TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

500C Chestnut Street Tower II

June 12, 1979

Director of Nuclear Reactor Regulation
Attention: Mr. Thomas A. Ippolito, Chief
Branch No. 3
Division of Operating Reactors
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Ippolito:

In the Matter of the	)	Docket Nos. 50-259
Tennessee Valley Authority	)	50-260
		50-296

In response to your letter to me dated May 31, 1979, a meeting between TVA and NRC was held on June 1, 1979, to discuss the primary containment purge system design and operation at the Browns Ferry Nuclear Plant. At that meeting TVA was requested to provide additional information not available for distribution in the meeting. In response we have provided your staff with electrical schematics, logic diagrams, and mechanical control diagrams for the Browns Ferry primary containment purge system. Also included was additional material in support of the purge valve operability analysis performed by TVA. Enclosure 1 to this letter provides general information regarding purge operations at Browns Ferry. Enclosure 2 provides the analysis of purge valve operability. If we can be of any further assistance to you, please get in touch with us.

Very truly yours,

fo, J. M. Mills
J. E. Gilleland
Assistant Manager of Power

Enclosures

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ENCLOSURE 1

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PURGE OPERATIONS AT BROWNS FERRY

Purge operations are conducted at Browns Ferry for two reasons:

1. Air Purge - to provide a breathable atmosphere for personnel working in the primary containment.

2. Nitrogen Purge - to inert the containment for routine plant operation.

The present operating license restricts the use of the main purge valves during power generation to within 24 hours after placing the reactor in "run" mode, and 24 hours before unit shutdown. These technical specifications allow purging to be conducted without adversely affecting unit output, yet ensure that the overall time spent purging at power is low.

General Description of Purge Activities

Typical purge operations for a yearly fuel cycle are summarized below. Actual operating times are presented in Table 1, and a more detailed description of typical purge operations is shown on Figures 2-4. A schematic of the primary containment purge systems is shown on Figure 1 and additional valve information is included on Tables 3 and 4. While the reactor is refueling (cold), the purge system is used intermittently to provide fresh air for maintenance workers in the drywell. Following the refueling, air purge is used for two to six days to allow drywell access for numerous required inspections of the reactor and primary system piping during the initial ascension to rated pressure. Nitrogen purge is then started to complete inerting within 24 hours after entering "run" mode. Once inerted, no purge system operation is required and all purge systems are isolated and secured. If a drywell or torus entry becomes necessary for maintenance, nitrogen must be displaced before personnel entry. Air purge is initiated about eight hours before the reactor shutdown so that workers will have a suitable atmosphere at the time the unit is taken off-line. Normally the reactor remains pressurized during this period to facilitate inspections at pressure and to speed restart. The reactor is not taken cold unless required for specific maintenance items. We estimate that three to five primary containment entries will be necessary during a typical yearly cycle, one of which will require a cold shutdown. However, as indicated by the spread of data in Table 1, the necessity for drywell/torus entries tends to be circumstantial, and wide variations in the purge time can be noted. Following maintenance activities, the primary containment is reinerted as the reactor is restarted.

Basis for Inerting

Containment inerting was originally required by NRC for the control of combustible gases during post LOCA events which could release excessive amounts of hydrogen due to zirconium-water reactions. Although the NRC has since permitted utilities alternate methods of controlling hydrogen in containment we believe it is not feasible for TVA to discontinue the nitrogen inerting program at Browns Ferry for the following reasons: The fire protection afforded the drywell equipment by the nitrogen atmosphere is considerable both for normal and abnormal operations. Also, the electrical connectors in the drywell have been environmentally qualified for the inerted atmosphere. Addressing these two concerns assuming continuous air atmosphere would be most difficult.

Basis for Air Purging

Based on actual experience, TVA has concluded that it is too dangerous for personnel to work in an inerted atmosphere.

Purge History for Browns Ferry

Table 1 summarizes actual purge system operating experience for Browns Ferry 1, 2, and 3 for the past two years.

TABLE 1

CONTAINMENT PURGE-HOURS
OF OPERATION 1977-78

	Total (1)	Cold (2) Shutdown	Hot (3) (Mod.Temp>212°F)	Run Mode
		1977		
Unit 1	2118	2075	43	25
Unit 2	1412	1264	148	42
Unit 3	640	197	443	34
		1978		
Unit 1	768	404	364	112
Unit 2	1765	1711	54	23
Unit 3	2100	1853	247	57

NOTES

(1) Total = Cold + Hot time
(2) Mostly refueling outage time
(3) Includes time in Run mode

2307 275

Operational Disadvantages of Restricted Purging

Besides the lost power generation which would be significant, there are other important considerations concerning purging in cold shutdown only.

Certain inspections, system performance evaluations, and tests can be meaningfully conducted only when the reactor is pressurized and operating. This is particularly true regarding the system integrity inspections following refuel outages. Unidentified leakage paths can generally be located only when the primary system is at rated pressure and temperature.

The most frequent maintenance activities in the primary containment can be accomplished with the reactor pressurized. Several examples are:

1. Replacement of drywell blower motors
2. Repair of sump pumps
3. Replace/repair H_2 and O_2 sensors
4. Open or close manual valves
5. Replace limit switches on valves
6. Repair of limit-torque valve operators and motors
7. Replacement of air operator on MSRV's
8. Tighten valve packings
9. Repair IRM, SRM drive motors or TIP indexers.
10. Replace mirror-insulation
11. Fix leaks on drywell control air

Operationally, it is never desirable to bring the reactor cold unless absolutely necessary. If the reactor can be held hot, most plant systems remain aligned in a manner very similar to that used during power operation. Cold shutdown requires that all auxiliary systems be placed into service and the normal systems secured. Our experience indicates that reactor startups from hot conditions are much simpler. The probability of equipment failures and personnel operating errors increases with the complexity of the unit recovery operation. Several specific problems associated with going to cold shutdown are:

1. Increased thermal fatigue cycles on the reactor vessel and appurtenances.
2. Increased operating duty on auxiliary systems such as the Residual Heat Removal system and Service Water system.
3. Increased water processing requirements (182,000 gallons) which increase plant releases to the river.
4. Increased fuel oil consumption to fire auxiliary boiler to provide steam to maintain steam seals and air ejector operation.
5. Increased probability of radiation leakage to the environment since primary coolant must be interfaced with secondary shutdown cooling systems.

Economic Losses Due to Restricted Purge Operations

As shown below, the direct economic penalty due to restricted purge operation is severe. To approximate the losses, we will consider a typical cycle based on the actual operating data. Our model yearly cycle will consist of one refueling outage and four containment entries, one of which is assumed to require a cold shutdown.

