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NORTHERN STATES POWER COMPANY

Minneapolis, Minnesota

REPORT ON TORUS TO DRYWELL VACUUM BREAKERS TESTS AND MODIFICATIONS FOR MONTICELLO NUCLEAR GENERATING PLANT

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NORTHERN STATES POWER COMPANY
MONTICELLO NUCLEAR GENERATING PLANT
DOCKET NO. 50-263 LICENSE NO. DPR-22

REPORT ON TORUS-TO-DRYWELL VACUUM BREAKERS

The following information has been prepared in response to an AEC letter, dated January 12, 1973, requesting information on the subject vacuum breakers.

I. System Description

The wetwell/drywell vacuum relief system includes ten (10), eighteen-inch vacuum relief valves. The valves are located as follows: one vacuum breaker installed at each of six vent-to-vent header positions and two vacuum breakers installed at each of the remaining two vent-to-vent header positions. The design actuation set point is 0.5 psi for full open. Based on the estimated closing moment at full open, however, the actual actuation set point is less than 0.3 psi. Operability of the vacuum breakers is determined through the use of a test air operator. The operator is provided to open the valves remotely. Redundant indicator lights are provided to note the open and closed positions.

The vacuum breakers installed at Monticello are manufactured by Atwood and Morrill Co. The valve flange rating is 150 lbs. The position switches are snap lock limit switches, Model #S12-67 and #SL2C-67, manufactured by the National Acme Company. Figure 1 shows the vacuum breaker as installed at Monticello. The test air operator and position switch configuration, as well as a list of materials are shown in this drawing. The present vacuum breaker position indication provides local and remote indication of valve position at indication/test panel C04 in the control room and at a panel located at the 935' level of the northeast portion of the reactor building. Both panel indications are powered from the same power supply and the same breakers, Y20 circuit 1. The redundant snap lock switches actuated by a shaft mounted cam provide the means of detecting valve position.

The materials were designed for the following conditions:

a. Normal Operation

Drywell:	2 psig, 30-150°F, 100% RH
Suppression Chamber:	2 psig, 50-150°F, 100% RH

b. Transient Accident

Drywell:	57 psig, 281°F
Suppression Chamber:	35 psig, 180°F

c. Radiation environment will be 300 mrem/hr

d. Lowest service metal temperature is 30°F

The valve bodies are ASTM A-352 GRLCB and meet the impact test requirements of ASME Code Section III, Paragraph N-1210. The disc is cast aluminum. The valves were subjected to a 225 psig hydrostatic test. Certified copies of all mill certificates are available.

The suppression chamber coating is Carbo-Zinc 11 primer and phenoline-368 finish. Carbo-Zinc 11 was also used to coat the carbon steel and cast iron surfaces of the valve.

There should be no deleterious effects on the valve materials from the coating or the nitrogen atmosphere.

There has been no test performed on the valve or the position indicators in a simulated accident environment.

The only material that is not completely suited for this environment is the teflon packing. Teflon will begin out-gassing fluorine at about $1.0 \times 10^{+4}$R. Total time integrated dose over a 40 year design life will be approximately $9.3 \times 10^{+4}$R, based on an exposure rate of 300 mrem/hr. This is not considered an immediate problem due to the relatively small exposure so far received and for reasons discussed later in this report.

Both the preoperation and periodic surveillance tests included essentially only a functional check of the air operator and position indicators. The only acceptance requirement is that the valve is verified, by indicating lights, to close. The required surveillance frequency is once per operating cycle. Although there have been no regularly scheduled surveillance tests to date, special tests have been conducted on a number of occasions. The torus vacuum breakers were exercised weekly during startup to monitor effects of a humid environment. No problems were reported. Exercise tests were conducted on several occasions when it was determined to be appropriate by the plant staff. In November of 1971, it was discovered that the line supplying air to one of the air operators on a vacuum breaker valve was damaged by movement of the torus baffles. Repairs were made and an exercise test was conducted during startup on January 19, 1972. No significant problems were discovered until December 15, 1972 when an exercise test was conducted in conjunction with an inspection because of reports of problems at Quad Cities. Results of that inspection are discussed in the following section.

II. Summary of December 15, 1972 Findings and Results

Due to recent torus-to-drywell vacuum breaker problems experienced at other operating nuclear plants, it was decided to inspect the Monticello torus-to-

drywell vacuum breakers for proper operation. This inspection was performed during a scheduled maintenance shutdown on December 15, 1972. One of the ten vacuum breakers was found to be approximately 1 1/4 inches open; however, the position indicating lights indicated that this valve was closed. During the inspection, an exercise test was performed and four of the vacuum breakers did not close fully. In addition, two of the test operators did not operate properly.

Manual exercising of the valves indicated excessive friction between the shaft and shaft packing. The valves are constructed with a close tolerance teflon bushing on each end of the shaft with several rings of teflon packing outboard of the bushing. All of the teflon packing was removed. It is not expected that the teflon packing will be replaced, however, a substitute shaft sealing method proposed by Atwood and Morrill is being investigated for use at Monticello. With the packing removed, all the vacuum breakers were leak tested by establishing a .5 psi differential pressure between the drywell and torus and surveying for leaks with a sonic probe. No significant shaft leakage could be detected. Some minor seat leakage was detected and as a result, the valve seating surfaces were cleaned and the metal areas were dressed up with emery cloth.

Two exercise air operators required cleaning and replacement of the actuator piston sealing rings. Following these repairs, the operators functioned properly.

Prior to reinerting the primary containment on December 20, 1973 each of the ten torus-to-drywell vacuum breakers was manually lifted 1/2 inch off its seat and released. All valves closed fully from this 1/2 inch open position. Valve exercising with the air operators also resulted in free operation in both directions.

In addition, a leak rate test was conducted to determine the amount of leakage through the vacuum breakers. This test was conducted by pressurizing the drywell to approximately 7 inches of water above that of the torus and observing the pressure decay. A leakage rate of approximately 18 SCFM was measured. An inspection of the vacuum breakers with the drywell slightly pressurized indicated that most of this leakage was through five of the vacuum breakers. This inspection also confirmed that any shaft leakage as a result of removing the packing is insignificant with respect to total leakage. Also noted was the inability to accurately determine the valve position from the presently installed position indication system.

The torus-to-drywell vacuum breaker position is detected by limit switches that are actuated by small arms attached to the valve shaft. The disc must travel a considerable distance before sufficient shaft rotation has occurred to actuate the limit switches. Adjusting the limit switches to detect small openings of the vacuum breaker is difficult.

As a result of these findings, a program was undertaken by the licensee, with assistance from the architect-engineer and the reactor vendor. The objective of this program was to develop appropriate modifications for installation during the refueling outage scheduled to commence March 2, 1973. An augmented surveillance test program was developed and conducted for the intervening period of continued operation.

