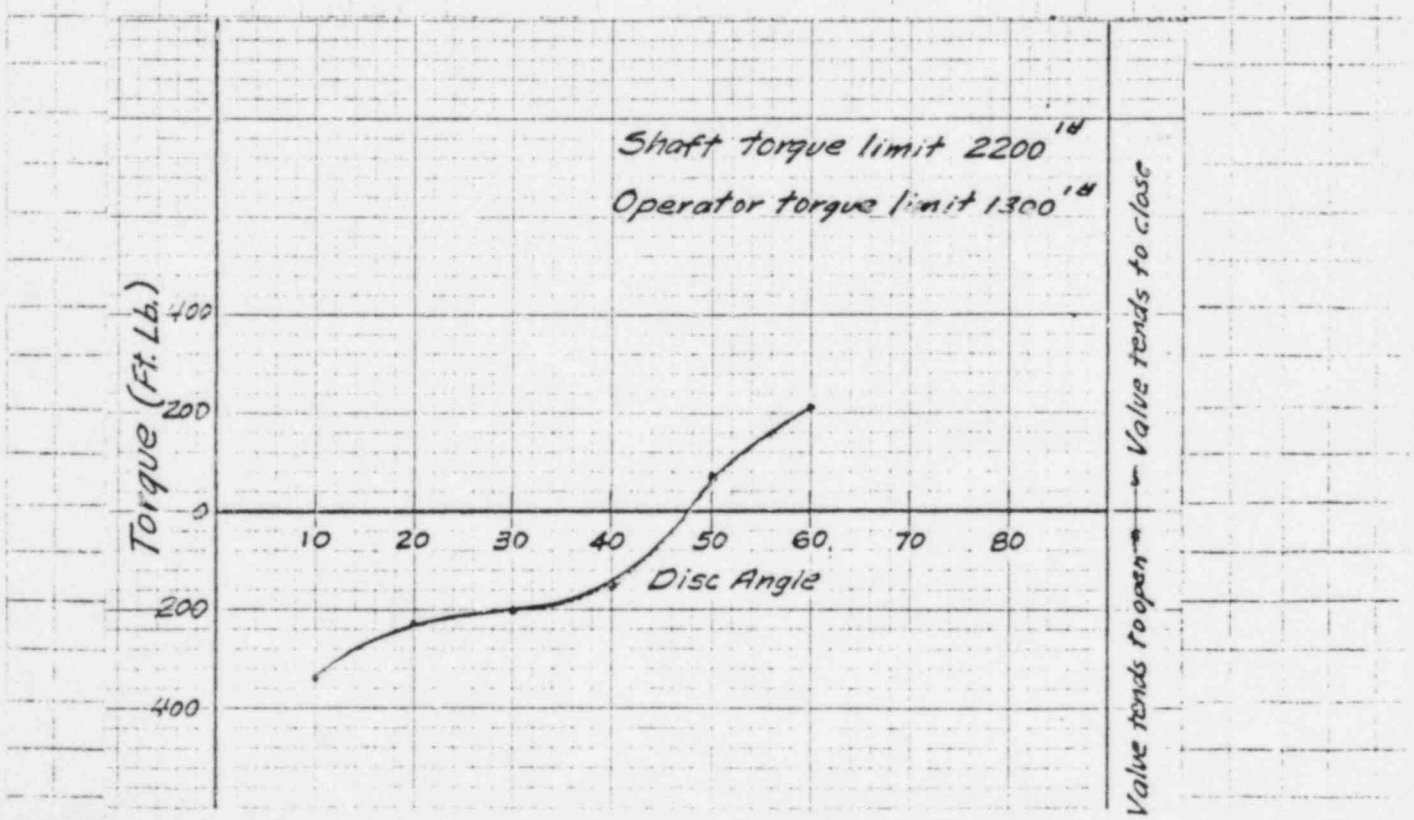
Analysis for Valve 230 MV Location: Wetwell

Valve Seat Location Upstream A-C Test # 32 Fig. # 10

Upstream Piping: Preceded by 45° elbow, shaft 90° out of plane, preceded by 90° elbow shaft in plane

Closing time: 14 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°						
80						
70	Valve is blocked at 66° open.					
60	7	6	5.2	250	34	216
50	14.8	13.5	1.4	151	76	75
40	17.8	16.8	-.4	-54	95	-149
30	19.4	19.4	-.58	-90	110	-200
20	20.5	20.5	-.7	-115	116	-231
10	21.4	21.4	-1.27	-217	121	-338



CUSTOMER: NPPD Cooper Nuclear Station | DATE | SHEET 53 OF

SUBJECT: Dynamic Torque Analysis - Closing Stroke | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.-A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY: R. Zeiders

CHKD. BY: Cdth

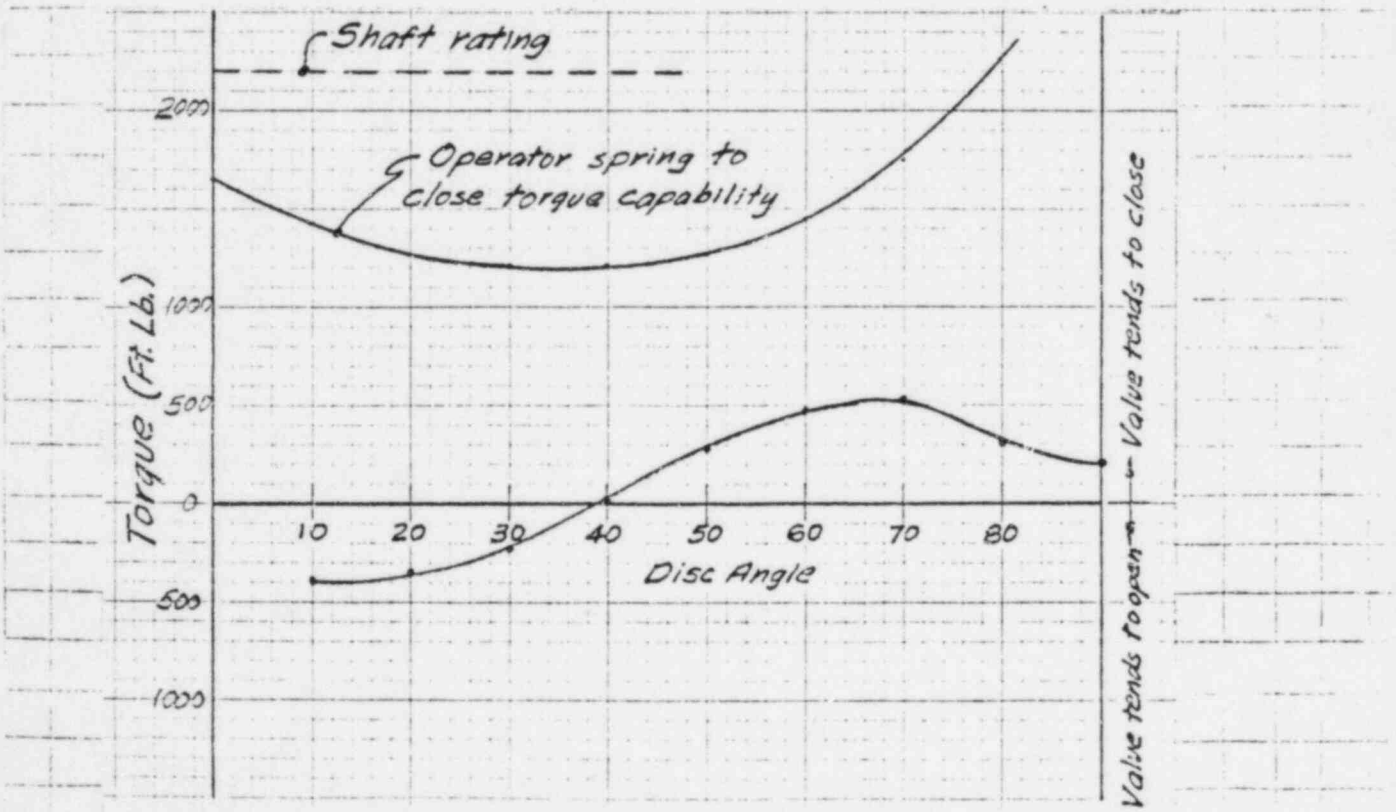
Analysis for Valve 245 AV — Location: Wetwell

Valve Seat Location Downstream — A-C Test # 30 Fig. # 11

Upstream Piping: Preceded by 230 MV throttled at 60° open.

Closing time 14 seconds.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°		.5	43	192	3	189
80		1.7	23	313	10	303
70		4.1	16.5	541	23	518
60		9	7.4	533	51	482
50		12.5	3.6	360	71	289
40		16	.8	102	90	12
30		19	-.8	-122	107	-229
20		20.4	-1.5	-245	115	-360
10		21.4	-1.6	-274	121	-395



CUSTOMER: NPPD Cooper Nuclear Station | DATE | SHEET 54 OF

SUBJECT: Dynamic Torque Analysis - Closing Stroke | PRELIM. | FINAL

DRAWING NUMBER: –

LITHO IN U.S.A. – A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY: R. Zeiders

CHKD. BY: [illegible]

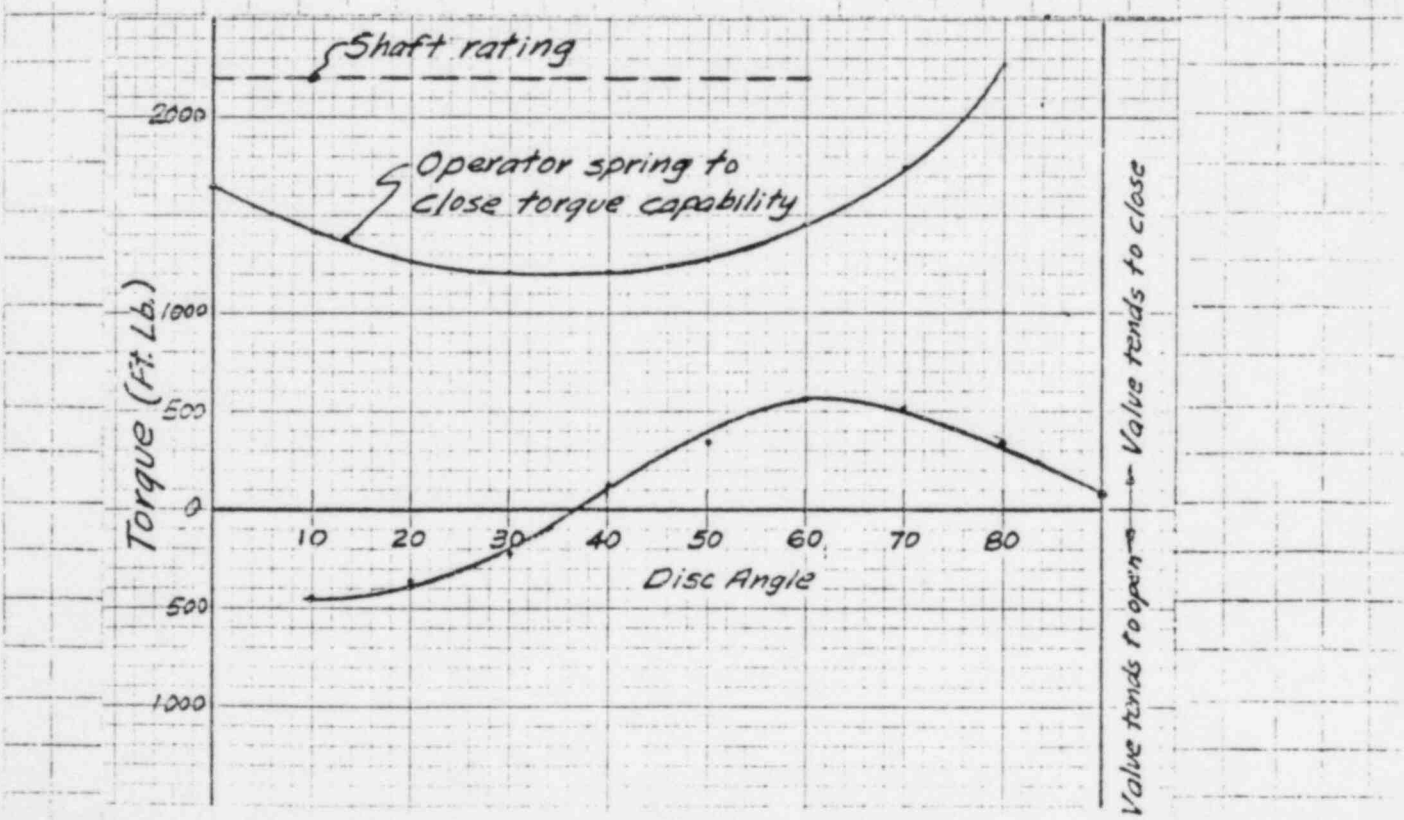
Analysis for Valve 245 AV — Location: Wetwell

Valve Seat Location Downstream — A-C Test # 31 Fig. # 12

Upstream Piping: Preceded by 230 MV throttled at 60° open.