Using Figures 2-4, the expected purge operation time is outlined in Table 2 below.

Table 2: Purge Time During Typical Cycle

Post Refuel Hot	44 hours
Remaining Cycle Hot	164 hours
Total Hot	208 hours
Run Mode	88 hours
Total Hot Including Run Mode	296 hours

Case A: Economic Impact of Purging Under Present License
The purge operations considered in Table 2 can be conducted with no loss of power generation.

Case B: Economic Impact of Purging With 90 Hour Restriction in Run Mode
Since the time spent purging in "run" mode is about 90 hours, there would be no impact on power generation unless additional containment entries became necessary.

Case C: Economic Impact of Purging With 90 Hour Restriction in Hot Condition - Post-refueling Period Waived
If the purge time immediately following the refueling is not considered, the 90 hour Hot allowance would be used up after the second containment entry. The remaining two containment entries would then have to be conducted in cold shutdown. This constitutes a loss of 104 hours (114400 MWe-hours) of power generation.

Case D: Economic Impact of Purging With 90 Hour Restriction in Hot Condition

Since the 90 hour allowance would be used up before the first containment entry, all four entries would have to be done with purging at cold shutdown. This results in 174 hours (191,400 MWe-hours) of lost power generation.

Case E: Economic Impact of Purging in Cold Shutdown Only
Economically this case is similar to case D above. However, TVA does not consider it feasible to restrict purge operation to cold shutdown only, since required inspections at rated temperature and pressure cannot be made. Case C and D above have the same problem once the 90 hour allowance is expended.

As can be seen from cases C-E, the economic losses as a result of going to cold shutdown are severe.

<u>CAD Override Controls</u>

In order to resolve NRC concerns with the testing of the CAD override switches, we are submitting a proposed technical specification change that provides for surveillance testing of these switches only during cold reactor conditions.