Valve operability was tested monthly by remote cycling with the air operators. Since the present limit switch arrangement cannot detect small opening of the valves, the operability test was followed by a leak test measurement.

The drywell pressure is increased to about 0.25 to 0.50 psid with respect to the wetwell. The nitrogen supply is isolated and the subsequent drywell to wetwell pressure transient is monitored. The 2 psig high drywell pressure set point is not exceeded. The 0.25 to 0.50 psid test pressure provides adequate margin against a spurious isolation.

The smallest pipes whose failure could result in a drywell-to-wetwell leakage path are the one-inch vent drain lines. The sensitivity of the interim leakage test is such that it would detect the rupture of one of these drain lines. This is accomplished by comparing the differential pressure decay rate to the equivalent differential pressure decay rate calculated for a one-inch orifice.

Analyses show that with an initial differential pressure between the drywell and wetwell of 0.25 to 0.50 psid, the differential pressure will decay to about 1/2 the initial value in 15 to 25 minutes through a 1" orifice. Therefore, a criteria that the differential pressure between the drywell and wetwell must be greater than 1/2 the initial value at the end of a one-half hour period demonstrates that a bypass area of less than a one-inch orifice exists. Results of this interim surveillance program have demonstrated a tendency of increased leakage although all tests were within acceptable limits.

III. Vacuum Breaker Modifications

Three modifications are planned to be made to the vacuum breaker system during the current refueling outage.

A. Improvement of Valve Closing Stroke to Provide Further Assurance of Proper Seating

The counter weight arms on the vacuum breakers will be adjusted so they are in the veritical position when the disc is in the seated position, and 10 pound weights will be located on each arm 9 1/4" from the pivot

points. This modification will provide a more constant closing moment over valve travel and further assure proper seating.

The maximum closing moment that can be attained with the existing configuration is shown in Figure 2. With the counter-balancing arms 30° from the vertical as they were prior to the modification in the seated position, only 95.5 inch-pounds of closing moment is realized. The frictional resistance in the stuffing box and shaft assembly is of this order of magnitude as evidenced by the tendency for the valve to stick slightly open; hence it is necessary to increase the closing moment when the valve is at its seat to ensure sufficient closing moment is present to overcome friction. To accomplish this, the counter-balancing arms are rotated to the vertical position when the valve is closed. This eliminates the effect of the counter-balance when the valve is seated but allows counter-balancing of the disc assembly as the valve is opened. The addition of weights to the counter-balance arms provides a means of adjusting the maximum closing moment with the valve open. As shown in Figure 2, with the arms in the vertical position and with 10 pound weights placed 9 1/4" from the pivot points, 242 inch-pounds of closing torque is realized in the seated position. Having the arms in the vertical with the valves seated nullifies the effect of the weights in this position, however, when the valve is full open the closing moment will be lowered to the indicated value of 362 inch-pounds. With the addition of frictional resistance, a combined moment of 338 inch-pounds must be overcome to lift the valve off its seat. The valve disc has 254 square inches of area exposed to the differential pressure and this area has an effective moment arm of 11 3/8" to the valve pivot. Consequently the valve will begin to open at .1165 psid.

B. Replacement of Snap Lock Limit Switches with Micro Switches to Improve Position Indication

The valve-closed position indicator switches will be replaced with Honeywell Model #2LS111, heavy duty, micro switches capable of detecting any non-closed vacuum breaker at a degree of opening less than that permitted for a single valve.

The maximum allowable bypass area is equivalent to a six-inch line which translates into a disc opening for all ten valves of 0.04" at all points around the circumference of the valve disc, or 0.08" open at the bottom of the disc when the top of the disc is on its seat. For a single vacuum breaker, the maximum allowable bypass area is 0.375" at all points around the circumference or 0.75" at the bottom of the disc with the top

of the disc at the seat. This latter linear displacement of the disc is approximately equivalent to a 2° angular displacement of the valve shaft. The replacement switches are rated for the following:

1. Standard in-line actuation

2. Low (36 oz) operating force plunger seal

3. Sealed head and contact block cavity protects internal parts from oil, coolants, water, dust and chips

4. Two circuit double break, rated for 10 amps, 120, 340 or 480 V ac

5. Pretravel to operating position .065" maximum, over-travel 0.219" minimum, differential travel to release position .009" minimum

It is not expected that the full potential accuracy can be realized due to variations introduced in the actual mounting of the swtiches in the valve body. However, it is expected that the micro switches mounted at the bottom of disc will be sufficiently accurate to detect movement of the disc within 1/8" off the bottom of the seating area. In summary, the planned installation of two limit switches in the vacuum breaker body has been reviewed in regard to:

1. Redundancy of operation

2. Meeting IEE-279 standards

3. Physical installation on valve

Redundancy is provided by installing two limit switches to detect the closed position. Existing limit switches will continue to monitor the open position. Since the purpose of these limit switches is to provide information to the operator, physical separation of the control wiring or indicating lights is not required. Existing wiring will be utilized with the new limit switches connected in place of the existing limit switches. This connection will provide redundant signals to the control room.

C. Upgrading of Corrosion Resistance of the Air Operators to Further Ensure Testability

The internals of the air operating assembly for the 18" torus-to-drywell vacuum breaker are to be electroplated for corrosion resistance. The piston cylinder, spring spacer, pistion, and upper cylinder cap are to be plated with 1 mil thickness of nickel. The spring is to be cadmium coated.

Technical Specification 4.7.A.4 requires that eight of the ten drywell-pressure suppression chamber breakers shall be operable at all times when the primary containment is required. The testable feature of the vacuum breakers allows verification of operability. Experience has shown that the air test operators are subject to corrosion. Corrosion accumulation may prevent testing of a particular vacuum breaker or interfere with return of the vacuum breaker to the fully seated position. Application of corrosion resistant plating to the exercise cylinder internals will ensure proper operation of the exercise feature and provide additional assurance of vacuum breaker operability.

D. Surveillance Following the Modifications

1. Preoperational Tests

Prior to resuming power operation after the refueling outage the vacuum breakers will be preoperationally tested to verify the modifications. These tests will include a stroke test with the air operators and verification of indicating system. In addition, switch reset will be verified by manually pushing the disc off its seat with a depth gage and recording the lineal distance at which the indicating light is extinguished. All switches should reset within 1/8" of disc movement. The closing moment will be measured by applying a torque wrench to the valve shaft and recording the torque required to just lift the disc off its seat and the torque required to hold the disc fully open. If required, adjustments will be made so that the torque at full open does not exceed 362 inch-pounds.

2. Exercise Testing

Following completion of the proposed modification and the verification of position switch accuracy, the normal surveillance program will be resumed and will be basically as described below.