Closing time: 14 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°		.5	21	84	3	81
80		1.7	25	340	10	330
70		4.1	16	525	23	502
60		9	8.5	612	51	561
50		12.5	4	400	71	329
40		16	1.5	192	90	102
30		19.1	-.7	-106	107	-213
20		20.4	-1.6	-261	115	-376
10		21.4	-1.9	-325	121	-446



CUSTOMER	DATE	SHEET 55 OF
NPPD Cooper Nuclear Station	11/2/83	

SUBJECT	PRELIM.	FINAL
Operator Torque Absorption Capability Bettis 744A-SR1-41		

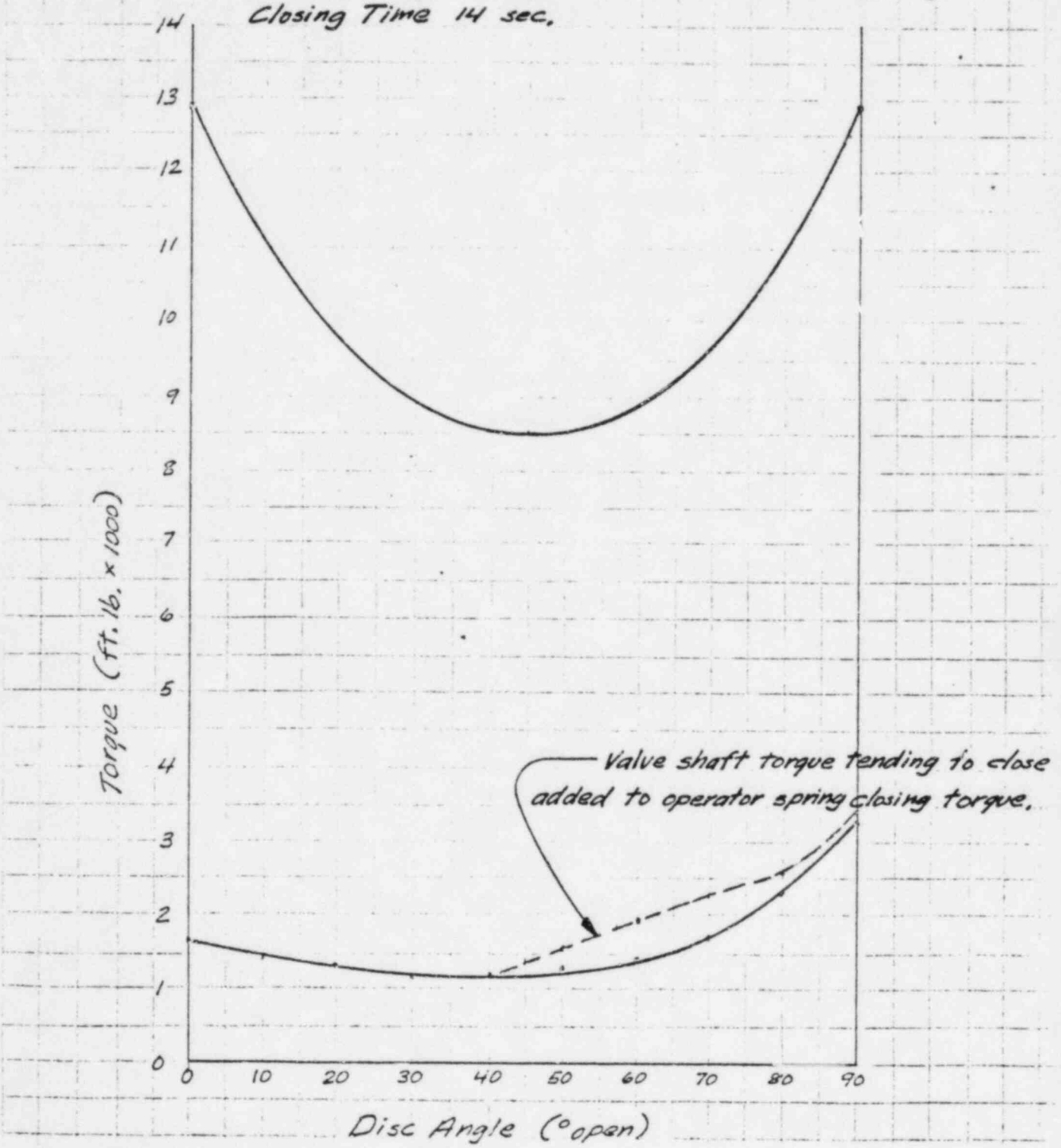
DRAWING NUMBER		CALCULATED BY
	ENGINEERING CALCULATION SHEET	R. Zeiders

LITHO IN U.S.A.-A-C

ALLIS-CHALMERS FORM 6715-1

Valve: 24.5 AV Ref. A-C Test #30, Fig. #11

Closing Time 14 sec.



CUSTOMER NPPD Cooper Nuclear

SUBJECT Pressure drop across (2) valves in series

DATE 9/83

DRAWING NUMBER

SHEET 56 OF

PRELIM. FINAL

CALCULATED BY Zeigers Ellis

ALLIS-CHALMERS ENGINEERING CALCULATION SHEET

FORM 6-15-1 LITHO IN U.S.A.-A-C

Two valves are in series in a pipeline. The upstream valve is blocked at 60° open and does not move. The downstream valve closes from wide open in 14 seconds.
Wetwell Pressure – Applies to 230 MV, 245 AV, 233 MV & 237 AV

Valve Closing Time (sec.)	Disc Angle MV	K MV	Disc Angle AV	K AV	K_T (K_{MV} + K_{AV})	C_{dT}	Equivalent Disc Angle	P_1	ΔP	ΔP_{MV}	ΔP_{AV}
0	60°	2.43	90°	.23	2.66	.522	59°	7.0	5.5	5.0	.5
1			85	.29	2.72	.518	58	11.3	10	8.9	1.1
2			80	.38	2.81	.512	57	14.2	12	10.4	1.6
3			74	.62	3.05	.497	56	16	13.8	11	2.8
4			68	1.19	3.62	.465	55	17.3	15	10.1	4.9
5			61	2.43	4.86	.413	52	18.1	16	8	8
6			53	4.54	6.97	.354	48	18.8	17.4	6.1	11.3
7			45	8.76	11.19	.286	43	19.4	18.2	4.0	14.2
8			37	17.9	20.33	.217	36	19.8	19.3	2.3	17.0
9			29	38	40.43	.155	28	20.3	20.3	1.2	19.1
10			22	79	81.4	.110	22	20.8	20.8	.6	20.2
11			16	168	170.4	.076	16	21.1	21.1	.3	20.8
12			10	452	454.4	.047	10	21.5	21.5	.1	21.4
13			5	1889	1891.4	.023	5	22	22	0	22
14			0°	–	–	–	–				

CUSTOMER	DATE	SHEET
NPPD Cooper Nuclear Station		57 OF

SUBJECT	PRELIM.		FINAL
Dynamic Torque Analysis - Closing Stroke			

DRAWING NUMBER		LITHO IN U.S.A. - A-C	CALCULATED BY
		ENGINEERING CALCULATION SHEET	R. Zeiders
		ALLIS-CHALMERS FORM 6715-1	CHKD. BY

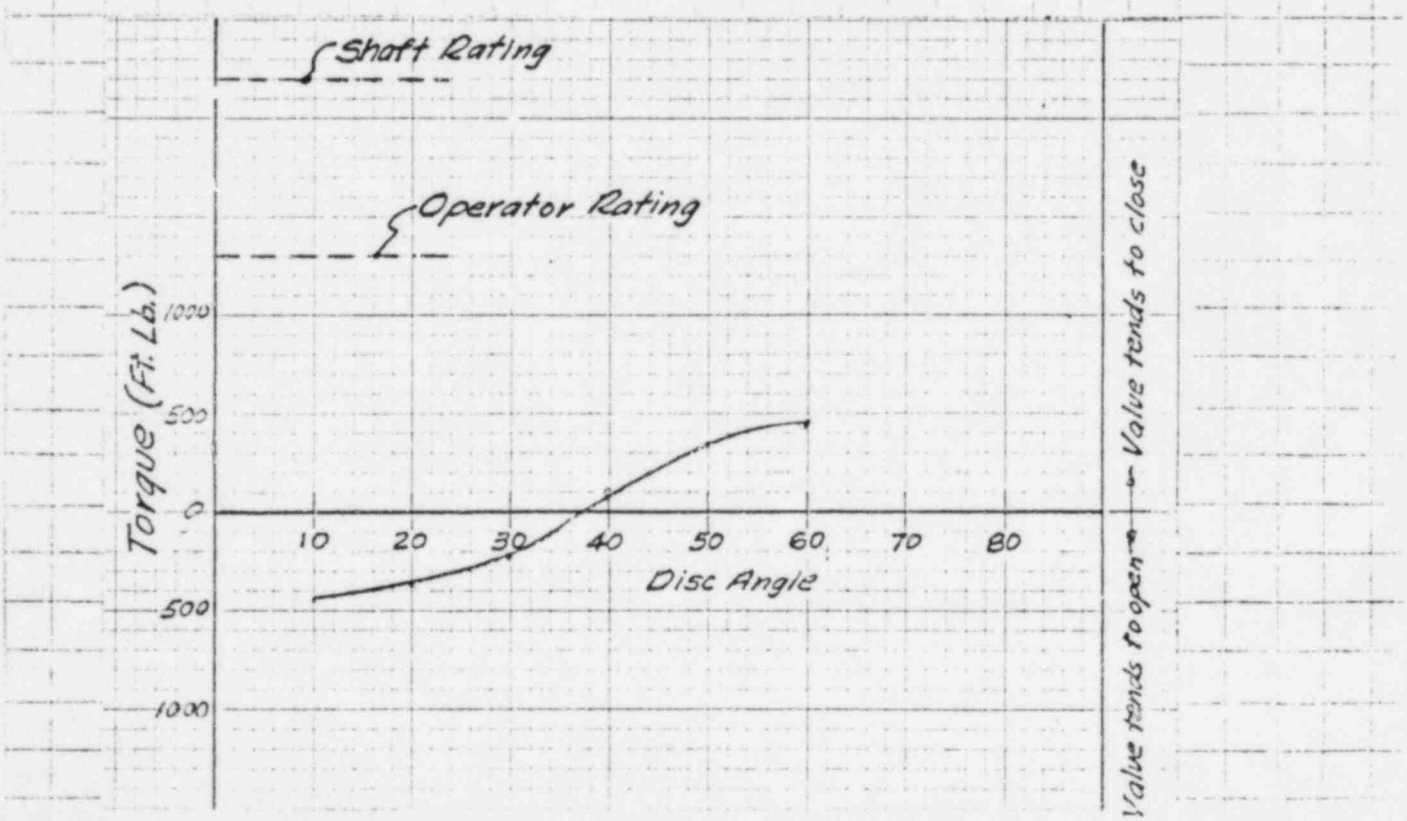
Analysis for Valve 233 MV Location: Wetwell

Valve Seat Location Downstream A-C Test # 31 Fig. # 12

Upstream Piping: Valve preceded by 90° elbow that is 60° out of plane.

Closing time: 14 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°						
80						
70		Valve is blocked at 60° open.				
60	7	6	10	480	34	446
50	14.8	13.5	3.8	410	76	334
40	17.8	16.8	1.45	195	95	100
30	19.4	19.4	-.72	-112	110	-222
20	20.5	20.5	-1.6	-262	116	-378
10	21.4	21.4	-1.9	-325	121	-446



CUSTOMER: NPPD Cooper Nuclear Station | DATE: 10/24/83 | SHEET 58 OF

SUBJECT: Dynamic Torque Analysis - Closing Stroke | PRELIM. | FINAL

DRAWING NUMBER

LITHO IN U.S.A. - A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY: R. Zeiders

CHKD. BY

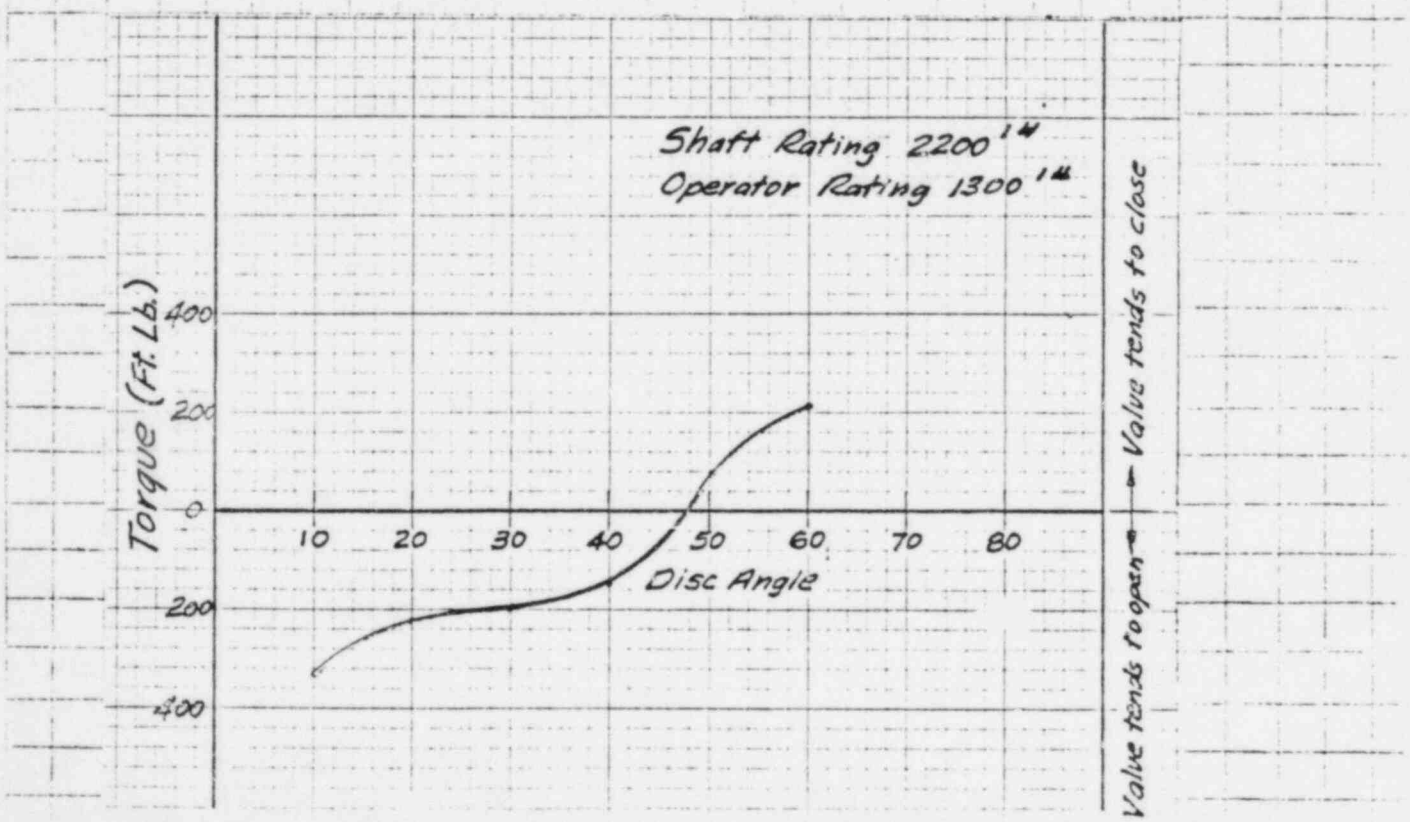
Analysis for Valve 233 MV Location: Wetwell

Valve Seat Location Upstream A-C Test # 32 Fig. # 10

Upstream Piping: Preceded by 90° elbow that is 60° out of plane.