TABLE 3

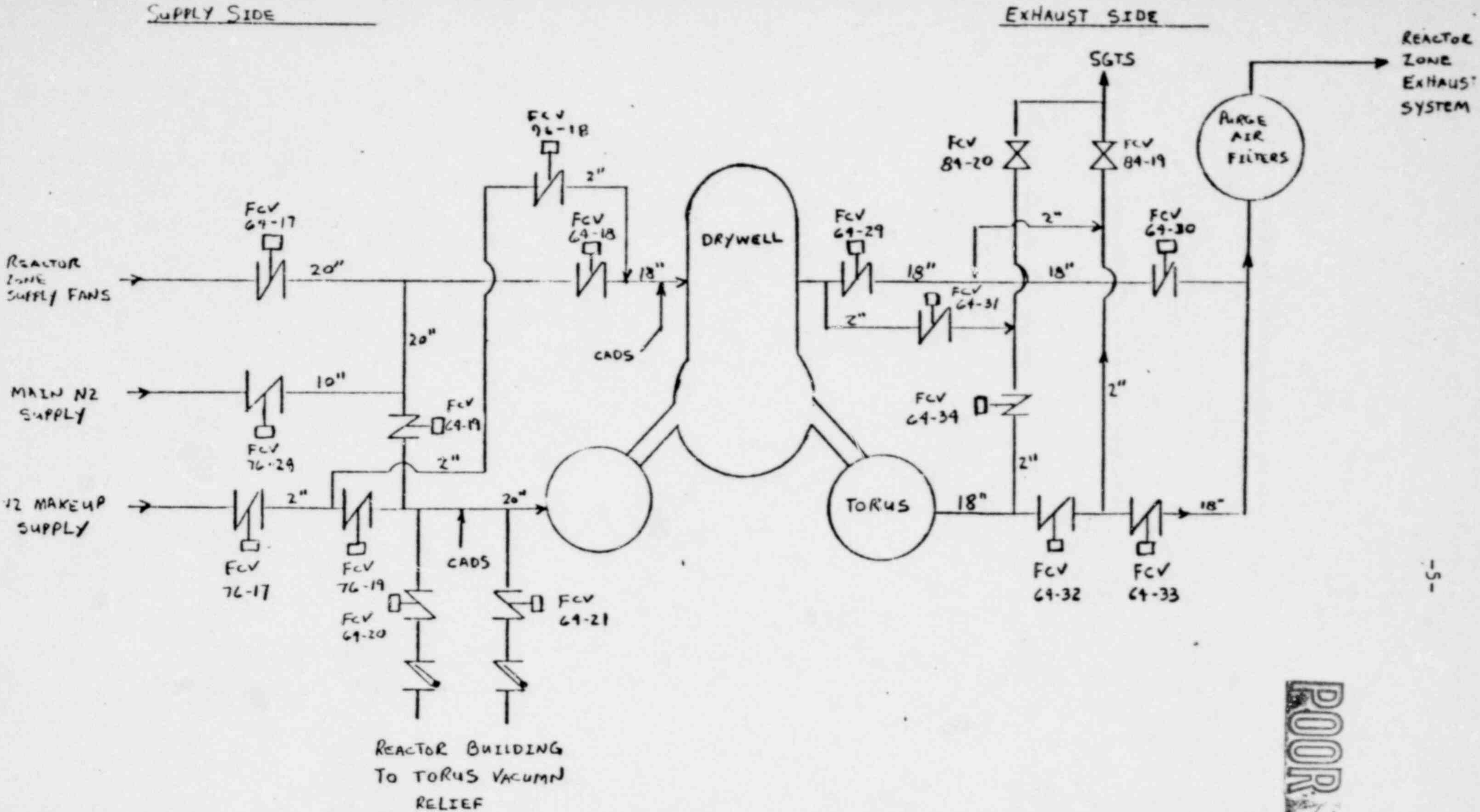
DATA FOR CONTAINMENT PURGE & VENT VALVE ASSEMBLIES

FACILITY: BROWNS FERRY
NUCLEAR VENDOR: GENERAL ELECTRIC
A&E: TVA

DATA FOR VALVES

NO.	DESIGNATION ON P.I. DRAWING	VALVE SIZE	VALVE TYPE	VALVE MANUFACTURER	TIMED,* SECONDS, VALVE CLOSE TIME			PART OR MODEL NUMBER	INSIDE OR OUTSIDE CONTAINMENT
1	64-17	20"	Butterfly	Rockwell	17	14	13	20-DW-2284W	Outside
2	64-18	18"	Butterfly	Rockwell	23	14	14	18-DW-2284W	Outside
3	64-19	20"	Butterfly	Rockwell	17	16	21	20-DW-2284W	Outside
4	64-29	18"	Butterfly	Rockwell	13	15	9	18-DW-2284W	Outside
5	64-30	18"	Butterfly	Rockwell	12	15	9	18-DW-2284W	Outside
6	64-31	2"	Butterfly	Rockwell	3	2	2	2-DW-2284W	Outside
7	64-32	18"	Butterfly	Rockwell	18	69	26	18-DW-2284W	Outside
8	64-33	18"	Butterfly	Rockwell	16	25	22	18-DW-2284W	Outside
9	64-34	2"	Butterfly	Rockwell	3	4	2	2-DW-2284W	Outside
10	76-17	2"	Butterfly	Masoneilan	3	2	1.5	34200	Outside
11	76-18	2"	Butterfly	Masoneilan	2	2	2	34200	Outside
12	76-19	2"	Butterfly	Masoneilan	2	3	2	34200	Outside
13	76-24	10"	Butterfly	Fisher	29	15	17	9110	Outside
				*Values were obtained from Surveillance Instructions performed.	U-1	U-2	U-3		

2307 278



BROWNS FERRY CONTAINMENT PURGE AND VENT SYSTEM

FIG. 1

FIGURE 2

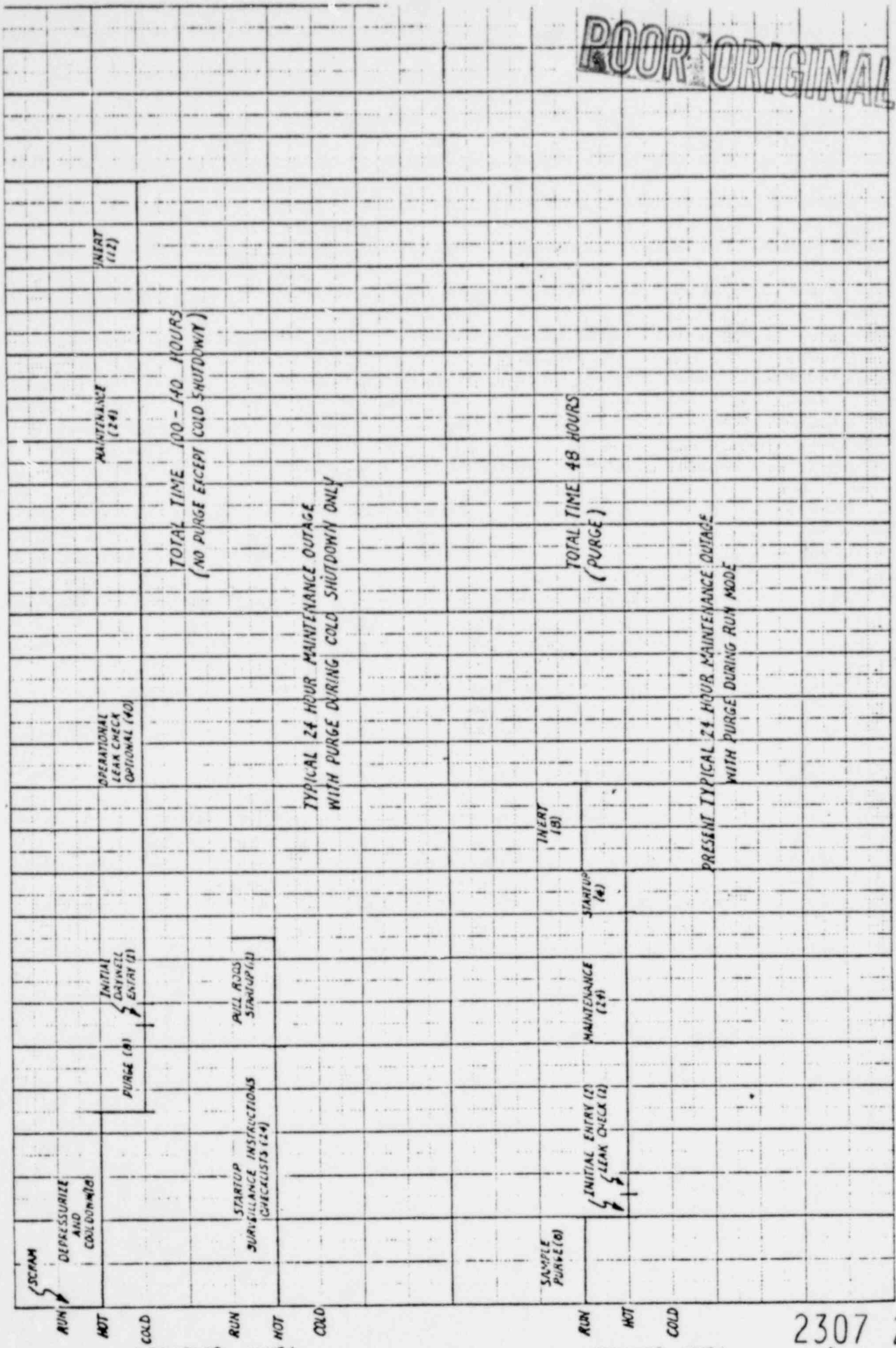

SCRAM
DEPRESSURIZE AND COOLDOWN (8)
PURGE (8)
INITIAL DRYWELL ENTRY (2)
OPERATIONAL LEAK CHECK OPTIONAL (40)
MAINTENANCE (24)
INERT (12)
STARTUP SURVEILLANCE INSTRUCTIONS (CHECKLISTS) (24)
PULL RODS STARTUP (2)
TOTAL TIME 100-140 HOURS
(NO PURGE EXCEPT COLD SHUTDOWN)
TYPICAL 24 HOUR MAINTENANCE OUTAGE
WITH PURGE DURING COLD SHUTDOWN ONLY
SAMPLE PURGE (8)
INITIAL ENTRY (2)
LEAK CHECK (2)
MAINTENANCE (24)
STARTUP (4)
INERT (8)
TOTAL TIME 48 HOURS
(PURGE)
PRESENT TYPICAL 24 HOUR MAINTENANCE OUTAGE
WITH PURGE DURING RUN MODE
RUN
HOT
COLD
PLANT CONDITION