Once each month during operation all vacuum breakers will be individually cycled to verify proper operation. Should any valve fail to indicate closed following cycling, a pressure test will be performed. This test will be essentially the same as the interim leak test described earlier.

3. Routine Leak Test

In addition, the following routine leak test is proposed. The objective of this test will be to detect flow paths between the drywell and wetwell whose total capacity is equal to or greater than the capacity of a one-inch diameter plate orifice. A combined leakage capacity less than this will be considered acceptable.

Using the drywell vent/purge system, the drywell pressure will be increased by at least 1 psi with respect to the wetwell pressure and held constant. The 2 psig isolation set point will not be exceeded. The subsequent wetwell pressure transient (if any) will be monitored with a sensitive pressure gauge. If the drywell pressure cannot be increased by 1 psi over the wetwell pressure, it would be because a significant leakage path exists; in this event, the leakage source will be identified and eliminated before power operation is resumed.

Figure 3 shows the drywell and wetwell pressure transients assuming a one-inch orifice leakage path and assuming the drywell pressure was increased to 1.25 psi in a 5-minute period. Figure 4 shows the associated pressure differential between the drywell and wetwell. There is a 1/4 hour period during which the differential would be greater than 1 psi, thus there would be ample time to conduct a 10-minute test.

The drywell to wetwell leak test will be performed at the end of each operating cycle and before power operation is resumed; during this time, there will be no energy dumps to the pool and a constant temperature condition is expected to exist in the suppression chamber at the time of the test.

During the test period there shall be no operation of the following equipment:

a. The RHR System in either the containment spray or pool cooling mode

b. LPCIS

c. HPCIS

d. Relief valves

The test will be conducted prior to pressurizing the primary system following refueling; under these circumstances there can be no operation of the LPCIS, HPCIS or relief valves. Should the reactor be pressurized at the time of the test, prohibiting the operation of any equipment that can dump energy to the pool will enhance temperature stability.

IV. Safety Considerations

A. Leakage Limits

The Monticello containment has been examined to determine what leakage between the drywell and wetwell can be tolerated. Figure 5 shows the

allowable leakage capacity, $A/\sqrt{K}$, as a function of primary system break area. (A is the area of the leakage path between the drywell and wetwell, and K is the total geometric loss coefficient associated with A.) For comparison, Figure 5a translates $A/\sqrt{K}$ into equivalent orifice by assuming a geometric loss coefficient of 2.69.

The allowable $A/\sqrt{K}$ is determined on the basis of the allowable steam mass that can be passed, the ΔP between the drywell and wetwell, and the bypass duration.

The maximum ΔP between the drywell and wetwell varies as a function of primary system break size. For large breaks the ΔP is high, but lasts for a short duration. The maximum ΔP would be for the DBA, and would also be for the shortest duration. Primary system breaks greater than 0.3 ft^2 will result in rapid depressurization of the primary system. Figure 6 shows the containment transient associated with breaks in this range. For a given primary system break, the allowable leakage capacity would result in the containment pressure being equal to the design pressure at the end of the reactor blowdown period.

For small primary system breaks the ΔP between the wetwell and drywell is equal to the downcomer submergence (1.8 psi), while vent flow losses are negligible. These breaks, however, do not depressurize the RPV rapidly and some operator action is required to terminate extended bypass duration. These small leaks are the most limiting and result in the maximum allowable leakage capacity.

As part of the overall evaluation of the leakage test, the containment response has been analyzed assuming the maximum leakage capacity allowed by the test to actually exist at the time of a primary system blowdown. The complete spectrum of primary system break sizes was investigated. The containment response to large primary system ruptures was found to be essentially unaffected by the existence of a one-inch orifice leakage path between the wetwell and drywell. This is because during the reactor blowdown period (up to 10 minutes) essentially all the blowdown flow goes through the main vent system and is condensed in the suppression pool. The consequences of a given leakage path increase as the size of the postulated primary system break is reduced; the worst case corresponds to small steam breaks that continuously inject steam into the containment but are not sufficiently large to result in primary system depressurization due to either break flow or ECCS operation.

For these small breaks, intermittent operation of either the LPCI, HPCI or feedwater systems maintains an adequate coolant inventory and the core decay power maintains reactor pressure near rated. Thus, blowdown flow and leakage flow will continue until the reactor is depressurized.

Figure 7 shows the response of the containment to a small break (0.025 ft^2). The analysis assumed that: (1) reactor pressure remains at rated, (2) a leakage path equivalent to a one-inch orifice exists between the wetwell and drywell and (3) there is no condensation of the steam flowing through the leakage path. In practice most of this flow would either condense on the large pool surface or be condensed by the activation of the drywell sprays.

Even under these degraded conditions, the containment design pressure would not be approached for 14 hours. Thus the plant operators have ample time in which to shut the plant down in an orderly manner.

The current wetwell spray system has sufficient capacity to condense all the steam that could flow through a one-inch orifice leakage path. If the plant operator activates these sprays shortly after the break has occurred, there will be no long-term pressurization of the containment due to leakage flow.

However, in regard to the containment spray, analysis for the type of break considered here has been made and is included in the FSAR. No credit was taken for the potentially beneficial effects of the spray systems; the progression of events under the postulated conditions is not, and should not, be dependent on spray system operation.

Procedures may, however, be devised to initiate the sprays as a manual function to mitigate overall effects that in themselves would not result in consequences more severe than those previously analyzed for which adequate non-spray protection exists.

To include sprays in the sequence for protection against the breaks hypothesized is to imply their need in other, more severe break situations for which analysis indicates they are not necessary.

It is recognized that any action that would aid in minimizing the effects of breaks is definitely advantageous and should be considered as an operating option. Such options, however, must be treated as additional conservative elements in the analysis that may be excluded without jeopardizing the safety of the plant or its ability to sustain the postulated event.

The following table shows a postulated sequence of events between the time the accident occurs and the time the reactor pressure is reduced to 0 psig, and the transient terminated.

In both cases the pressure is down to 0 psig in 5 hours; this is well within the theoretical limit of 14 hours.

Normal Auxiliary Power Available	Plant Operating on Station Diesels
1. Accident occurs.	1. Accident occurs, off site power lost.
2. High drywell pressure scrams reactor. Suppression chamber reaches 20 psig and continues to increase at ~3 psi/hr.	2. High drywell pressure scrams reactor. Suppression chamber reaches 20 psig and continues to increase ~3 psi/hr.
3. After short period, operator decides to cool down and start to dump to main condenser at a rate that gives a 100°F/hr cooldown rate.	3. Loss of condenser vacuum prevents use of main condenser. Operator decides to cool down by dumping steam to the pool via relief valves at rate that will give a 100°F/hr cooldown.
4. Feedwater and/or HPCI maintains adequate coolant inventory.	4. Adequate coolant inventory is maintained by HPCI.
5. Operator starts wetwell sprays after the accident and thus condenses all leakage flow. Containment pressurization ceases.	5. Operator starts wetwell sprays shortly after the accident and thus condenses all leakage flow. Containment pressurization ceases.
6. At 50 psia in the reactor and following RHRS flushing, the RHRS is put into the shutdown mode. Cooldown continued.	6. At 50 psia in the reactor and following RHRS flushing, the RHRS is put into the shutdown mode. One RHRS heat exchanger and pump is sufficient to continue cooldown.
7. Reactor pressure down to 14.7 psia 5 hours after the accident.	Reactor pressure down to 14.7 psia 5 hours after the accident.