Closing time: 14 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°						
80						
70	Valve is blocked at 60° open					
60	7	6	5.2	250	34	216
50	14.8	13.5	1.4	151	76	75
40	17.8	16.8	-.4	-54	95	-149
30	19.4	19.4	-.58	-90	110	-200
20	20.5	20.5	-.7	-115	116	-231
10	21.4	21.4	-1.27	-217	121	-338



CUSTOMER: NPPD Cooper Nuclear Station | DATE | SHEET 62 OF

SUBJECT: Dynamic Torque Analysis - Closing Stroke | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A. - A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY: R. Zeiders

CHKD. BY:

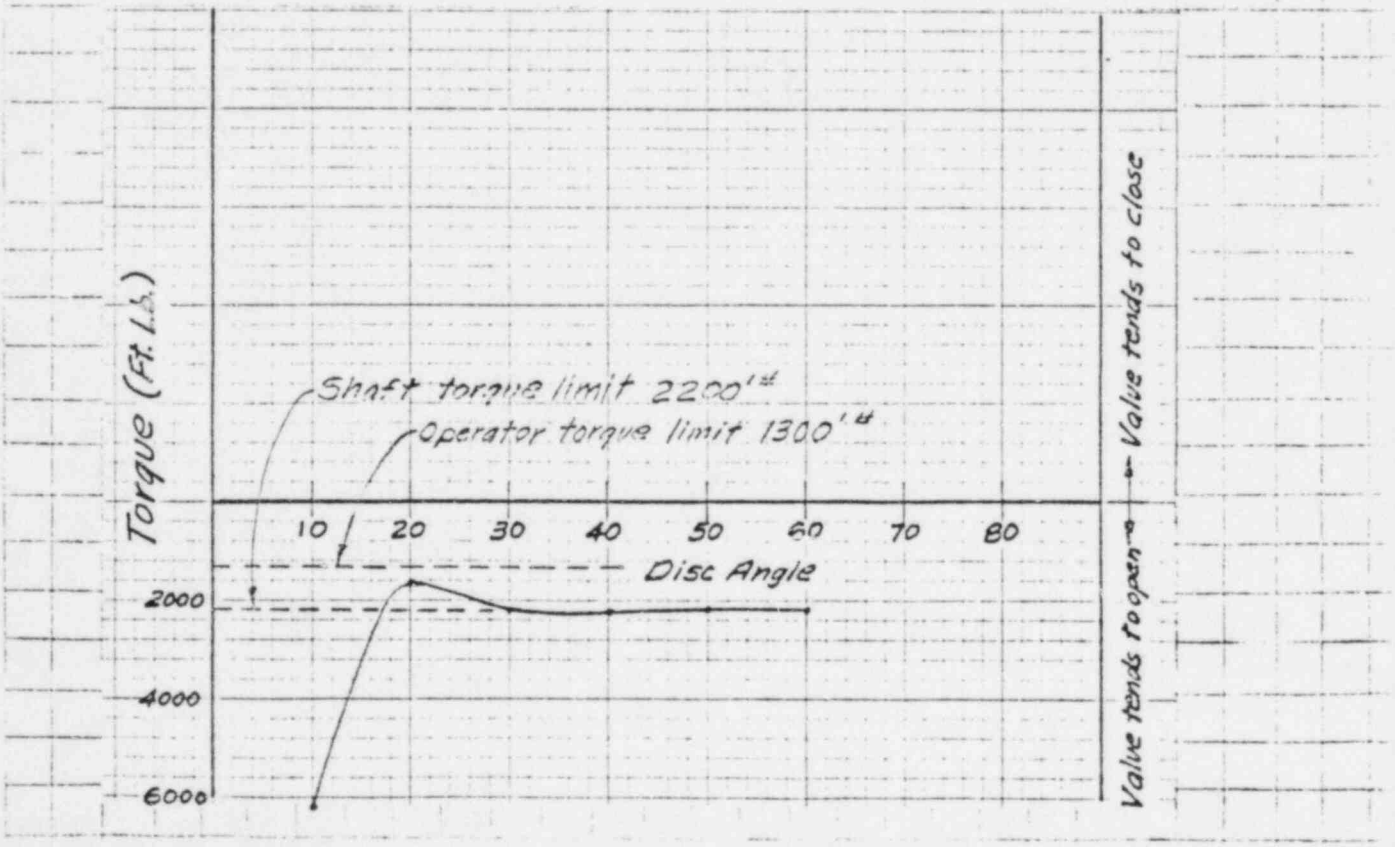
Analysis for Valve 231 MV Location: Drywell

Valve Seat Location Upstream A-C Test # 3 Fig. #

Upstream Piping: Valve preceded by 45° elbow - shaft 90° out of plane, preceded by 90° elbow - shaft in plane

Valve closing time: 4 seconds

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°						
80						
70	Valve is blocked at 60° open					
60	41.5	30.5	-9.87	-2408	172	-2236
50	48	33	-9.25	-2442	186	-2256
40	50	46	-7.5	-2760	260	-2500
30	51.3	51.3	-6.63	-2721	290	-2431
20	47	47	-5.14	-1933	266	-1667
10	43.7	43.7	-18.86	-6593	247	-6346



CUSTOMER: NPPD Cooper Nuclear Station | DATE | SHEET 63 OF

SUBJECT: Dynamic Torque Analysis - Closing Stroke | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.-A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS | FORM 6715-1

CALCULATED BY: R. Zeiders

CHKD. BY: CAW

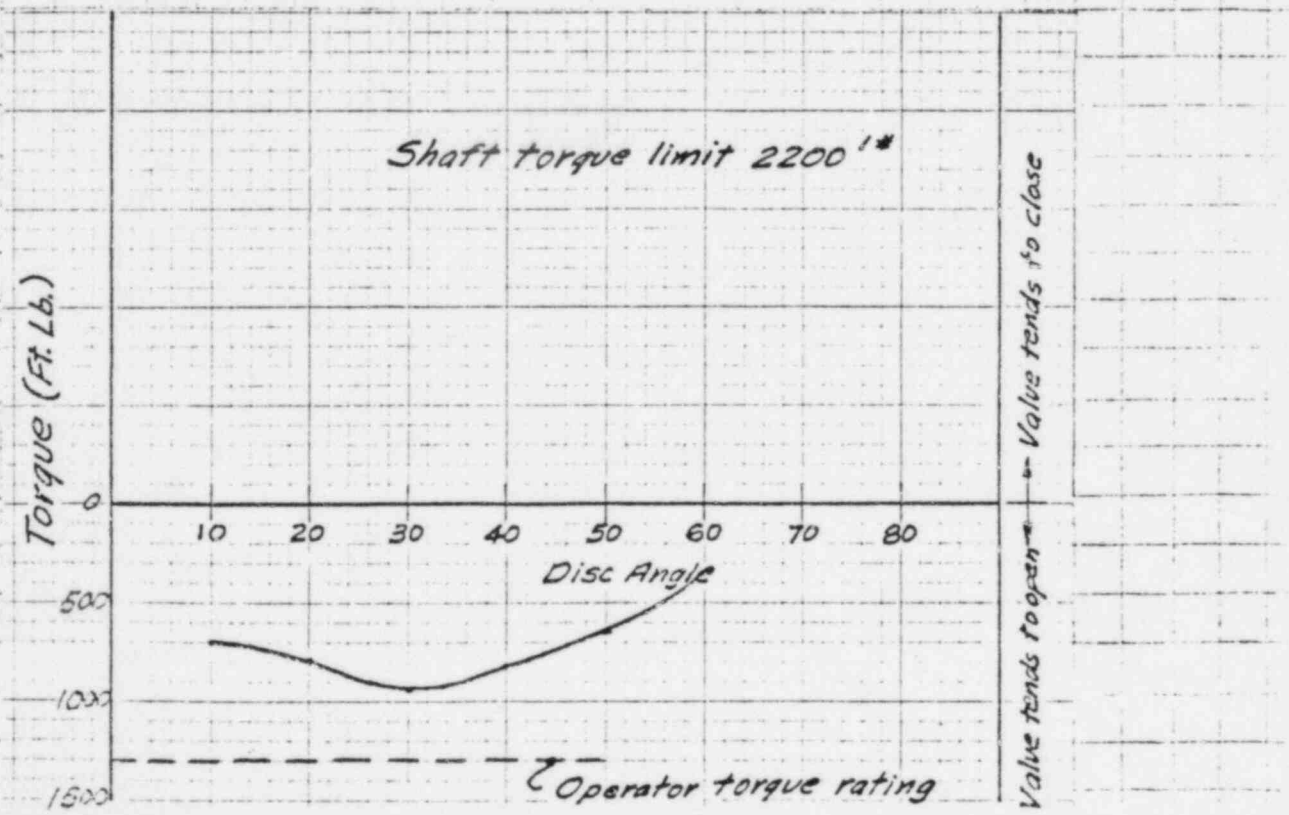
Analysis for Valve 231 MV Location: Drywell

Valve Seat Location Upstream A-C Test # 29 Fig. # 9

Upstream Piping: Valve preceded by 45° elbow - shaft 90° out of plane, preceded by 90° elbow - shaft in plane

Valve closing time: 4 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°						
80						
70	Valve is blocked at 60° open					
60	41.5	30.5	-.7	-171	172	-343
50	48	40.5	-1.3	-421	229	-650
40	50	46	-1.5	-552	260	-812
30	51.3	51.3	-1.6	-657	290	-947
20	47	47	-1.4	-526	266	-792
10	43.7	43.7	-1.3	-454	247	-701



CUSTOMER	DATE	SHEET 64 OF
NPPD Cooper Nuclear Station		

SUBJECT	PRELIM.		FINAL
Dynamic Torque Analysis - Closing Stroke			

DRAWING NUMBER		LITHO IN U.S.A. - A-C	CALCULATED BY
		ENGINEERING CALCULATION SHEET	R. Zeiders
		ALLIS-CHALMERS FORM 6715-1	CHKD. BY

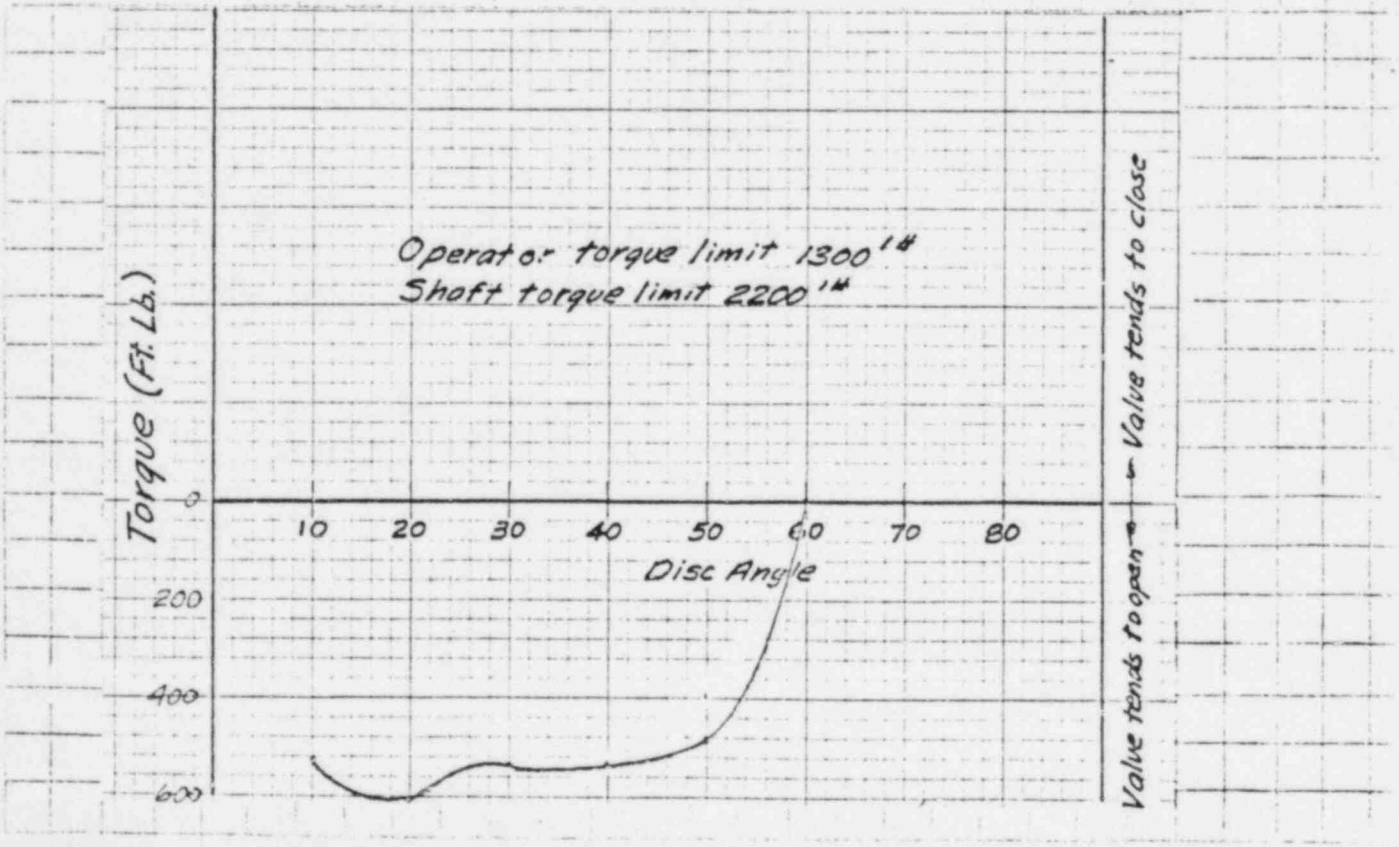
Analysis for Valve 231 MV Location: Drywell

Valve Seat Location Upstream A-C Test # 32 Fig. # 10

Upstream Piping: Valve preceded by 45° elbow - shaft 90° out of plane, preceded by 90° elbow - shaft in plane.

Valve closing time: 4 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°						
80						
70	Valve is blocked at 60° open					
60	41.5	30.5	.7	171	172	1
50	48	40.5	-.8	-259	-229	488
40	50	46	-.75	-276	260	536
30	51.3	51.3	-.6	-246	290	536
20	47	47	-.9	-338	266	604
10	43.7	43.7	-.8	-280	247	527



CUSTOMER: NPPD Cooper Nuclear Station | DATE | SHEET 65 OF

SUBJECT: Dynamic Torque Analysis - Closing Stroke | PRELIM. | FINAL

DRAWING NUMBER

LITHO IN U.S.A. - A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY: R. Zeiders

CHKD. BY

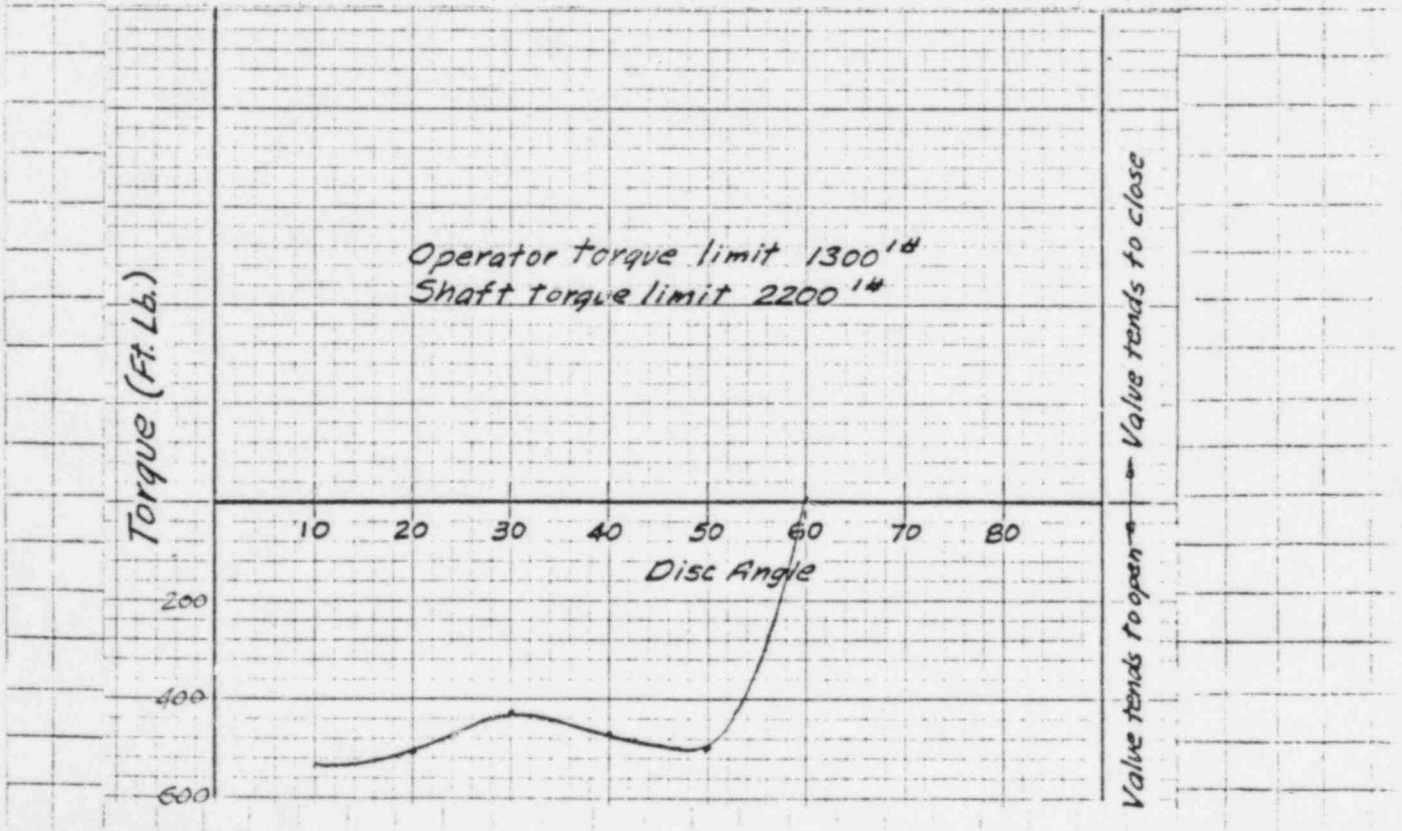
Analysis for Valve 231 MV — Location: Drywell