FIGURE 3

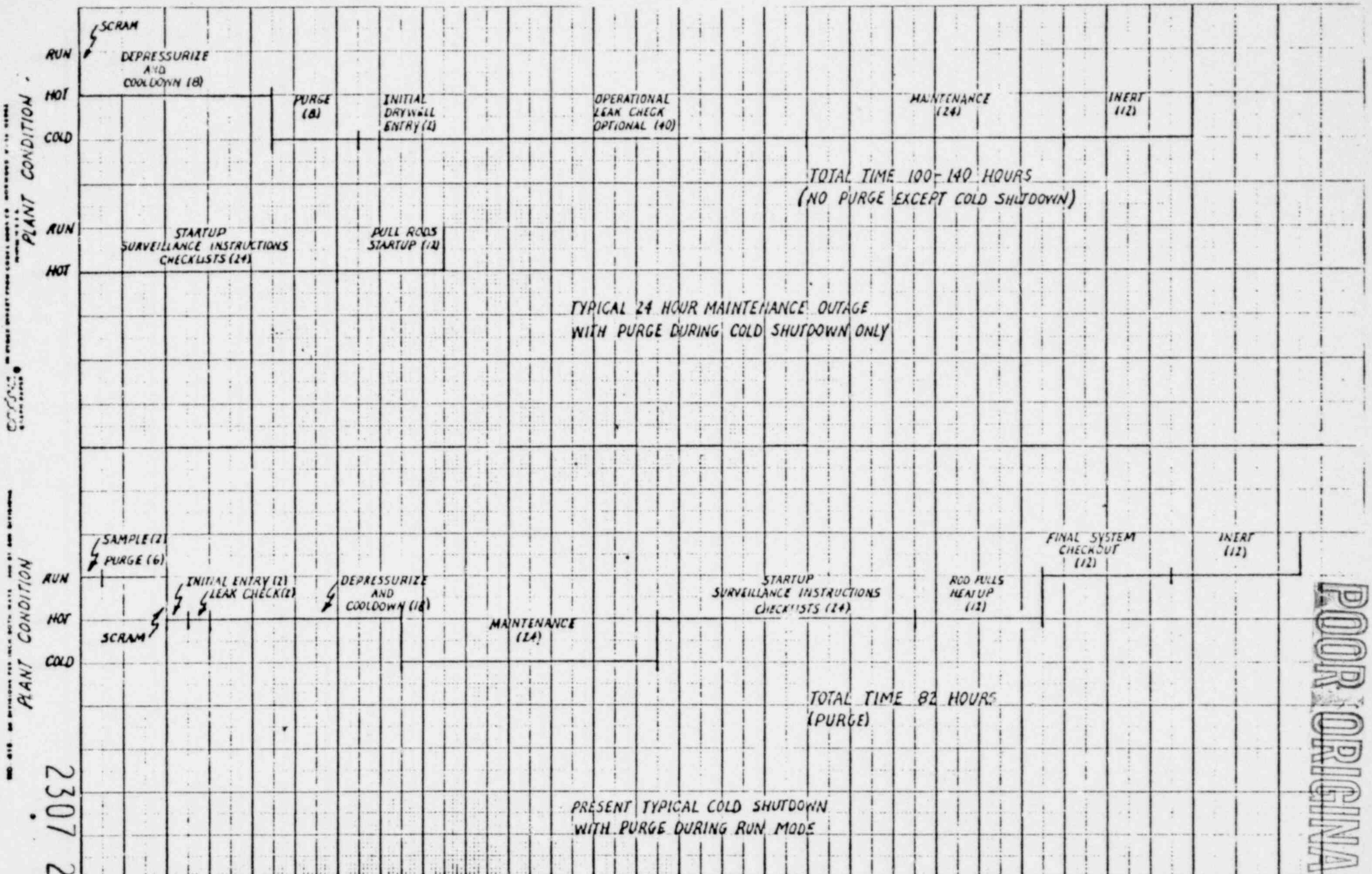


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FIGURE 4

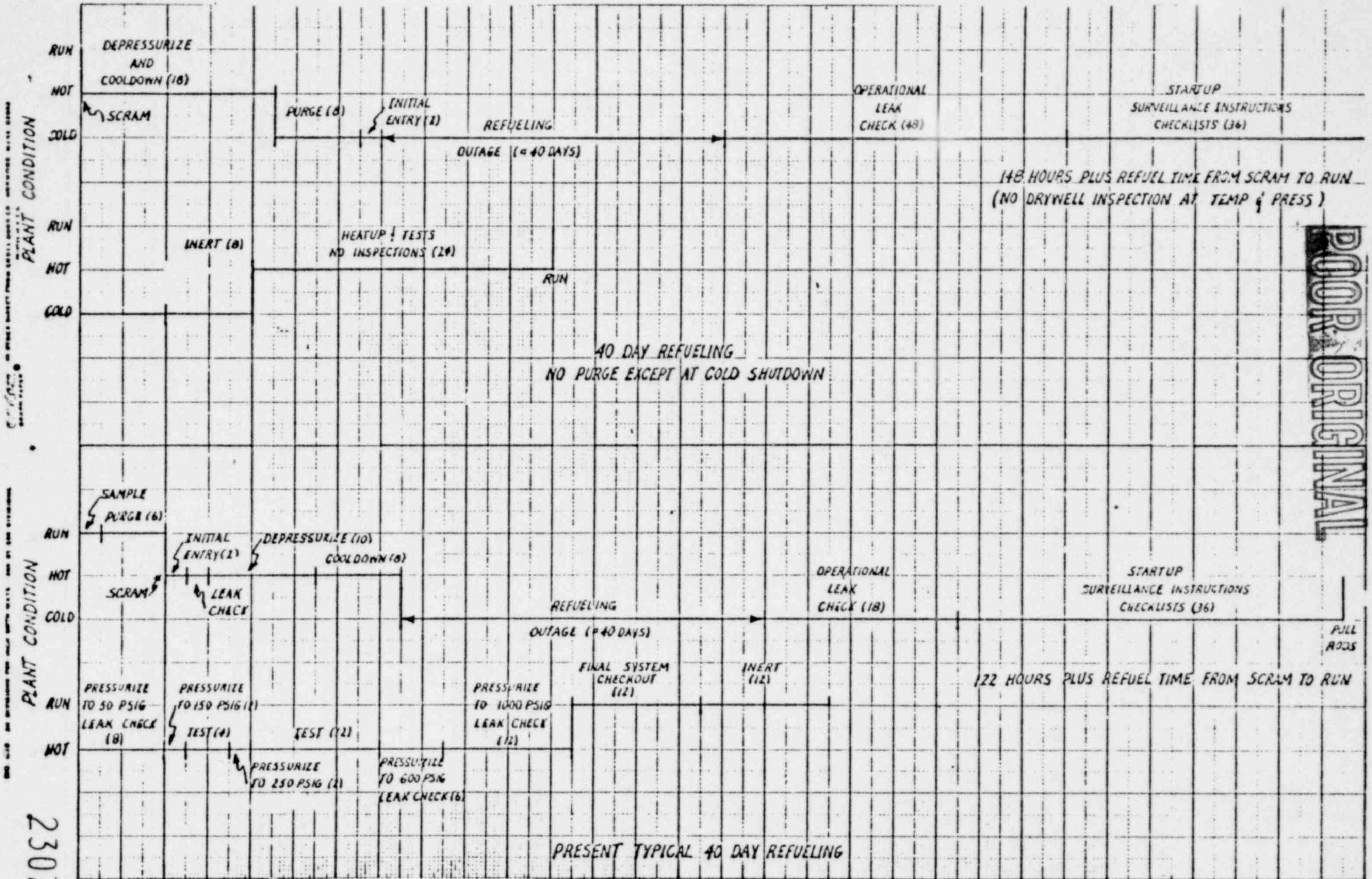

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TABLE 4

BROWNS FERRY

DATA FOR ACTUATORS

NO.	ACTUATOR MANUFACTURER	ACTUATOR TYPE	ACTUATOR PART OR MODEL NUMBER	INFORMATION FOR PILOT VALVE IF AIR CYLINDER ACTUATORS: MANUFACTURER	PART OR MODEL NO.	INSIDE OR OUTSIDE CONTAINMENT
1	64-17 Bettis	Air Open Fail Closed	732-A-SR-51-A	Asco	WPHTX8300 B45F 76967T	Outside
2	64-18 Bettis	A.O.F.C.	732-A SR-63	Asco	WPHTX8300 B45F 77967T	Outside
3	64-14 Bettis	A.O.F.C.	64-17	Asco	WPHTX8300 B45F 77967T	Outside
4	64-24 Bettis	A.O.F.C.	64-18	Asco	WPHTX8300 B45F 77967T	Outside
5	64-30 Bettis	A.O.F.C.	64-18	Asco	WPHTX8300 B45F 77967T	Outside
6	64-31 Bettis	A.O.F.C.	150-A-SR-21	Asco	WPHTX8300 B45F 77967T	Outside
7	64-32 Bettis	A.O.F.C.	64-18	Asco	WPHTX8300 B45F 43629A	Outside
8	64-33 Bettis	A.O.F.C.	64-18	Asco	WPHTX8300 B45F 43629A	Outside
9	64-34 Bettis	A.O.F.C.	64-31	Asco	WPHTX8300 B45F 77967T	Outside
10	76-17 Masoneilan Annin CYL Operator	A.O.F.C.	68-3422	Asco	WPHTX8300 B68U 58568T	Outside

Which Valve Assemblies Have Been Seismically Qualified?

ALL

Average Purge Time (Hours) Per Yr. Per Unit

ATTACHED

2307 283

TABLE 4 Continued

BROWNS FERRY - PAGE 2

DATA FOR ACTUATORS

NO.		ACTUATOR MANUFACTURER	ACTUATOR TYPE	ACTUATOR PART OR MODEL NUMBER	INFORMATION FOR PILOT VALVE IF AIR CYLINDER ACTUATORS: MANUFACTURER	PART OR MODEL NO.	INSIDE OR OUTSIDE CONTAINME
11	76-18	Masoneilan Annin CYL Operator	A.O.F.C.	76-17	Asco	WPHTX8300 B68U 58566T	Outside
12	76-19	Masoneilan Annin CYL Operator	A.O.F.C.	76-17	Asco	WPHTX8300 B68U 58568T	Outside
13	76-24	Fisher	A.O.F.C.	656-60	Asco	8302C29F 94905S	Outside

Which Valve Assemblies Have Been Seismically Qualified?	Average Purge Time (Hours) Per Yr. Per Unit
ALL	ATTACHED

POOR ORIGINAL

2307 284

ENCLOSURE 2

2307 285

BROWNS FERRY NUCLEAR PLANT

Purge Valve Operability

We have completed an evaluation of the purge valve operability and have concluded that the present valve design is totally adequate to withstand the dynamic effects of a LOCA. The following discussions provide the basis for our conclusion.

Statement of Problem

Should a large LOCA occur, the drywell is pressurized to a high pressure in a very short period of time. If a purge line happens to be open, the pressure in the drywell will produce a sonic flow in the purge line. It is necessary to show that:

1. The valve will close in the presence of the hydrodynamic flow.

2. The valve will not be damaged during and upon closing.