Thus, the existence of a leakage path whose capacity is slightly less than the maximum permitted by the routine leak test will allow the reactor operator to shut down in a normal manner following a small unisolable steam leak inside the containment.

For the Monticello unit, the maximum allowable leakage capacity is an $A/\sqrt{K} = 0.12\ ft^2$. Typically the geometric loss factor would be 3 or greater, thus the actual allowable leakage area would be $0.2\ ft^2$; this corresponds to a 6" line. It should be noted that a one-inch plate orifice has an $A/\sqrt{K} = 0.0033\ ft^2$. Thus, the leakage test will detect a leakage path whose capacity is only 3% of the maximum allowable.

When calculating the allowable leakage capacities shown in Figure 5, the following sequence of events is assumed. Immediately after a small primary system break, a rapid rise in containment pressure would occur as the non-condensible gases in the drywell are washed over to the suppression chamber. During this portion of the transient, the assumption is made that the plant operators assume everything is normal, i.e., no leakage path exists. Under normal circumstances the maximum pressure calculated to occur in the suppression chambers of the Monticello unit is 30 psig. This is the pressure that would result if all of the non-condensible gases initially in the containment are carried over the the wetwell free space. For the allowable leakage calculations, the plant operators are assumed to be unaware that a leakage path exists until the suppression chamber pressure reaches 35 psig. Further, a 10-minute delay is assumed before any action is taken to terminate the transient.

The corrective action taken 10 minutes after the pressure has exceeded 35 psig is assumed to take 5 minutes to be effective. Figure 8 shows the sequence of events for a typical small break. For the calculations, the specific nature of the corrective action taken after 10 minutes was not defined; the operators have several options available to them. If the source of the leakage is undefined, they would probably depressurize the primary system via either the main condenser or relief valves (ADS).

When calculating the allowable leakage capacities shown (Figure 5) the following assumptions were made. Flow through the postulated leakage path is pure steam. For a given leakage path, postulating that the leakage flow consisted of a mixture of liquid and vapor would increase the total leakage mass flow rate but would decrease the steam flow rate. Since it is the steam entering the suppression chamber free space that is resulting in the containment pressurization, this is a conservative assumption.

There is no condensing of the leakage flow on either the suppression pool surface or the torus and vent system structures. Because condensation results in less steam being in the suppression chamber free space, this is a conservative assumption. In practice there would be condensation, expecially for the larger primary system breaks, when there would be vigorous agitation of the pool surface during blowdown.

If the source leakage is a malfunctioning vacuum breaker, the operator would be alerted by the redundant control room vacuum breaker position indicators. In this event, the operators would attempt to close the open valve by exercising it with the remote actuator. This action, together with the force acting on the valve disc as a result of the flow that is occurring, would in all probability close the valve.

B. Flow Considerations

Calculations were performed, based on the modified balance arm configuration, to determine the flow versus area characteristics of the vacuum breakers. It was determined that dynamic forces were sufficient that the valve would be held fully open with a mass flow rate to the drywell of approximately 23 lbm/sec. This corresponds to a differential pressure of approximately 0.8 psid (based on dry nitrogen at standard temperature and pressure.) Below 0.8 psid, it was determined that the valve bypass area varied with the flow rate. This relationship was examined by assuming that the flow velocity head acted as a counter-balancing force to the closing moment. Since the closing moment increases with the angular displacement of the valve shaft, the flow rate must also decrease with the angular displacements. These calculations are summarized in Figure 9, which shows the flow rate versus the angular displacement of the valve shaft. The angular displacement is correlated to flow area in Figure 10.

V. Technical Specification Considerations

Proposed Technical Specifications will be submitted separately after the necessary reviews are complete. Consideration is being given to adding the following conditions and surveillance requirements.

Limiting Conditions for Operation

3.7.A.4 Drywell-Pressure Suppression Chamber Vacuum Breakers

a. When primary containment is required, all drywell-suppression chamber vacuum breakers shall be operable and positioned in the closed position as indicated by the position indication system, except during testing and except as specified in 3.7.A.4.b and c, below.

b. Any drywell-suppression chamber vacuum breaker may be non-fully closed as indicated by the position indication system provided that a drywell to torus pressure differential can be maintained within allowable limits for 1 hour with no N_2 makeup.

c. Up to two drywell-suppression chamber vacuum breakers may be determined to be inoperable for opening provided that they are secured in the closed position.

d. If Specifications 3.7.A.4.a, b or c cannot be met, the situation shall be corrected within 24 hours or the reactor shall be placed in a cold shutdown condition within 24 hours.