Valve Seat Location Upstream — A-C Test # 32 Fig. # 10

Upstream Piping:

Valve closing time 14 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°						
80						
70						
60	42	31	.7	174	175	1
50	49.5	41.5	-.8	-266	234	500
40	40.5	38	-.85	-258	215	473
30	40	40	-.65	-208	226	434
20	41	41	-.84	-276	232	508
10	42	42	-.9	-302	237	539



CUSTOMER	DATE	SHEET 66 OF
NPPD Cooper Nuclear Station		

SUBJECT	PRELIM.		FINAL
Dynamic Torque Analysis - Closing Stroke			

DRAWING NUMBER		LITHO IN U.S.A.-A-C	CALCULATED BY
		ENGINEERING CALCULATION SHEET	R. Zeiders
		ALLIS-CHALMERS FORM 6713-1	CHKD. BY

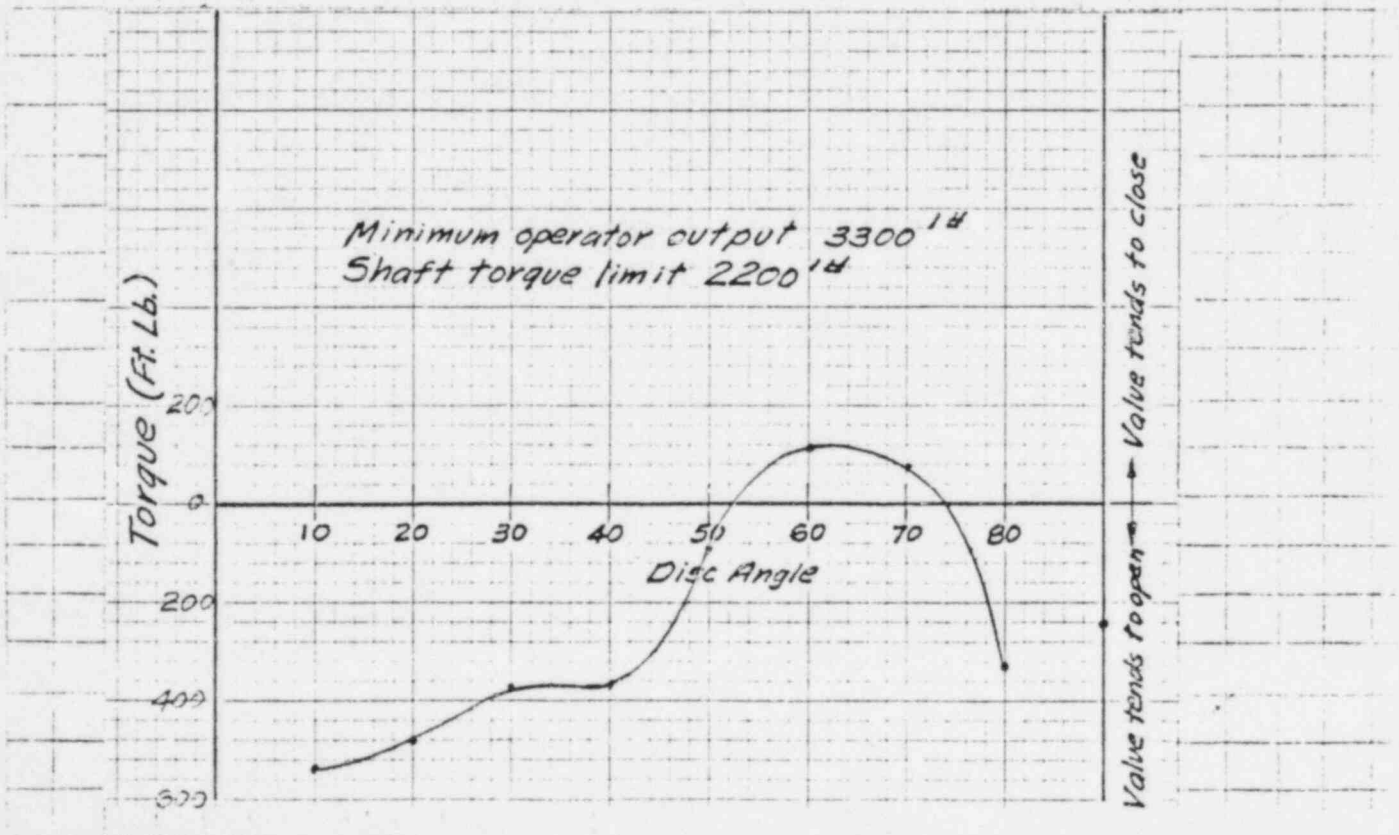
Analysis for Valve 246 AV Location: Drywell

Valve Seat Location Upstream A-C Test # 32 Fig. # 10

Upstream Piping: 231 MV blocked at 60° open preceded by 45° elbow (shaft 90° out of plane) preceded by 90° elbow (shaft in plane).

Valve closing time 9 seconds.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°		2.7	-10.6	-229	15	-244
80		5.9	-6.4	-302	33	-335
70		11.2	1.5	134	63	71
60		17.9	1.5	215	101	114
50		25.7	.25	51	145	-94
40		32.3	-.74	-191	182	-373
30		37.1	-.6	-178	210	-388
20		38.9	-.85	-265	220	-485
10		40	-1.0	-320	226	-546



CUSTOMER	DATE	SHEET
NPPD Cooper Nuclear Station	10/21/83	67 OF

SUBJECT	PRELIM.		FINAL
Dynamic Torque Analysis - Closing Stroke			

DRAWING NUMBER		CALCULATED BY
	ENGINEERING CALCULATION SHEET	R. Zeiders
	ALLIS-CHALMERS FORM 3715-1 LITHO IN U.S.A.-A-C	CHKD. BY

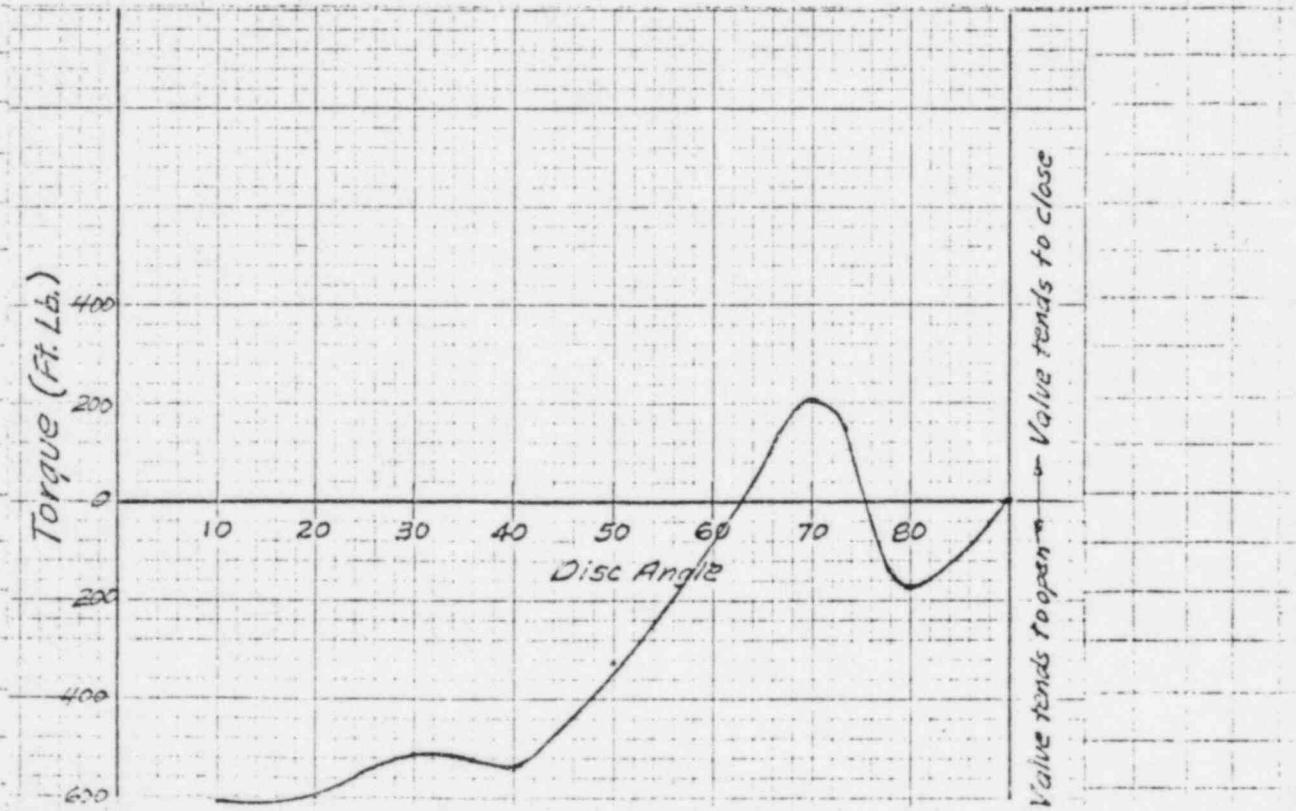
Analysis for Valve 246 AV Location: Drywell

Valve Seat Location Upstream A-C Test # 29 Fig. # 9

Upstream Piping: 231 MV blocked at 60° open preceded by 45° elbow (shaft in plane) preceeded by 90° elbow (shaft 90° out of plane)

Valve closing time: 9 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°		2.7	.6	13	15	2
80		5.9	-4.0	-142	33	-175
70		11.2	3.0	269	63	206
60		17.9	-0.2	-29	101	-130
50		25.7	-0.9	-185	145	-330
40		32.3	-1.4	-362	182	-544
30		37.1	-1.0	-297	210	-507
20		38.9	-1.2	-373	220	-593
10		40	-1.2	-384	226	610



CUSTOMER	DATE	SHEET 68 OF
NPPD Cooper Nuclear Station		

SUBJECT	PRELIM.	FINAL
Dynamic Torque Analysis - Closing Stroke		

DRAWING NUMBER		CALCULATED BY
		R. Zeiders
		CHKD. BY

LITHO IN U.S.A.-A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

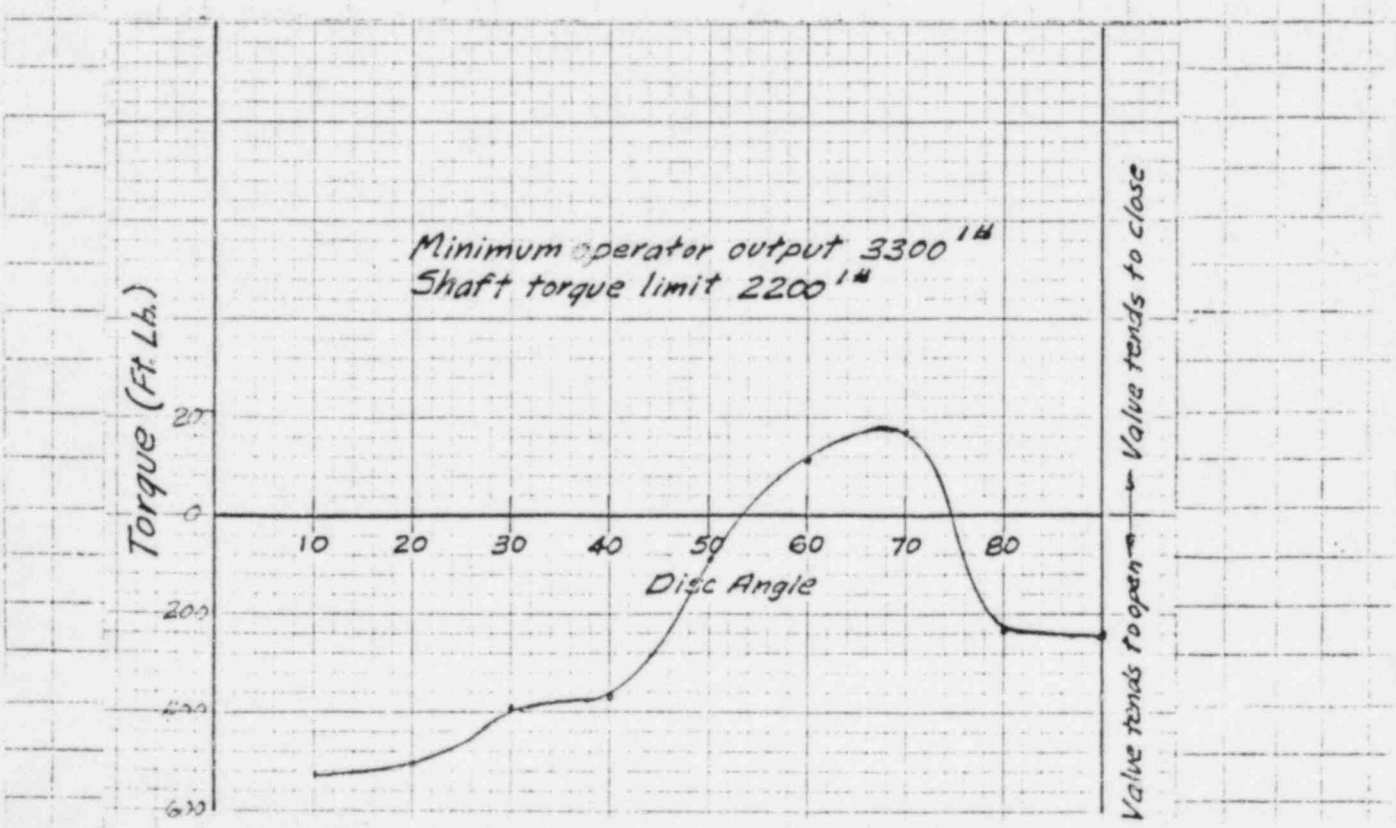
Analysis for Valve 246 AV Location: Drywell

Valve Seat Location Upstream A-C Test # 32 Fig. # 10

Upstream Piping: 231 MV blocked at 60° open preceded by 45° elbow (shaft 90° out of plane) preceded by 90° elbow (shaft in plane).