Assumptions

TVA has performed analyses to determine the effects of the forces on the valve during a LOCA. The LOCA chosen for operability analyses was the design basis accident to maximize the loads considered.

The basic assumptions are:

1. The peak drywell pressure is 42 psig. This value is taken from the Mark I Program Browns Ferry Plant Unique Loads Report.

2. The pressure is constant from the start of the LOCA till the valve is completely closed. This is a conservative assumption which maximizes the hydrodynamic force and disk closing velocity.

3. The velocity of the fluid escaping the purge line is based on pure steam at 42 psig. This provides a conservative velocity as the inclusion of air would reduce the fluid velocity.

4. The density of the fluid was based on air at 42 psig and 120 F. This conservative assumption maximizes the drag on the valve disk.

Evaluation

A 20-inch axisymmetric butterfly valve was chosen for the evaluation. This is the largest purge valve at Browns Ferry. To begin evaluating the valve, it is necessary to determine how each of the torques acts on the valve.

2307 286

1. Operator Torque

The valve is provided with a pneumatic actuator which requires air to open and is spring loaded to close. There are two air pistons and one spring on a single shaft (Figure 1). The operator torque has two components (a) the operator spring torque which causes the valve to close and (b) the operator air torque supplied by the decaying air pressure and piston cylinder volume as the valve closes, which slows the closure of the valve.

The spring provides a torque of 8,200 in-lbs when the valve is fully closed and 16,400 in-lbs when fully open. Figure 2 provides a plot of spring torque versus disk angle. This spring requires an operator air pressure of 65 psig to open the valve. Nominal operator air pressure at Browns Ferry is 90 psig.

The torque on the air side of the operator was calculated during closure. The analysis was performed considering bleeding down the two air cylinders based on chocked flow while accounting for the change in air cylinder volume with time.

2. Hydrodynamic Torque

This is the torque that the flowing fluid exerts upon the valve disk and will cause the valve to close when the disk is in any position other than the fully opened or fully closed positions.

We have evaluated the hydrodynamic torque on the disk using the Kirchhoff-Rayleigh model. (See "Torque and Cavitation Characteristics of Butterfly Valves" by T. Sarpkaya, ASME Journal of Applied Mechanics, 1961.)