Surveillance Requirements

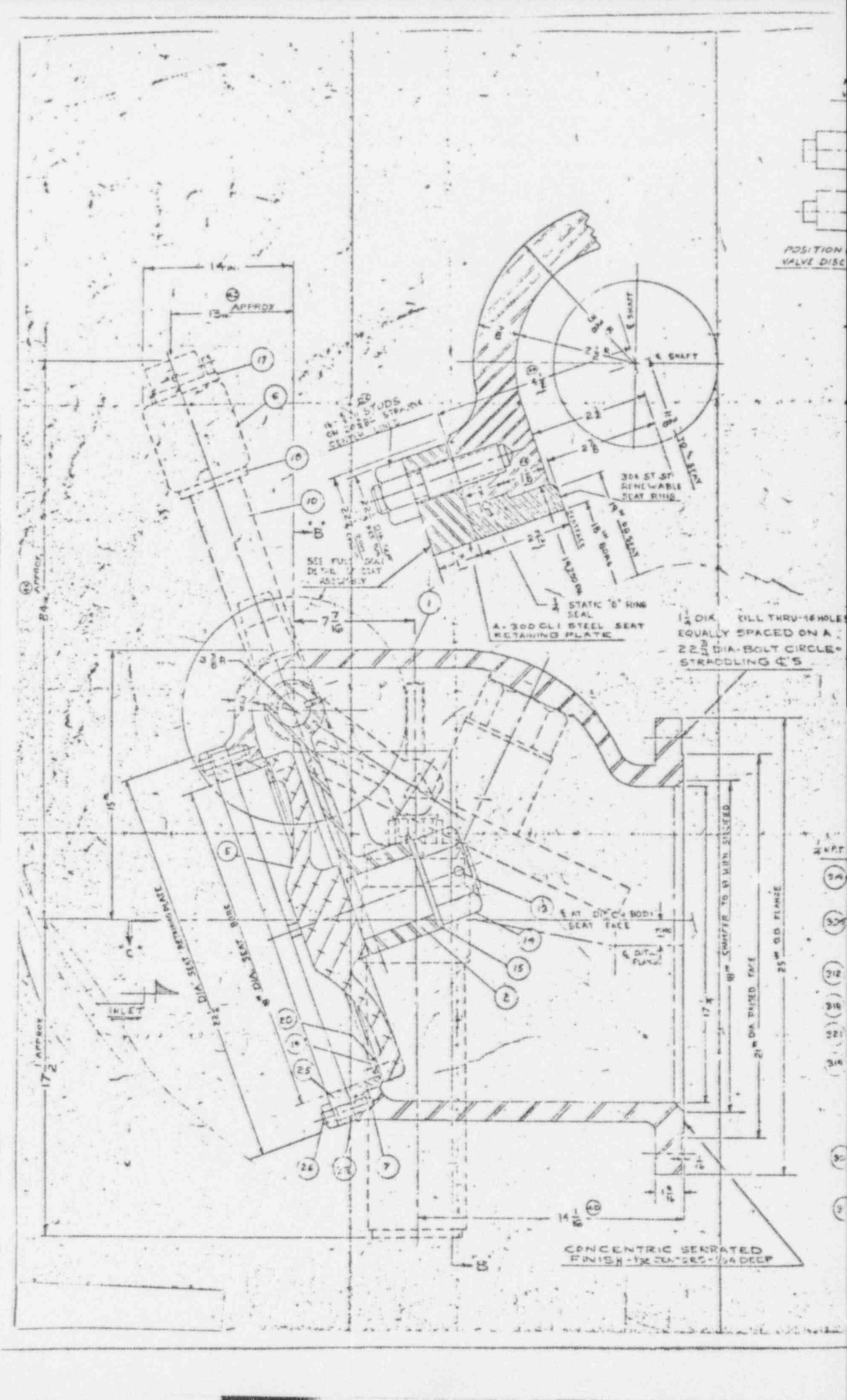
4.7.A.4 Drywell-Pressure Suppression Chamber Vacuum Breakers

a. Each drywell-suppression chamber vacuum breaker shall be exercised through an opening-closing cycle monthly.

b. When it is determined that any vacuum breaker valve is not fully closed as indicated by the position indication system at a time when such closure is required, the apparently malfunctioning vacuum breaker valves shall be exercised and pressure tested as specified in 3.7.A.4.b immediately and every 15 days thereafter until the apparently malfunctioning valves have been returned to normal service.

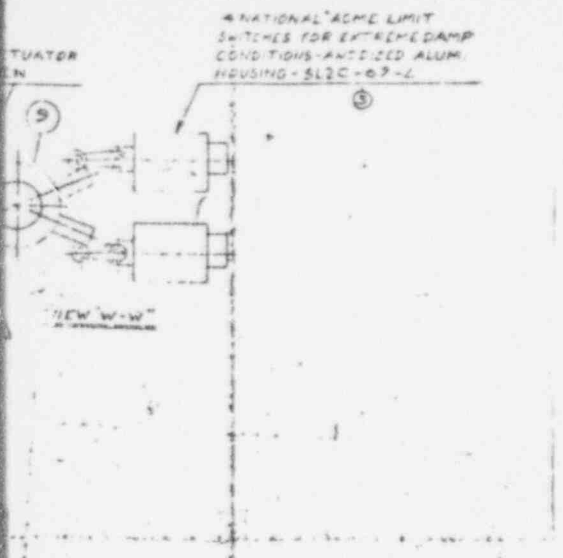
c. Once each operating cycle, each vacuum breaker valve shall be visually inspected to ensure proper maintenance and operation.

d. A leak test of the drywell to suppression chamber structure shall be conducted during each refueling outage.


POSITION
VALVE DISC
14
13 APPROX
STUDS
304 ST ST
RENEWABLE
SEAT RING
STATIC "O" RING
SEAL
A-300 CL 1 STEEL SEAT
RETAINING PLATE
1 1/4 DIA. DRILL THRU-16 HOLES
EQUALLY SPACED ON A
22 1/2 DIA. BOLT CIRCLE-
STRADDLING C'S
7 7/16
84 APPROX
INLET
17 1/2 APPROX
15
DIA. SEAT BORE
DIA. SEAT RETAINING PLATE
SEAT FACE
21" DIA RAISED FACE
25" O.D. FLANGE
14 1/16
CONCENTRIC SERRATED
FINISH - 1/32 CENTERS - 1/64 DEEP

LIST OF MATERIAL

Pc No.	Name of Part	Material	Pc No.	Name of Part	Material
1	Body	Cast St A352 Gr LCB	20	Disc Seat	Ethylene Propylene
2	Disc Arm	Cast St A352 Gr LCB	21	Stuff'g Box Bush	Teflon
3	Stuffing Box	Cast St A352 Gr LCB	22	Packing	Teflon
4	Lever Cone	Cast Steel	23	"O" Ring	Neoprene
5	Disc	Cast Aluminum	24	Gasket	Graphite Asbestos
6	Weight	Cast Iron	25	Seat Retaining Plate	Steel A-300 CL 1
7	Body Ring	Stainless Steel Type 304	26	Studs	Steel
8	Shaft	Stainless Steel Type 410	301	Cylinder Cap	Cast Iron
9	Switch Actuator	Steel	371	Spring Spacer	Cast Iron
10	Weight Lever	Steel	308	Lever	Cast Steel
11	Switch Bracket	Steel	307	Piston	Stainless Steel
12	Seat Ring	Stainless Steel	304	Cylinder	Steel (Rust Proofed)
13	Pin	Stainless Steel	305	Piston Rod	Steel (Rust Proofed)
14	Disc Nut	Steel	306	Pull Down Bolt	Steel
15	Washer	Steel	312	Roll Pin	Steel
16	Key	Steel	319	Spring	Spring Steel
17	Weight Rod W/Lug	Bronze	313	Snergac	[illegible]
18	Weight Rod W/Lug	Bronze	314	"O" Ring	Teflon
19	Retaining Ring	Aluminum W/Alum Bev	308	Flanged Nut	Stainless Steel