Valve closing time 14 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°		2.7	-10.6	-229	15	-244
80		5.2	-5.0	-208	29	-237
70		9	3.0	216	51	165
60		17	1.5	204	96	108
50		25	.25	50	141	-91
40		32	-.75	-192	181	-373
30		38	-.6	-182	215	-397
20		40.5	-.86	-279	229	-508
10		41.7	-.9	-300	236	-536



CUSTOMER: NPPD Cooper Nuclear Station | DATE: 10/21/83 | SHEET 69 OF

SUBJECT: Dynamic Torque Analysis - Closing Stroke | PRELIM. | FINAL

DRAWING NUMBER

LITHO IN U.S.A. - A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY: R. Zeiders

CHK'D. BY: CWB

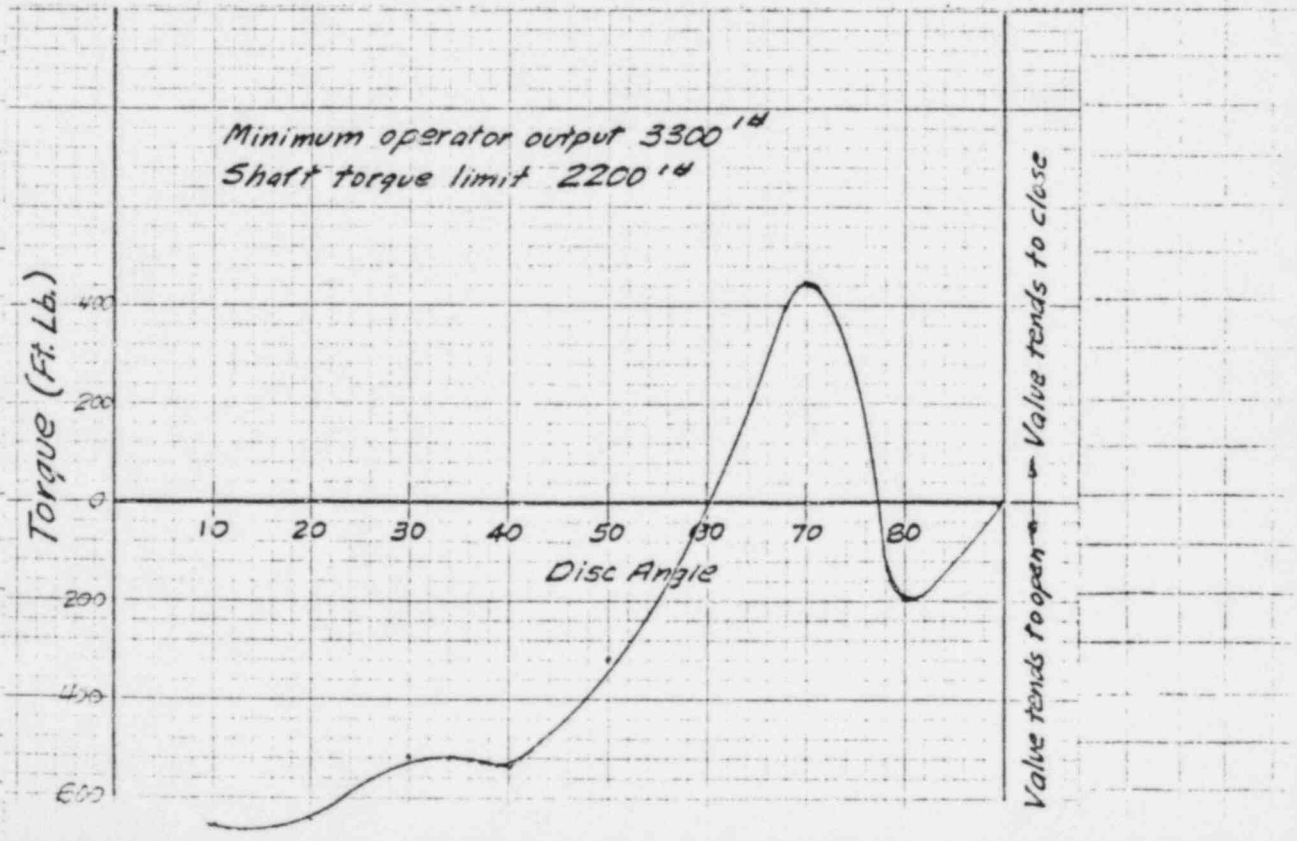
Analysis for Valve 246 AV Location: Drywell

Valve Seat Location Upstream A-C Test # 27 Fig. # 9

Upstream Piping: 231 MV blocked at 60° open preceded by 45° elbow (shaft in plane) preceeded by 90° elbow (shaft 90° out of plane)

Valve closing time: 14 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°		2.7	.6	13	15	2
80		5.2	-4.0	-166	29	-195
70		9	7	504	51	453
60		17	.3	41	96	-55
50		25	-.9	-180	141	-321
40		32	-1.4	-358	181	-539
30		38	-1.0	-304	215	-519
20		40.5	-1.3	-421	229	-650
10		41.7	-1.3	-434	236	-670



CUSTOMER	DATE	SHEET
NPPD Cooper Nuclear Station	10/27/83	70 OF

SUBJECT	PRELIM.	FINAL
Operator Torque Absorption Capability Bettis T-420B-SRI		

DRAWING NUMBER		CALCULATED BY
		Zeiders

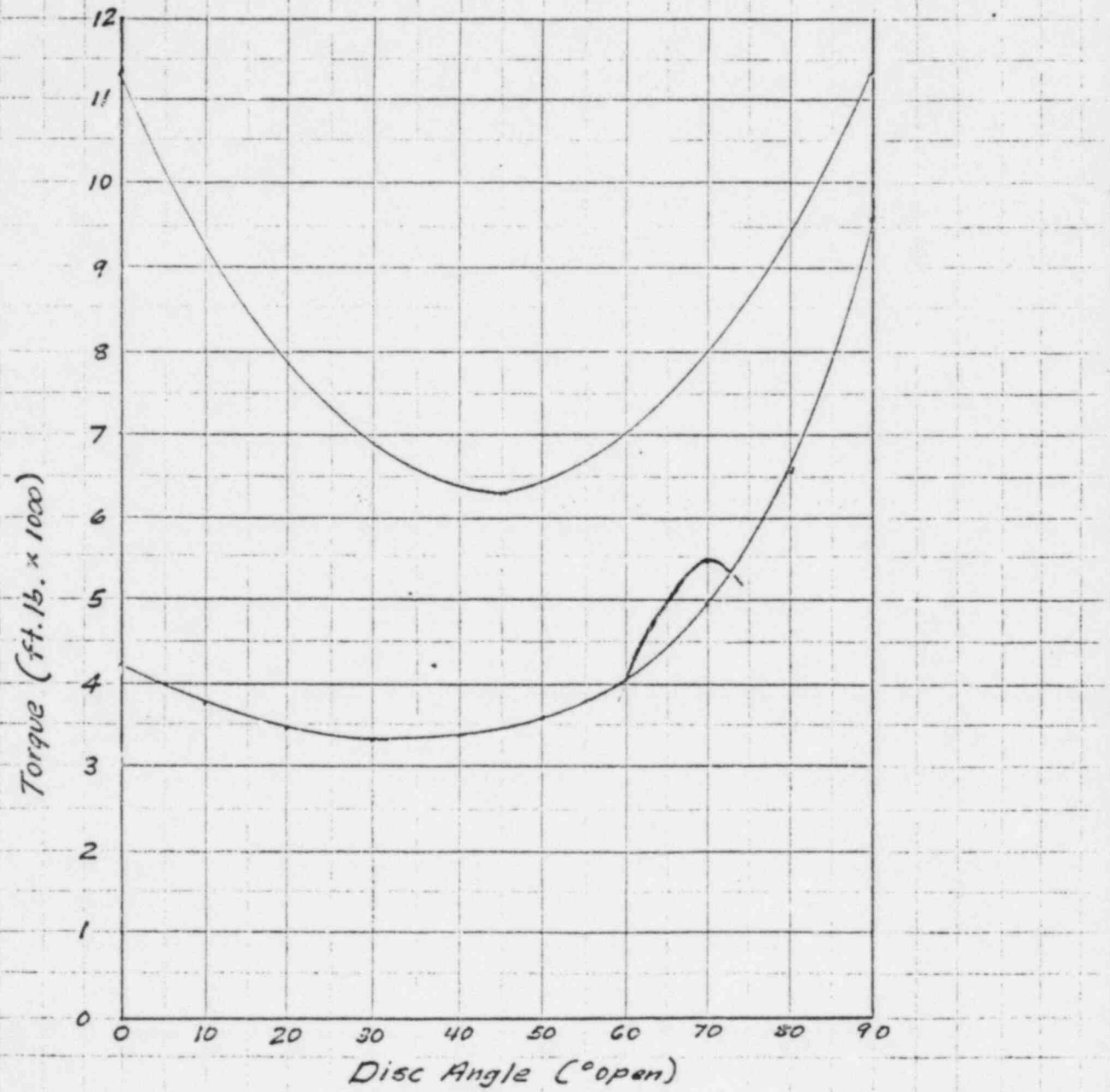
LITHO IN U.S.A.-A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

Valve: 246 AV Ref. A-C Test #29 Fig. 9

Closing time: 14 sec.



CUSTOMER NPPD Cooper Nuclear — DATE 9/83 — SHEET 71 OF

SUBJECT Pressure drop across (2) valves in series

DRAWING NUMBER — LITHO IN U.S.A. — CALCULATED BY Zeigers — PRELIM. — FINAL

ALLIS-CHALMERS — ENGINEERING CALCULATION SHEET — FORM 6713-1

#246

Two valves are in series in a pipeline. The upstream valve is blocked at 60° open and does not move. The downstream valve closes from wide open in 9.0 seconds.

Drywell Pressure - Applies to 231 MV, 246 AV, 232 MV & 238 AV

Valve Closing Time (sec.)	Disc Angle MV	K MV	Disc Angle AV	K AV	K_T ($K_{MV}+K_{AV}$)	C_{dT}	Equivalent Disc Angle	P_1	ΔP	ΔP_{MV}	ΔP_{AV}
0	60°	2.43	90°	.23	2.66	.522	59°	42.5	31.5	28.8	2.7
.5			87°	.26	2.69	.52	58°	47.1	35	31.6	3.4
1.0			83°	.35	2.78	.514	57°	48.8	37	32.3	4.7
1.5			79°	.49	2.92	.505	57°	50	37.5	31.2	6.3
2.0			74°	.73	3.16	.49	56°	51.2	39	30	9
2.5			69°	1.1	3.53	.47	55°	48	37.5	25.8	11.7
3.0			64°	1.7	4.13	.44	54°	45.2	35.5	20.9	14.6
3.5			58°	2.8	5.23	.40	51°	43.2	36.5	17	19.5
4.0			52°	4.8	7.23	.35	47°	41.5	36.5	12.3	24.2
4.5			45°	8.8	11.23	.286	42°	40.6	37.5	8.1	29.4
5.0			38°	16.4	18.83	.224	37°	40	38.5	5	33.5
5.5			32°	28.2	30.63	.178	31°	39.7	39.7	3.1	36.6
6.0			26°	51.5	53.93	.135	25°	39.8	39.8	1.8	38
6.5			21°	86.3	88.73	.105	21°	39.9	39.9	1.1	38.8
7.0			16°	170	172.43	.076	16°	40	40	.6	39.4
7.5			11°	369	371.43	.052	11°	40.2	40.2	.3	39.9
8.0			7°	890	892.43	.033	7°	40.4	40.4	.1	40.3
8.5			3°	—	—	—	—	40.7	40.7	—	—
9.0	▼	▼	0°	—	—	—	—	41	41	—	—

CUSTOMER NPPD Cooper Nuclear

SUBJECT Pressure drop across (2) valves in series

DRAWING NUMBER

DATE 9/83

SHEET 72 OF

PRELIM. FINAL

CALCULATED BY Zeiders

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS

FORM 6713-1

LITHO IN U.S.A.-A-C

Two valves are in series in a pipeline. The upstream valve is blocked at 60° open and does not move. The downstream valve closes from wide open in 14 seconds.

Drywell Pressure – Applies to 231 MV, 246 AV, 232 MV & 238 AV

Valve Closing Time (sec.)	Disc Angle MV	K MV	Disc Angle AV	K AV	K_T ($K_{MV}+K_{AV}$)	C_{AT}	Equivalent Disc Angle	P_1	ΔP	ΔP_{MV}	ΔP_{AV}
0	60°	2.43	90°	.23	2.66	.522	59°	42.5	31.5	28.8	2.7
1			85°	.29	2.72	.518	58°	48.8	36.5	32.6	3.9
2			80°	.38	2.81	.512	57°	51.2	38.5	33.3	5.2
3			74°	.62	3.05	.497	56°	45.2	35	27.9	7.1
4			68°	1.19	3.62	.465	55°	41.5	32.5	21.8	10.7
5			61°	2.43	4.86	.413	52°	40	33.5	16.8	16.7
6			53°	4.54	6.97	.354	48°	39.8	35	12.2	22.8
7			45°	8.76	11.17	.286	43°	40	36.5	7.9	28.6
8			37°	17.9	20.33	.217	36°	40.4	39	4.7	34.3
9			29°	38	40.43	.155	28°	41	41	2.5	38.5
10			22°	79	81.4	.110	22°	41.3	41.3	1.2	40.1
11			16°	168	170.4	.076	16°	41.8	41.8	.6	41.2
12			10°	452	454.4	.047	10°	42	42	.2	41.8
13			5°	1889	1891.4	.023	5°	41.4	41.4	.05	41.35
14	▼	▼	0	–	–	–					

CUSTOMER	DATE	SHEET 73 OF
NPPD Cooper Nuclear Station		

SUBJECT	PRELIM.		FINAL
Dynamic Torque Analysis - Closing Stroke			

DRAWING NUMBER		CALCULATED BY
	LITHO IN U.S.A. - A-C ENGINEERING CALCULATION SHEET ALLIS-CHALMERS FORM 6715-1	R. Zeiders CHKD. BY