Figure 3 shows the hydrodynamic torque curve for an 20-inch butterfly valve under LOCA conditions (See Assumptions 1, 2, 3, and 4 above.)

To show applicability of the Kirchhoff-Rayleigh model to compressible critical flow situation, a comparison was made with experimental data.

Figure 4 shows this comparison. (The experimental data is taken from "Effect of Fluid Compressibility on Torque in Butterfly Valves," ISA Transaction, Volume 8, No. 4.) As can be seen, the Kirchoff-Rayleigh model predicts a slightly higher peak torque than was found experimentally. It is important to note that: (a) both theoretically and experimentally, there is always a positive hydrodynamic torque to close the valve, (b) the integrated torque that will be used to calculate the disk velocity at closure is much higher for the Kirchhoff Rayleigh model than was found experimentally, and (c) the calculations for the comparison have been performed using air at 64.4 psia and critical flow, which were the conditions of the experiment.

3. Frictional Torque

Internal valve and operator friction resists any movement. Since the operator torque and hydrodynamic torque are both going to close the valve, frictional torque will be neglected. This is conservative since it will maximize the closure impact velocity of the valve.

4. Valves Structural Integrity

The Rockwell 2",18", and 20" Butterfly Valves equipped with Bettis air-operated spring-return operators are pressure-temperature rated at 150 pounds. At operating temperature,the valves are designed for 230 psi. Under any plant condition, the valves are structurally adequate and possess conservative margins of safety. The valve operators are designed for larger than specified margins of torque and verified for a seismic environment which has a margin of safety approximately four times greater than Browns Ferry specified values. Vital accessories have also been seismic and operability qualified to conditions greater than anticipated. Hence, the valves and accessories are structurally adequate for their intended service.

Conclusions

1. There is always a positive net torque to close the valve.

2. The net torque is given by:

   Net torque = Hydrodynamic torque
   + Operator spring torque
   - Operator air torque

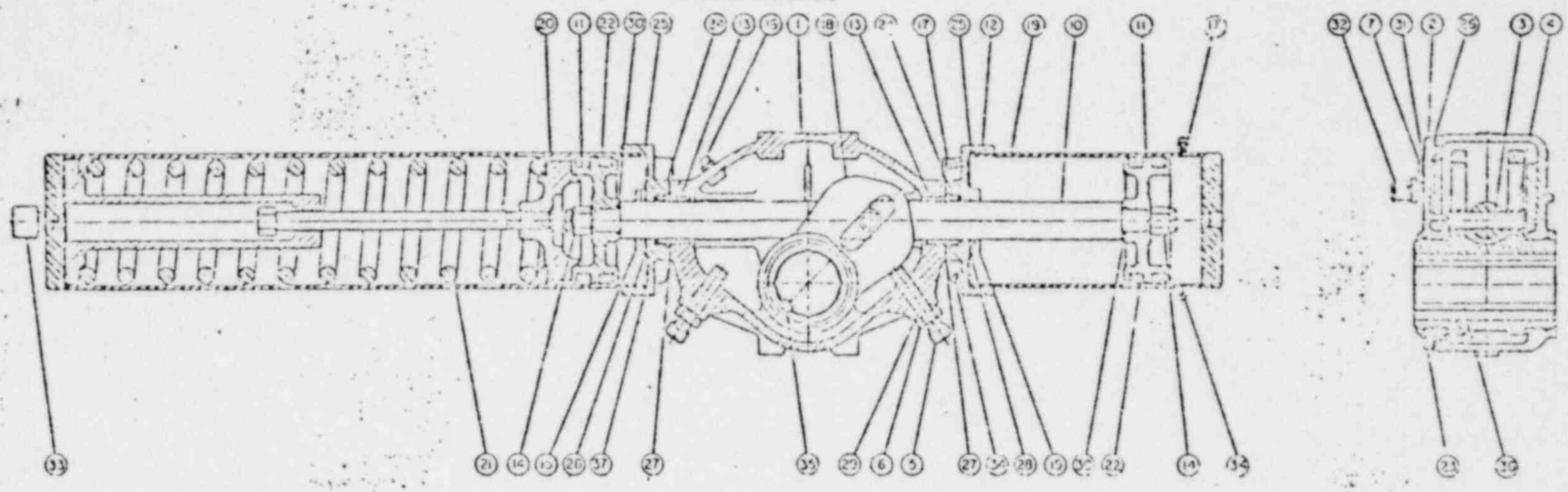
3. The valve and operator are well within their structural limits.

4. The purge valve operability is therefore not a safety concern.

ALWAYS FURNISH SERIAL NUMBER OF ACTUATOR WHEN ORDERING PARTS.

PARTS LIST 57/23C-2
JANUARY 15, 1979

HEAVY DUTY BETTIS ACTUATOR
732C-SR-H



Item	732C-SR-H Part No.	Description	Material	Quan.	Spare Parts
1	11328	HOUSING	DUCT. IRON	1	
2	11330	COVER	DUCT. IRON	1	
3	11331	PIN, YOKE	STEEL	1	
4	11415	ROLLER, YOKE PIN	STEEL	2	
5	16364	SCREW, STOP ADJUSTING	STEEL	2	
6	11335	NUT, STOP SCREW	STEEL	2	
7	4694	SCREW, COVER	STEEL	4	
8	3294	TAG, SERIAL NUMBER (NS)	STN. STEEL	1	
9	19955	SCREW, DRIVE TAG (NS)	STN. STEEL	4	
10	11332	ROD, PISTON	STEEL	1	
11	3780	PISTON	GRAY IRON	2	
12	21922	ADAPTER, CYLINDER	DUCT. IRON	1	
13	9076	BUSHING, ROD	BRONZE	2	
14	8333	NUT, HEX LOCK PISTON ROD	STEEL	2	
15	29134	SCREW, CYLINDER ADAPTER	STEEL ALLOY	8	
16	3727	PLUG, PIPE	STEEL	5	
17	30501	VALVE, BLEED	BRASS	2	
18	25557	YOKE	DUCT. IRON	1	
19	33581	CYLINDER	STEEL	1	
20	SEE BELOW	CYLINDER, SPRING	STEEL	1	
21	SEE BELOW	SPRING CARTRIDGE ASSY.		1	
22	8387	SEAL, PISTON	NITRILE	3	3
23	17439	SEAL, YOKE	NITRILE	2	2
24	30556	SEAL, PISTON ROD	NITRILE	2	2
25	8263	SEAL, CYLINDER	NITRILE	2	2
26	11334	GASKET, COVER	ASBESTOS	1	1
27	9094	GASKET, CYLINDER ADAPTER	ASBESTOS	2	2
28	3272	GASKET, ADAPTER SCREW	COPPER	8	8
29	29980	GASKET, STOP SCREW	COPPER	2	2
30	5216	SEAL, PISTON HEAD	NITRILE	2	2
31	3272	GASKET, COVER SCREW	COPPER	4	4
32	11967	SNUBBER VALVE ASSY.		1	
33	29198	BREATHER, AIR	ALUMINUM	2	
34	19970	PLUG, PIPE	STEEL	2	
35	27168	KEY, YOKE	STEEL	1	
36	20543	PIN, YOKE KEY	STEEL	1	
37	2062	ADAPTER, CYLINDER	DUCT. IRON	1	