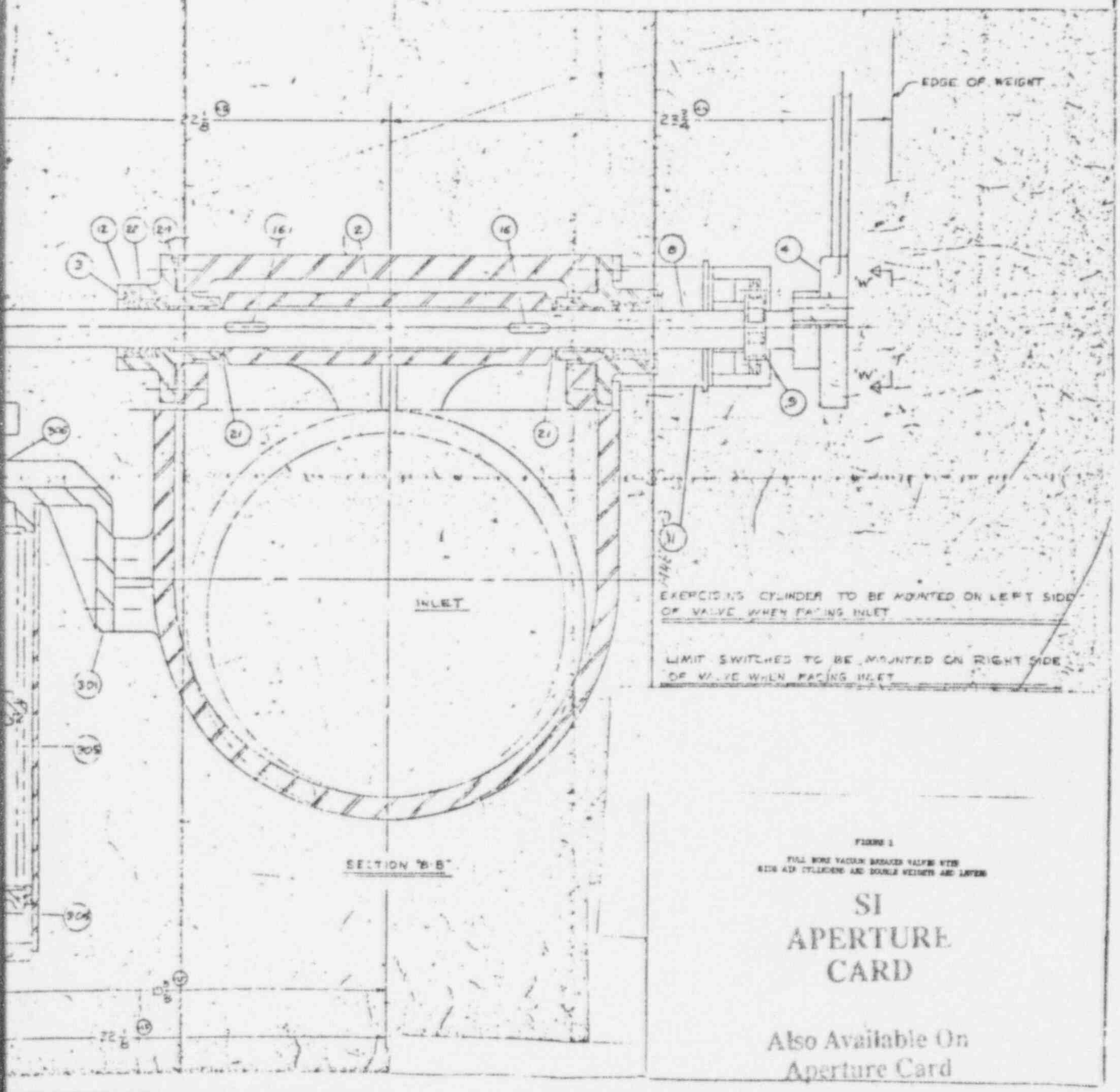


FIGURE 1

FULL BORE VACUUM BREAKER VALVES WITH SIDE AIR CYLINDERS AND DOUBLE WEIGHTS AND LEVERS

SI APERTURE CARD

Also Available On Aperture Card

9104250464-01

FIGURE 2

ANGULAR DISPLACEMENT OF VALVE SHAFT VERSUS CLOSING MOMENT

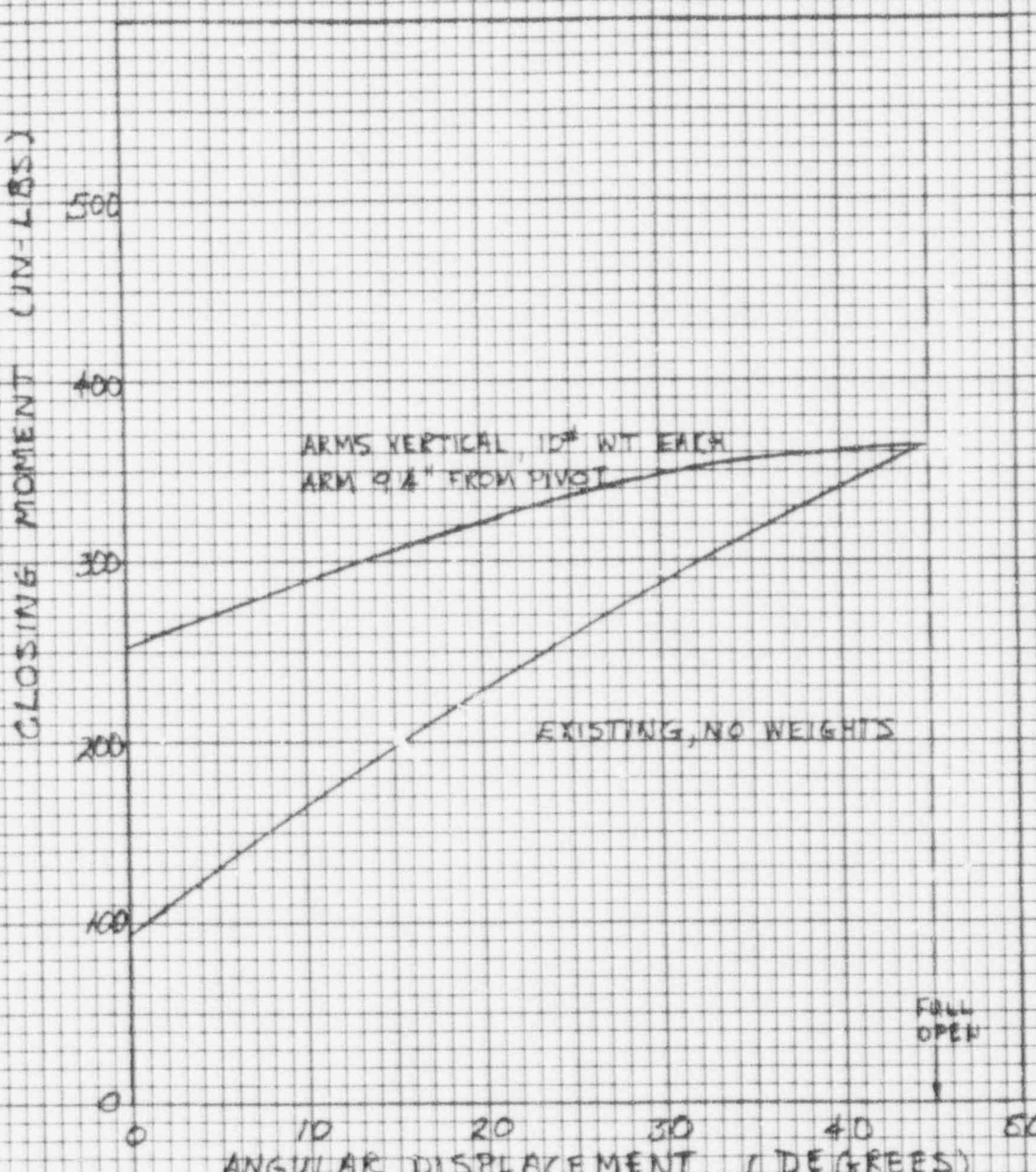


FIGURE 3

PROPOSED DRYWELL/WETWELL LEAK TEST