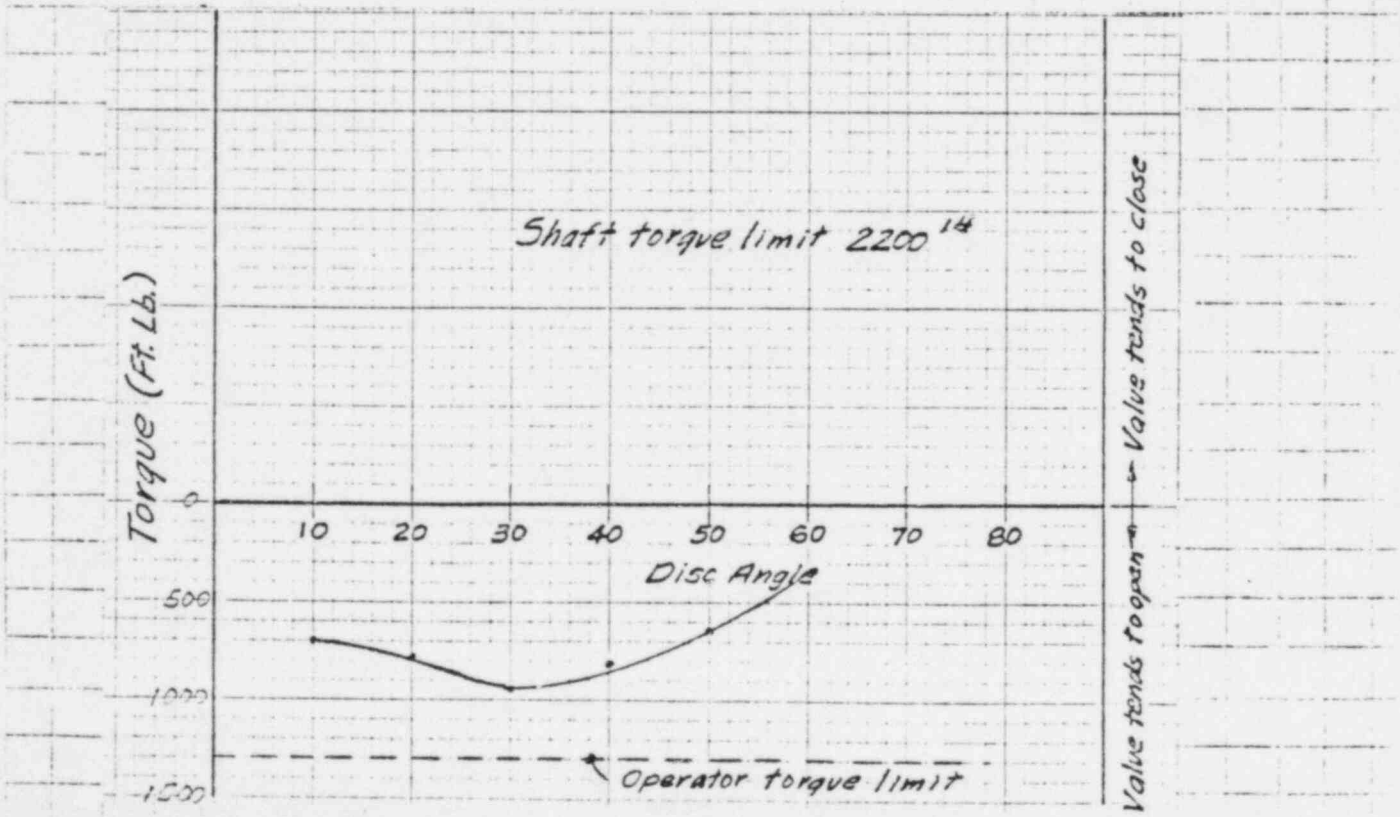
Analysis for Valve 232 MV Location: Drywell

Valve Seat Location Unknown A-C Test # 29 Fig. # 9

Upstream Piping: Straight Pipe - assume seat upstream

Valve closing time: 4 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°						
80						
70		Valve is blocked at 60° open				
60	41.5	30.5	-.7	-171	172	-343
50	48	40.5	-1.3	-421	229	-650
40	50	46	-1.5	-552	260	-812
30	51.3	51.3	-1.6	-657	290	-947
20	47	47	-1.4	-526	266	-792
10	43.7	43.7	-1.3	-454	247	-701



CUSTOMER: NPPD Cooper Nuclear Station | DATE | SHEET 74 OF

SUBJECT: Dynamic Torque Analysis - Closing Stroke | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.-A-C | CALCULATED BY: R. Zeiders | CHKD. BY: CLH

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

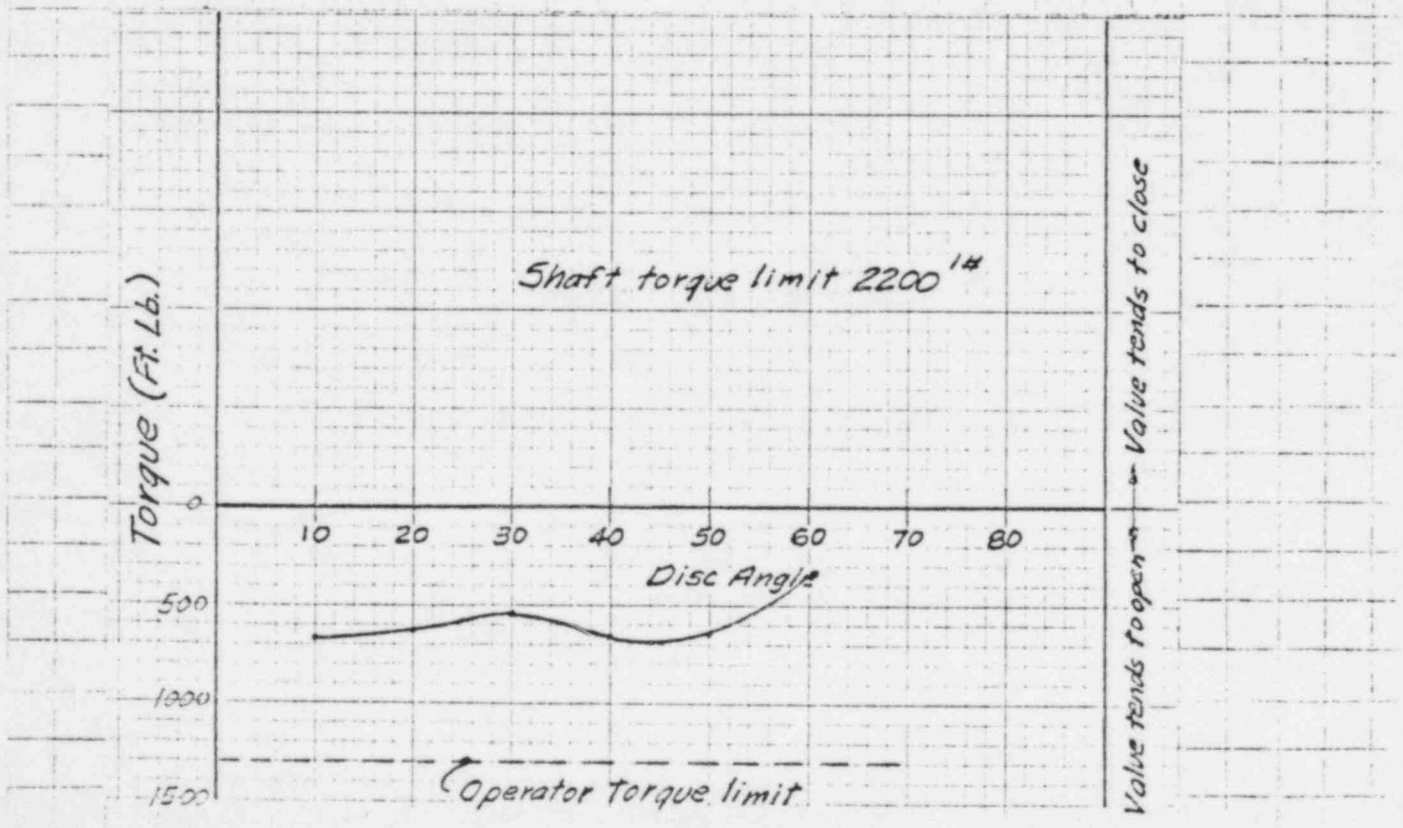
Analysis for Valve 232 MV Location: Drywell

Valve Seat Location UnKnown A-C Test # 29 Fig. # 9

Upstream Piping: Straight Pipe - assume seat upstream

Valve closing time: 14 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°						
80						
70		Valve is blocked at 60° open				
60	42	31	-.7	-174	175	-349
50	49.5	41.5	-1.25	-415	234	-649
40	40.5	38	-1.5	-456	215	-671
30	40	40	-1.8	-320	226	-546
20	41	41	-1.2	-394	232	-626
10	42	42	-1.3	-437	237	-674



CUSTOMER: NPPD Cooper Nuclear Station | DATE | SHEET 75 OF

SUBJECT: Dynamic Torque Analysis - Closing Stroke | PRELIM. | FINAL

DRAWING NUMBER

ENGINEERING CALCULATION SHEET

LITHO IN U.S.A.-A-C

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY: R. Zeiders

CHKD. BY: Calth

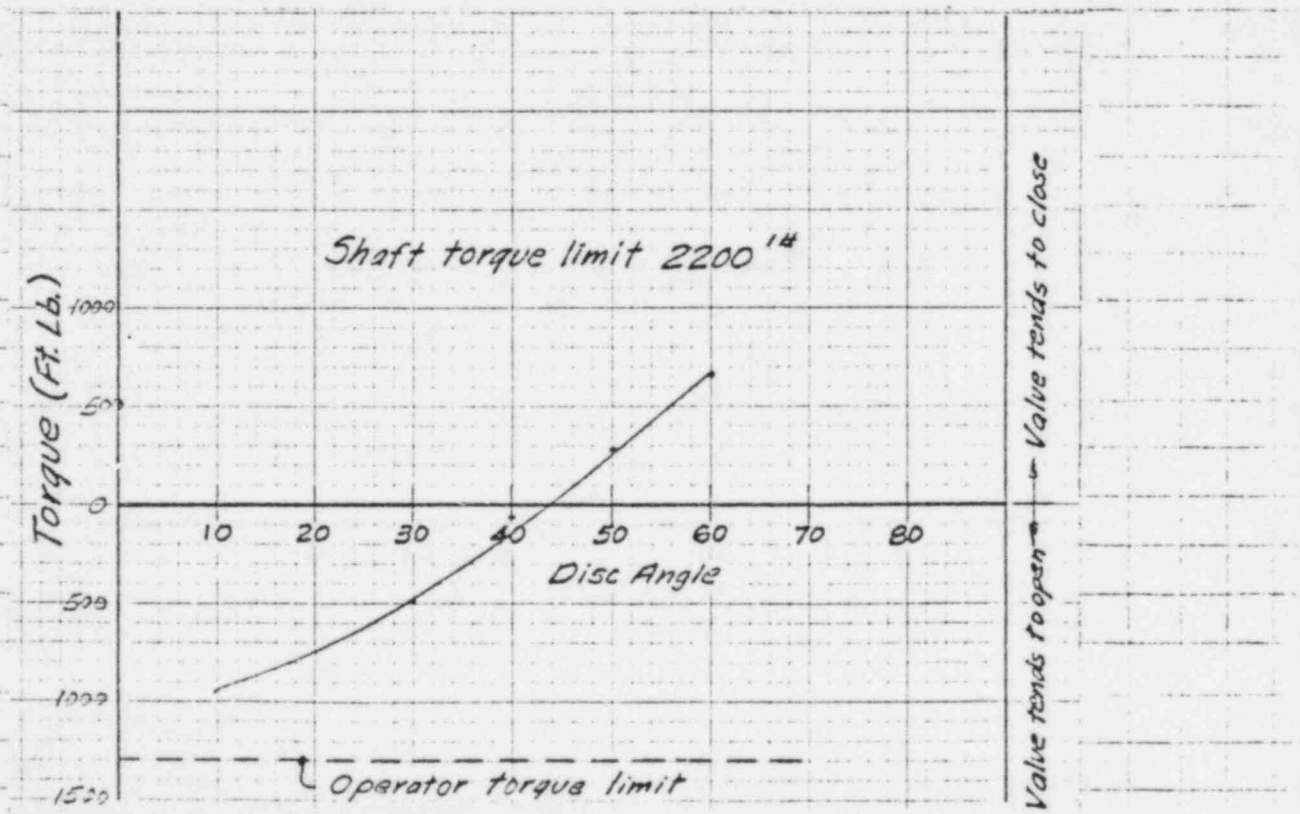
Analysis for Valve 232 MV Location: Drywell

Valve Seat Location UnKnown A-C Test # 30 Fig. # 11

Upstream Piping: Straight Pipe - assume seat downstream

Valve closing time: 4 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°						
80						
70	Valve blocked at 60° open					
60	41.5	30.5	3.4	830	172	658
50	48	40.5	1.6	518	229	289
40	50	46	.5	184	260	-76
30	51.3	51.3	-.5	-205	290	-495
20	47	47	-1.3	-489	266	-755
10	43.7	43.7	-2.0	-699	247	-946



CUSTOMER: NPPD Cooper Nuclear Station | DATE | SHEET 76 OF

SUBJECT: Dynamic Torque Analysis - Closing Stroke | PRELIM. | FINAL

DRAWING NUMBER

LITHO IN U.S.A.-A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY: R. Zeiders

CHKD. BY: Cath

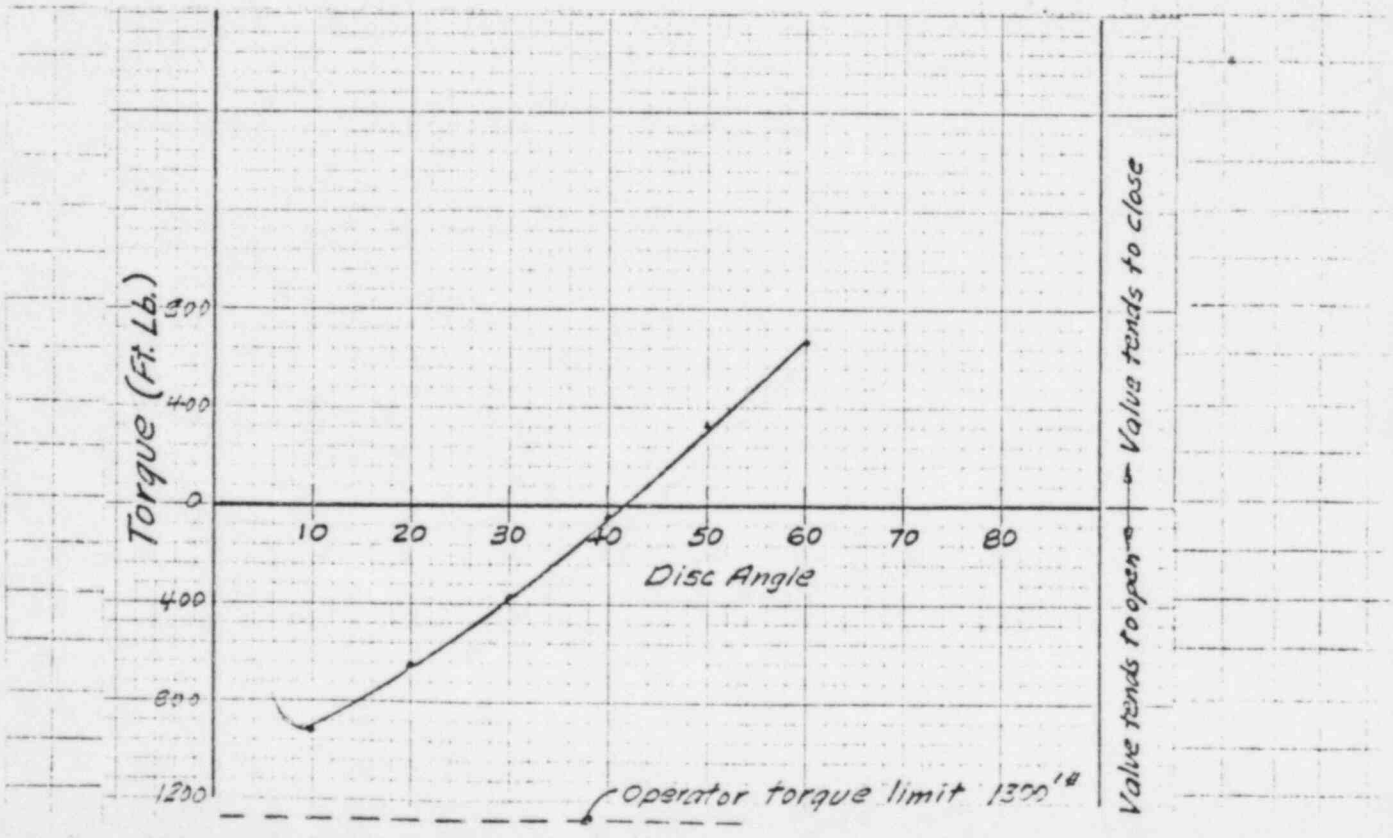
Analysis for Valve 232 MV — Location: Drywell