SPRING SIZE	732C-SR-H CYLINDER P/N	CART. P/N
40	16193	16195
60	16193	16196
80	30422	16207
100	30422	16216
125	16221	16225
150	16221	16220

(NS)- NOT SHOWN

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FIGURE 2

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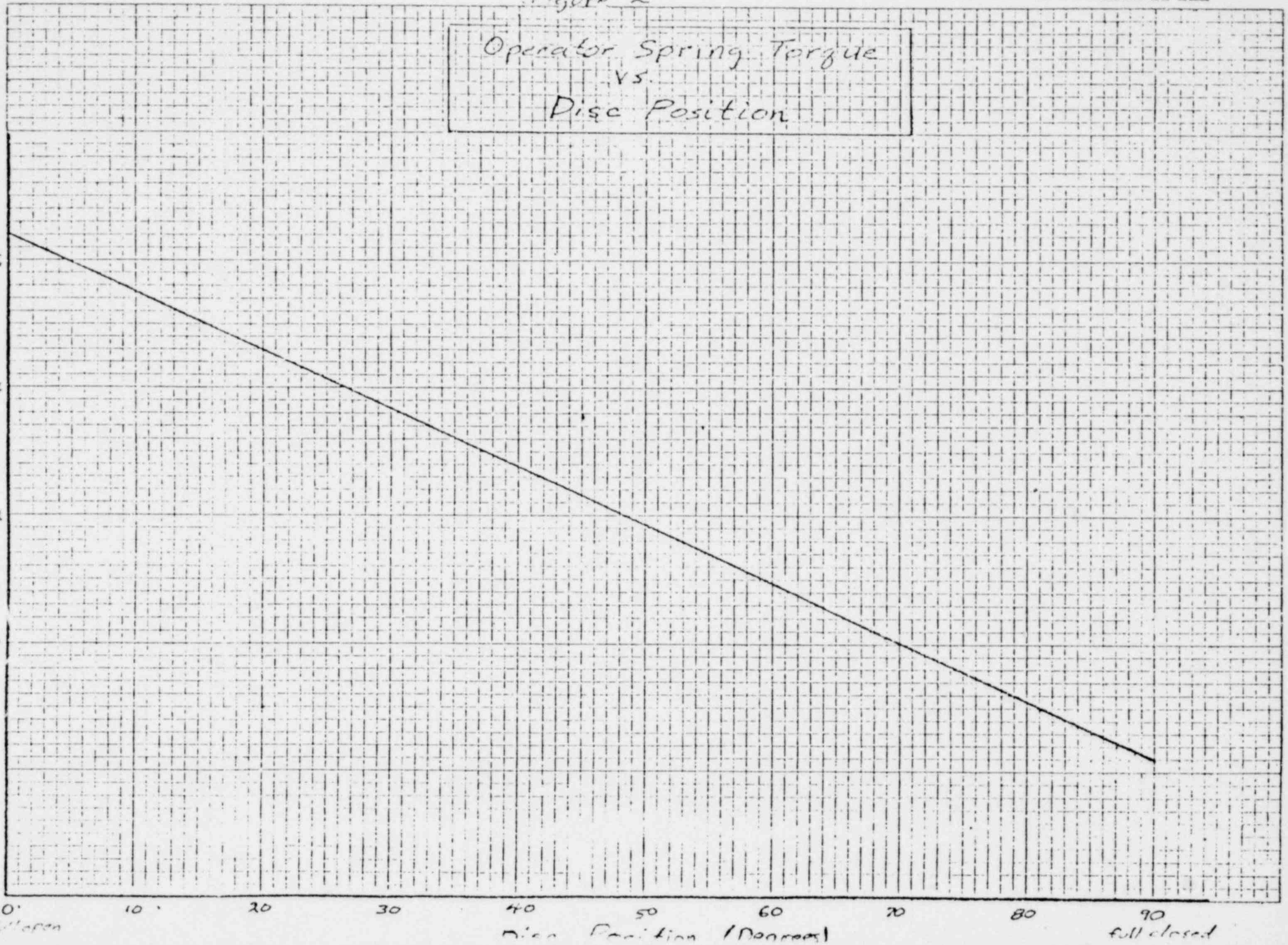
Figure 2