CONTAINMENT RESPONSE WITH LEAK EQUIVALENT
TO A ONE-INCH DIAMETER ORIFICE

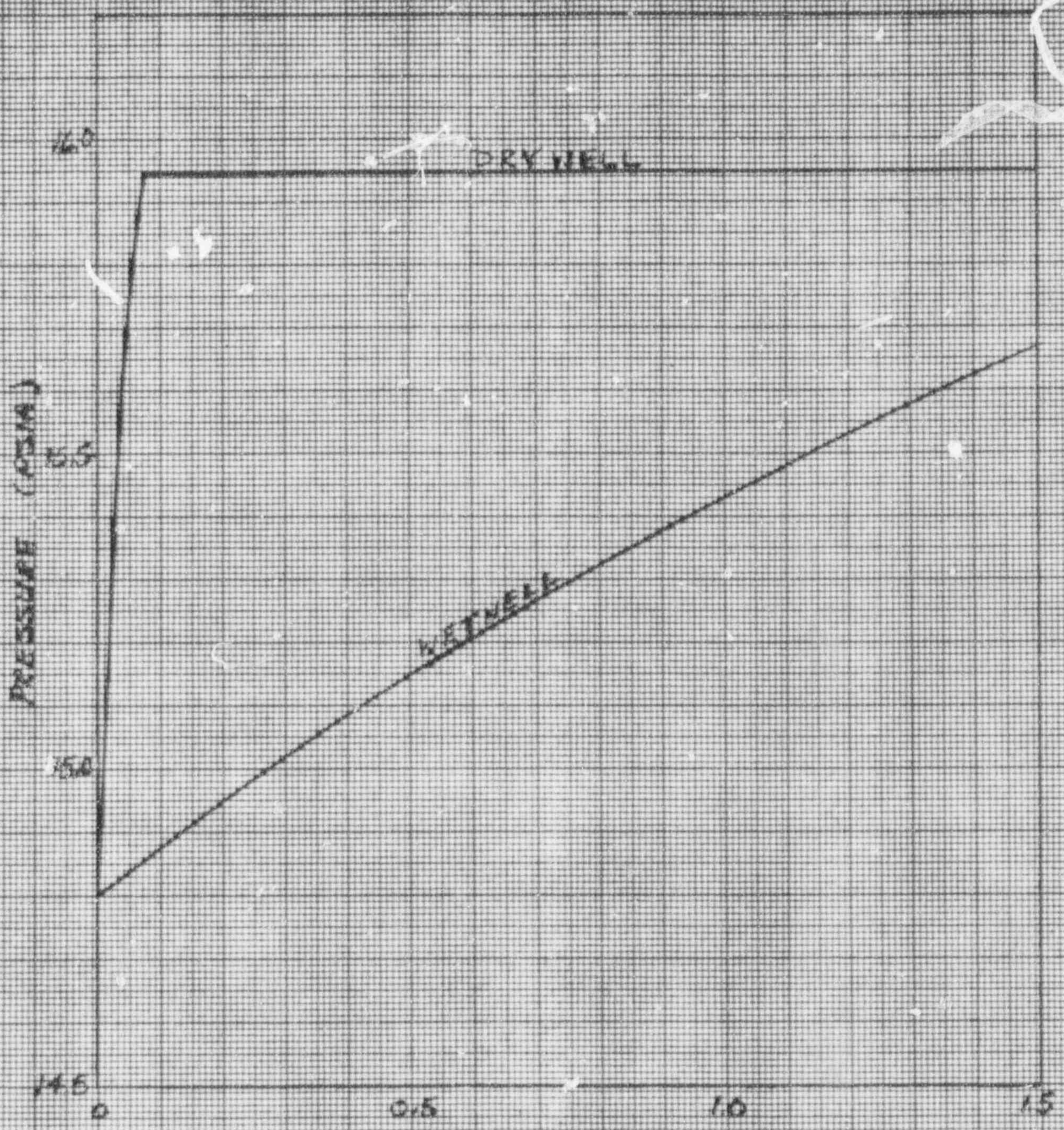


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FIGURE 4

PROPOSED DRYWELL/WETWELL LEAK TEST PRESSURE DIFFERENTIAL TRANSIENT WITH A LEAKAGE RATE EQUIVALENT TO A ONE-INCH ORIFICE

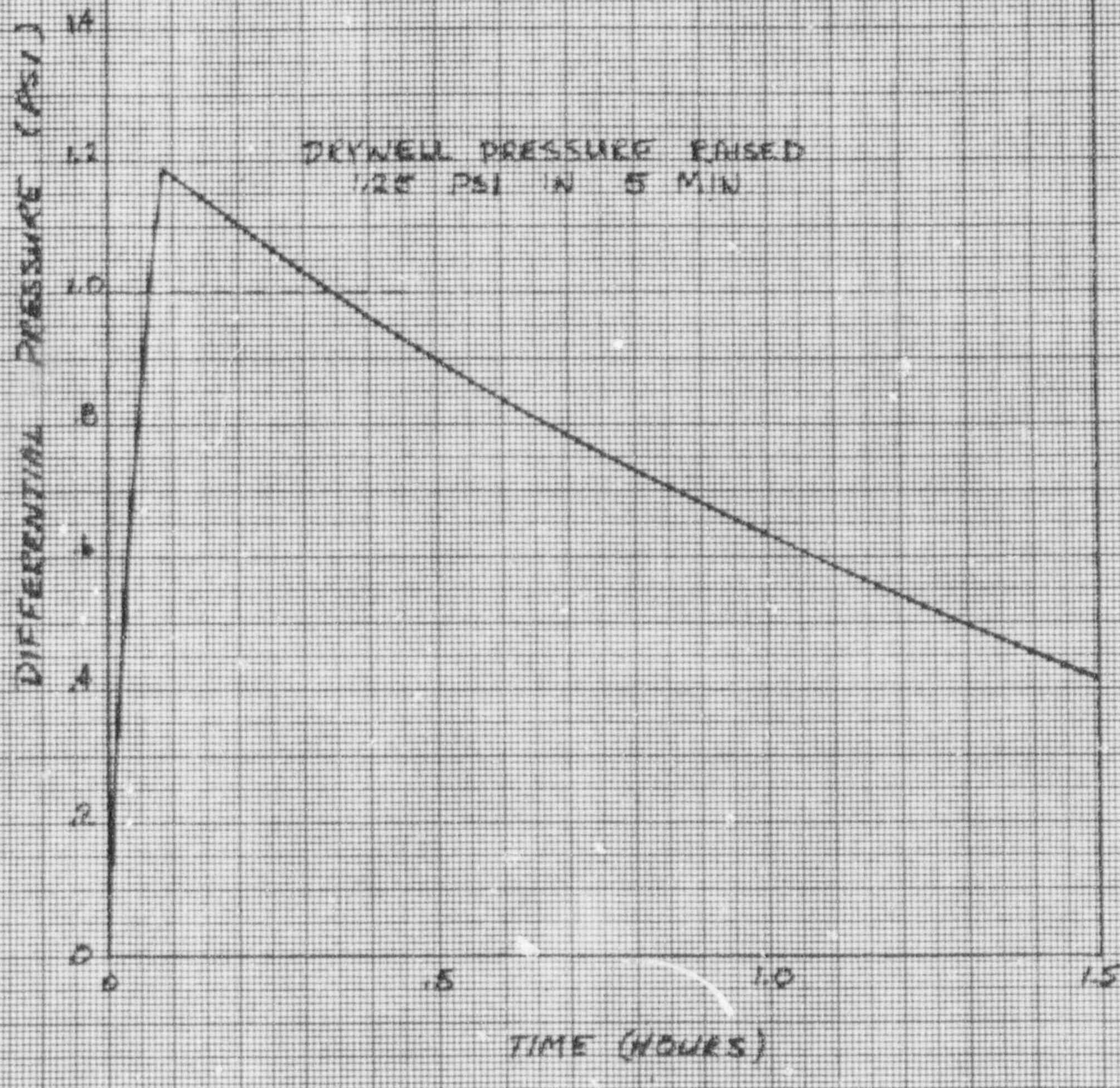