Valve Seat Location Unknown — A-C Test # 30 — Fig. # 11

Upstream Piping: Straight Pipe - assume seat downstream

Valve Closing Time: 14 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°						
80						
70		Valve is blocked at 60° open				
60	42	31	3.4	843	175	668
50	49.5	41.5	1.7	564	234	330
40	40.5	38	.5	152	215	-63
30	40	40	-.5	-160	226	-386
20	41	41	-1.3	-426	232	-658
10	42	42	-2.0	-672	237	-909



CUSTOMER: NPPD Cooper Nuclear Station | DATE: 10/24/83 | SHEET 77 OF

SUBJECT: Dynamic Torque Analysis - Closing Stroke | PRELIM. | FINAL

DRAWING NUMBER

LITHO IN U.S.A.-A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY: R. Zeiders

CHKD. BY: [illegible]

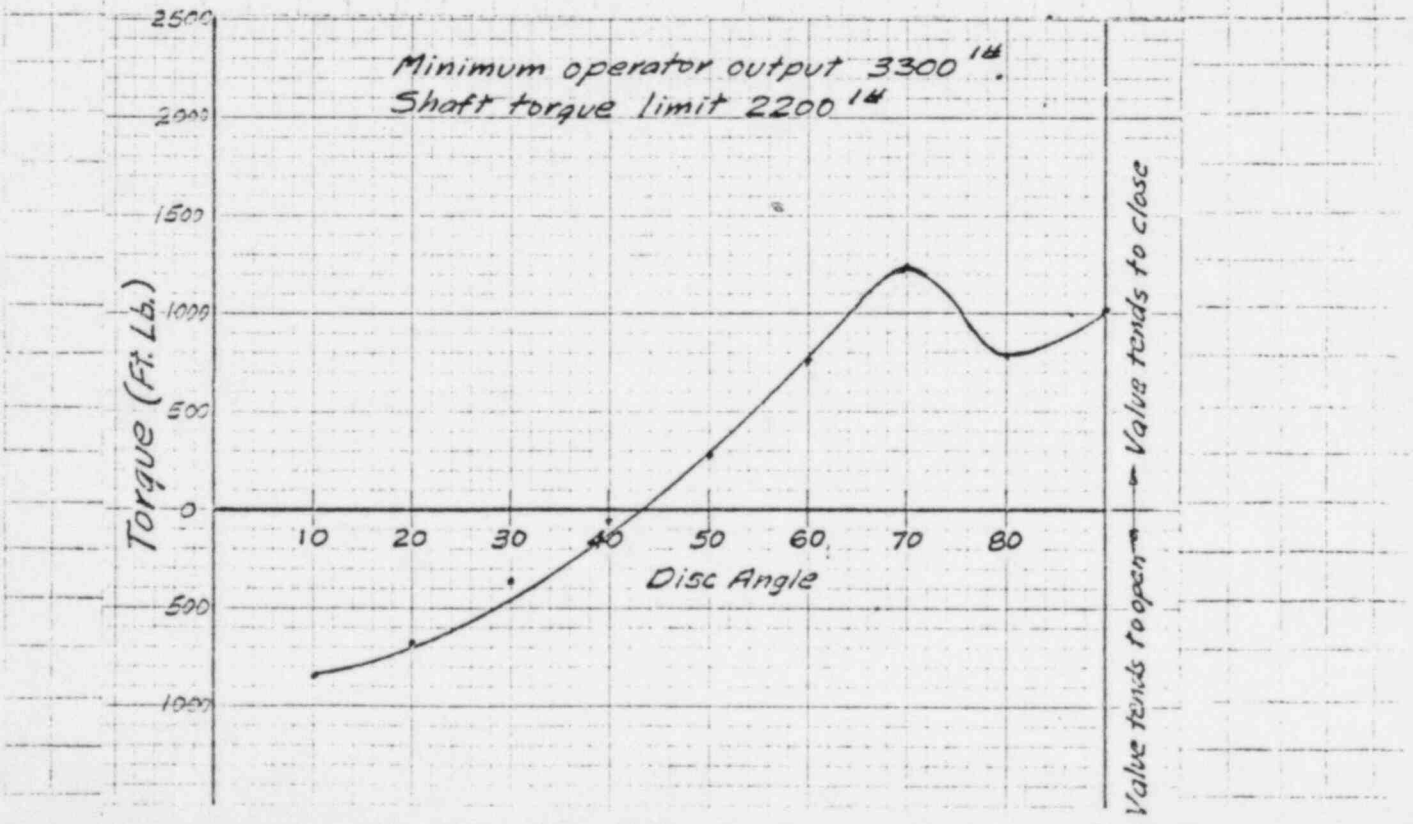
Analysis for Valve 238 AV Location: Drywell

Valve Seat Location Downstream A-C Test # 30 Fig. # 11

Upstream Piping: 35° elbow (shaft in plane) preceded by 232 MV (blocked at 60° open) preceded by straight pipe

Valve closing time: 6 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°		2.7	47.5	1026	15	1011
80		5.3	19.5	827	30	797
70		12.8	12.3	1311	72	1239
60		22.4	4.9	875	127	751
50		29	1.9	441	164	277
40		34.9	.5	140	197	-57
30		38.6	-.5	-154	218	-372
20		39.4	-1.5	-473	223	-696
10		39.5	-2.0	-622	223	-855



CUSTOMER: NPPD Cooper Nuclear Station | DATE: 10/24/83 | SHEET 78 OF

SUBJECT: Dynamic Torque Analysis - Closing Stroke | PRELIM. | FINAL

DRAWING NUMBER

LITHO IN U.S.A. - A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715.1

CALCULATED BY: R. Zeiders

CHKD. BY: CDA

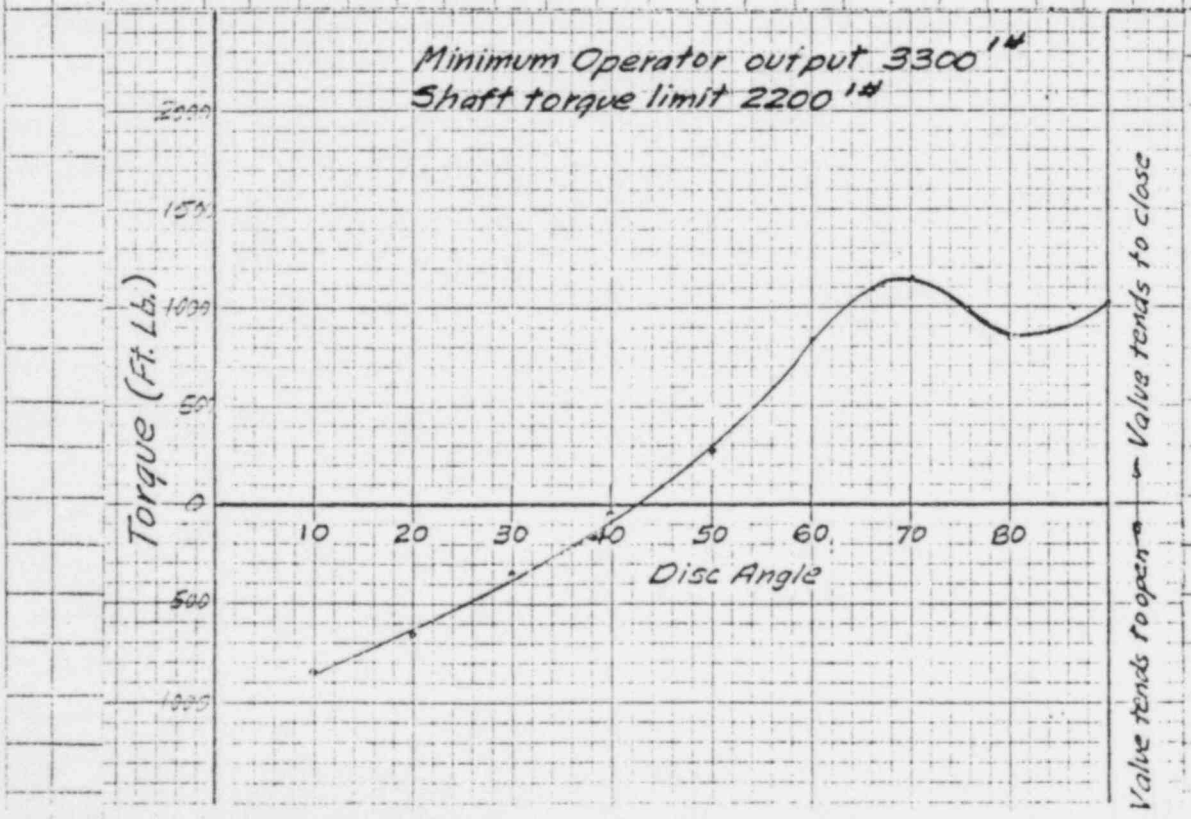
Analysis for Valve 238 AV — Location: Drywell

Valve Seat Location Downstream — A-C Test # 30 Fig. # 11

Upstream Piping: 35° elbow (shaft in plane) preceded by 232 MV (blocked at 60° open) preceded by straight pipe

Valve closing time: 9 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°		2.7	47.5	1026	15	1011
80		5.9	18.6	878	33	845
70		11.2	13.4	1201	63	1138
60		17.9	6.4	916	101	815
50		25.7	2.0	411	145	266
40		32.3	.5	129	182	-53
30		37.1	-.5	-148	210	-358
20		38.9	-1.5	-467	220	-687
10		40	-2.0	-640	226	-866



CUSTOMER: NPPD Cooper Nuclear Station | DATE: 10/24/83 | SHEET 79 OF

SUBJECT: Dynamic Torque Analysis - Closing Stroke | PRELIM. | FINAL

DRAWING NUMBER

LITHO IN U.S.A. - A-C

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY: R. Zeiders

CHKD. BY: Calvin

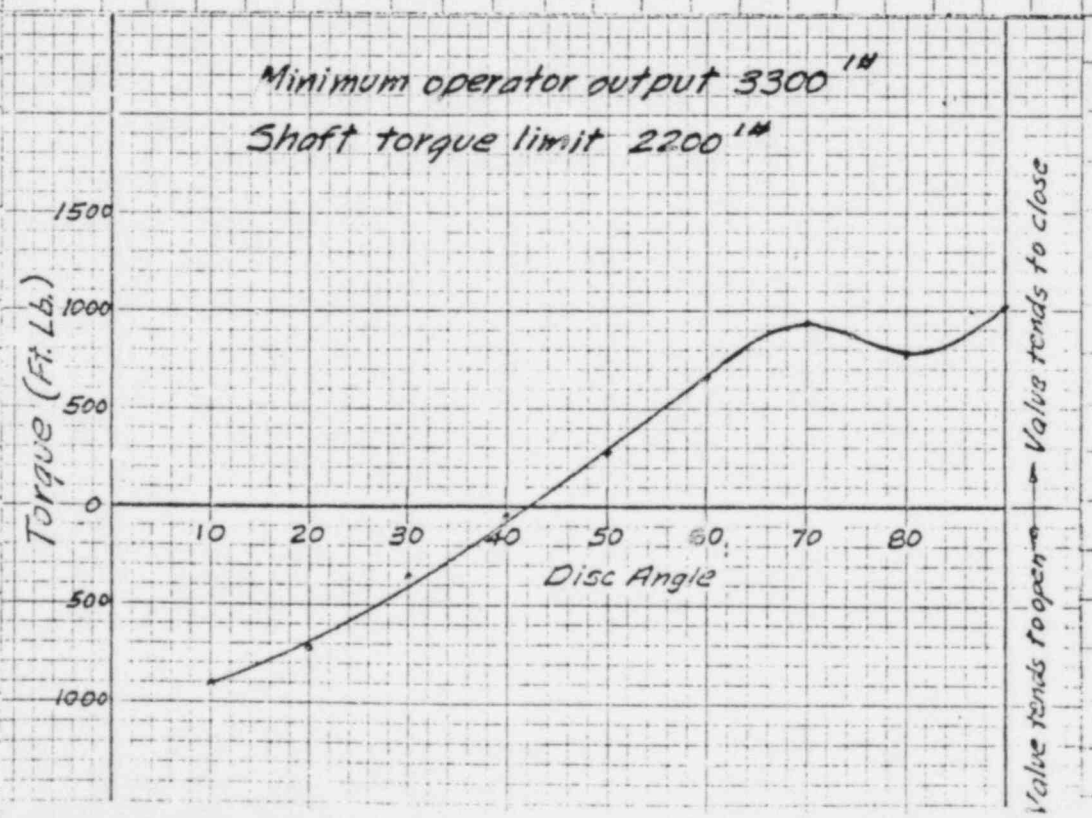
Analysis for Valve 238 AV — Location: Drywell

Valve Seat Location Downstream — A-C Test # 30 Fig. # 11

Upstream Piping: 35° elbow (shaft in plane) preceded by 232 MV (blocked at 60° open) preceded by straight pipe

Valve closing time: 14 sec.