10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

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Figure 3

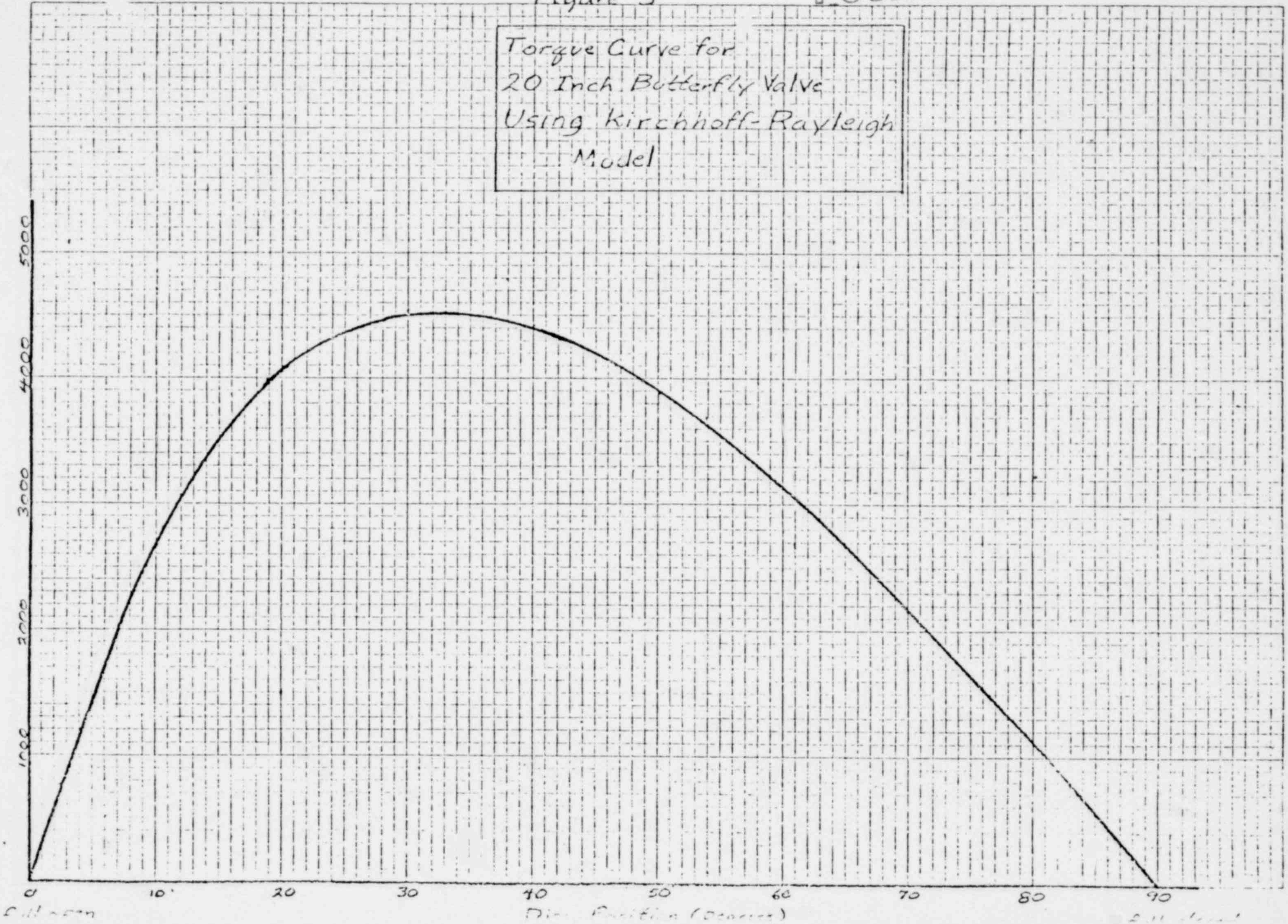
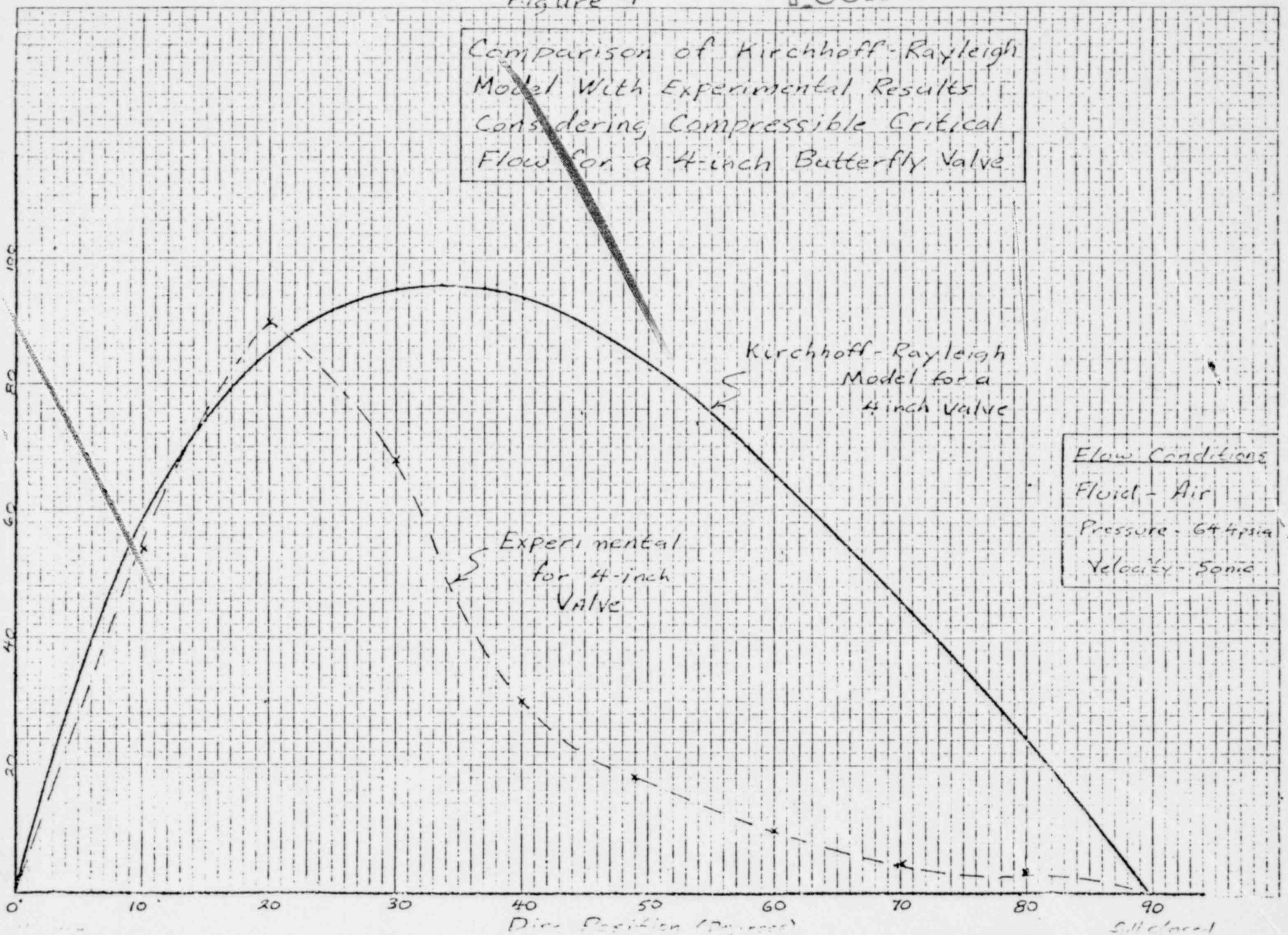


Figure 4


Comparison of Kirchhoff-Rayleigh Model With Experimental Results Considering Compressible Critical Flow for a 4-inch Butterfly Valve
Kirchhoff-Rayleigh Model for a 4 inch Valve
Experimental for 4-inch Valve
Flow Conditions
Fluid - Air
Pressure - 64.4 psia
Velocity - Sonic
0
10
20
30
40
50
60
70
80
90
100
Full closed