Disc Angle	P_1	ΔP	C_T	T_d	T_b	T_o
90°		2.7	47.5	1026	15	1011
80		5.2	19.5	811	29	782
70		9	13.6	979	51	928
60		17	5.6	762	96	666
50		25	2.1	420	141	279
40		32	.5	128	181	-53
30		38	-.5	-152	215	-367
20		40.5	-1.5	-486	229	-715
10		41.7	-2.0	-667	236	-903



CUSTOMER	DATE	SHEET
NPPD Cooper Nuclear Station	10/27/83	20 OF

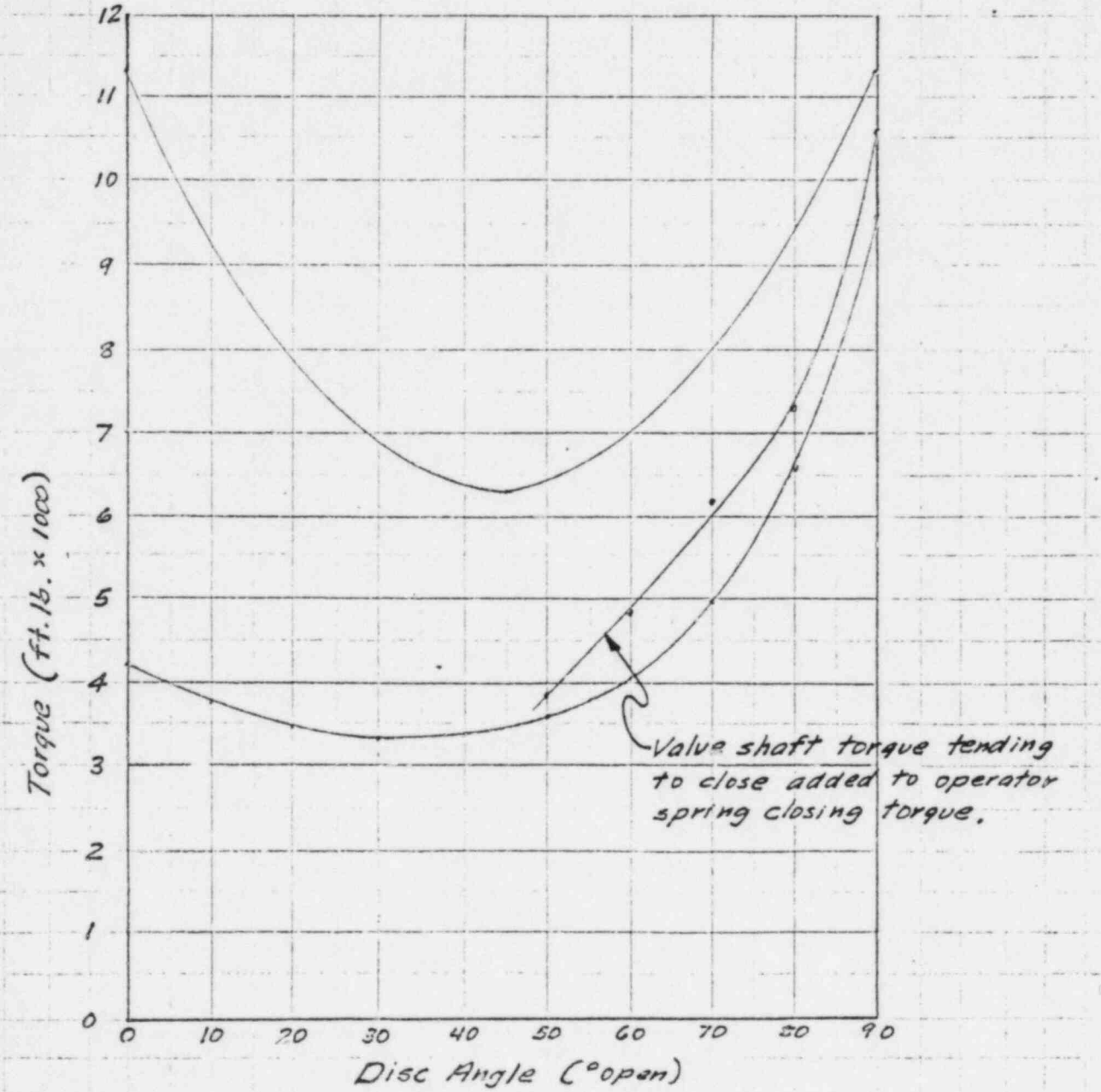
SUBJECT	PRELIM.		FINAL
Operator Torque Absorption Capability Bettis T-4208-SR1			

DRAWING NUMBER		CALCULATED BY
	ENGINEERING CALCULATION SHEET	Zeiders
	ALLIS-CHALMERS FORM 6715-1	

LITHO IN U.S.A.-A-C

Valve: 238 AV Ref. A-C Test #30 Fig. 11

Closing time: 6 sec.



Where valve disc tends to close, shaft torque is added to operator spring closing torque. During this condition, torque absorption capability of operator is not exceeded.

CUSTOMER	DATE	SHEET
NPPD Cooper Nuclear Station	10/27/83	81 OF

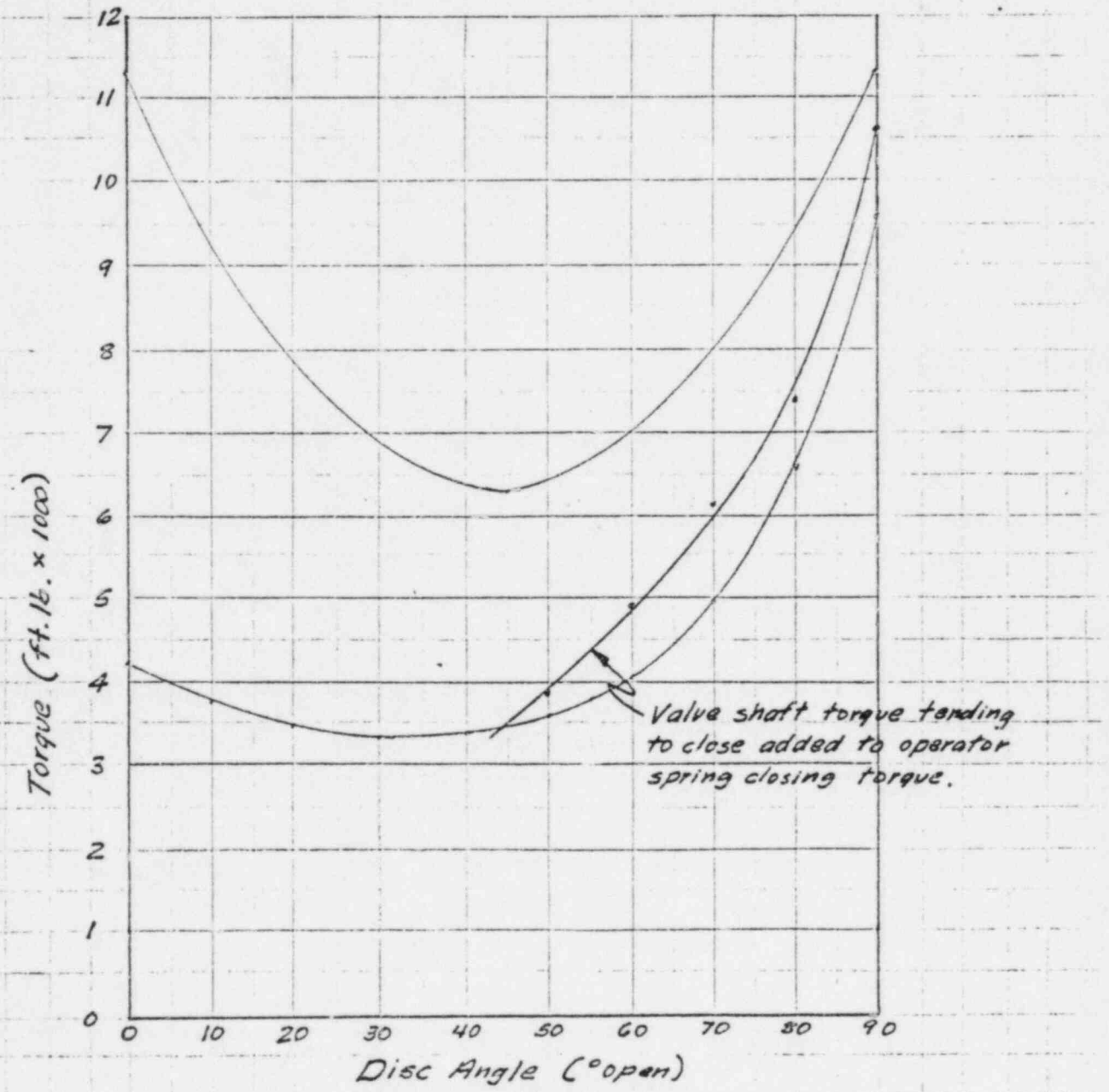
SUBJECT	PRELIM.		FINAL
Operator Torque Absorption Capability Bettis T-420B-SR1			

DRAWING NUMBER		CALCULATED BY
	ENGINEERING CALCULATION SHEET	Zeiders
	ALLIS-CHALMERS FORM 6715-1	

LITHO IN U.S.A.-A-C

Valve : 238 AV Ref. A-C Test #30 Fig. 11

Closing time : 9 sec.



Where valve disc tends to close, shaft torque is added to operator spring closing torque. During this condition, torque absorption capability of operator is not exceeded.

CUSTOMER	DATE	SHEET
NPPD Cooper Nuclear Station	10/27/83	82 OF

SUBJECT	PRELIM.		FINAL
Operator Torque Absorption Capability Bettis T-420B-SR1			

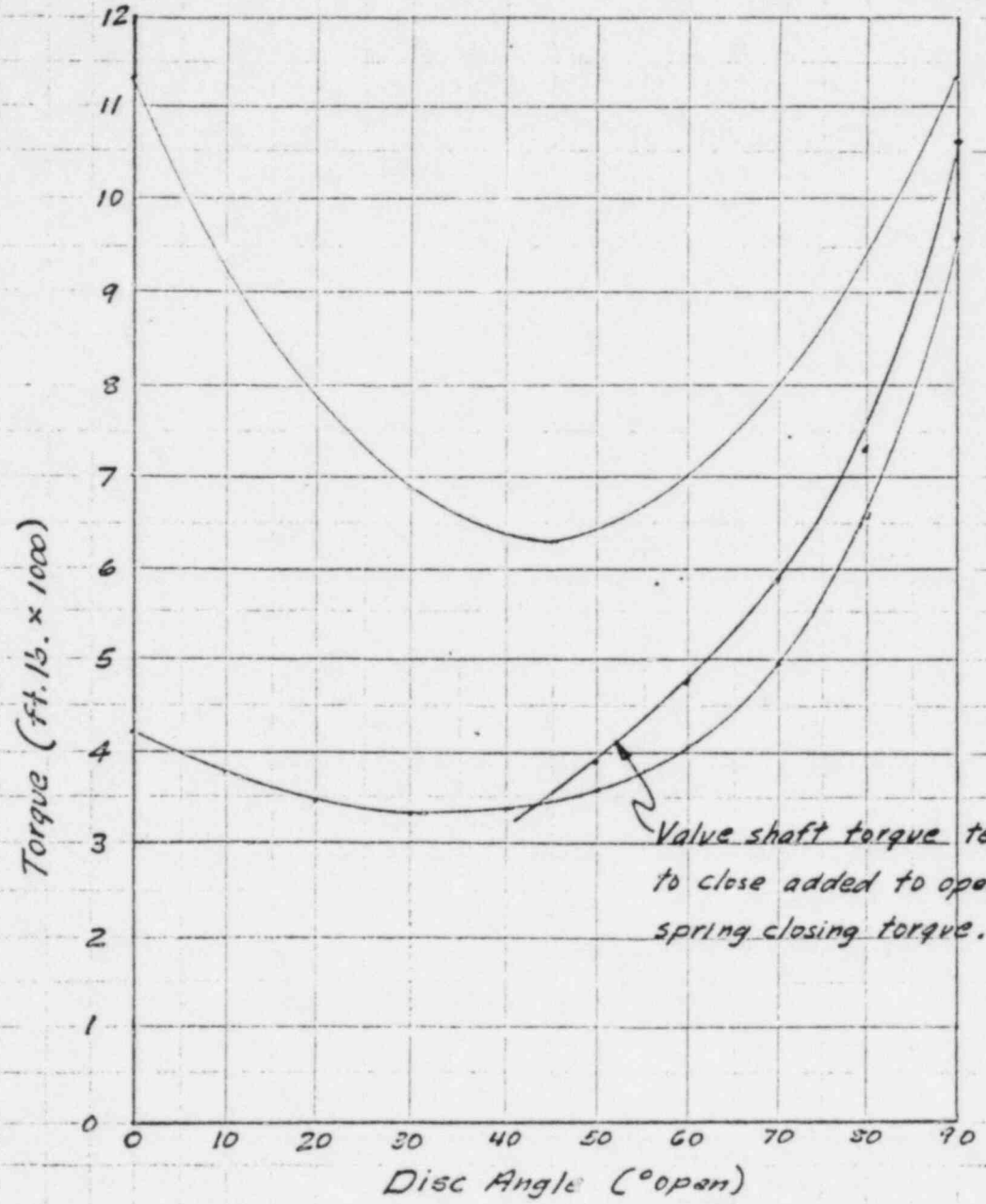
DRAWING NUMBER		CALCULATED BY
	ENGINEERING CALCULATION SHEET	Zeiders

LITHO IN U.S.A.-A-C

ALLIS-CHALMERS FORM 6715-1

Valve : 238 AV Ref. A-C Test #30 Fig. 11

Closing time : 14 sec.



Where valve disc tends to close, shaft torque is added to operator spring closing torque. During this condition, torque absorption capability of operator is not exceeded.

CUSTOMER: NPPD Cooper Nuclear

DATE: 9/83

SHEET 83 OF

SUBJECT: Pressure drop across (2) valves in series

PRELIM. FINAL

DRAWING NUMBER

LITHO IN U.S.A.—A-C

CALCULATED BY: Zeiders

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715.1

Two valves are in series in a pipeline. The upstream valve is blocked at 60° open and does not move. The downstream valve closes from wide open in 6.0 seconds.

Valve Closing Time (sec.)	Disc Angle MV	K MV	Disc Angle AV	K AV	K_T ($K_{MV}+K_{AV}$)	C_{dT}	Equivalent Disc Angle	P_1	ΔP	ΔP_{MV}	ΔP_{AV}
0	60°	2.43	90	.23	2.66	.523	59°	41.5	31	28.3	2.7
.5	↓	↓	84	.32	2.75	.516	58°	47.4	35	30.9	4.1
1.0			78	.49	2.92	.505	57°	49	38	31.6	6.4
1.5			71	.93	3.36	.479	56°	50.3	38.5	27.8	10.7
2.0			63	1.78	4.21	.438	53°	51.2	41	23.7	17.3
2.5			54	4.05	6.48	.366	49°	48.2	41	15.4	25.6
3.0			45	8.76	11.19	.286	43°	45.2	41	8.9	32.1
3.5			37	17.9	20.33	.216	35°	43	41.5	5.0	36.5
4.0			28	40.6	43.03	.151	28°	41.6	41.6	2.3	39.3
4.5			18	128	130.4	.087	18°	40.6	40.6	.8	39.8
5.0			11	369	371.4	.052	11°	39.9	39.9	.3	39.6
5.5			6	1371	1373.4	.027	6°	39.7	39.7	.1	39.6
6.0	↓	↓	0	—	—	—	—	—	—	—	—

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