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FIGURE 5

ALLOWABE DRYWELL TO WETWELL LEAKAGE CAPACITY VERSUS PRIMARY SYSTEM BREAK AREA

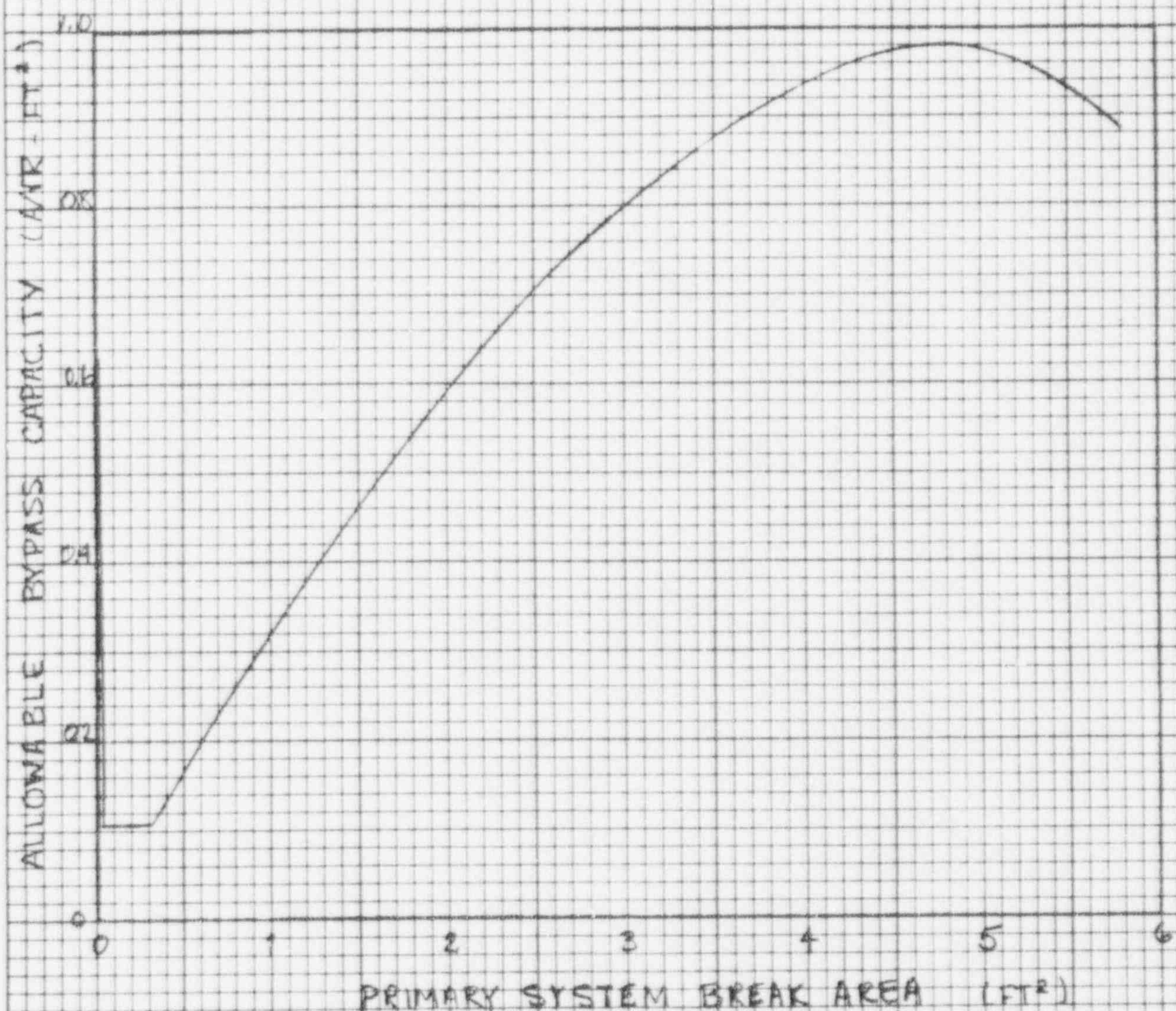

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FIGURE 5a

ALLOWABLE DRYWELL TO WET WELL LEAKAGE CAPACITY VERSUS PRIMARY SYSTEM BREAK AREA (LEAKAGE CAPACITY SHOWN IN EQUIVALENT ORIFICE)

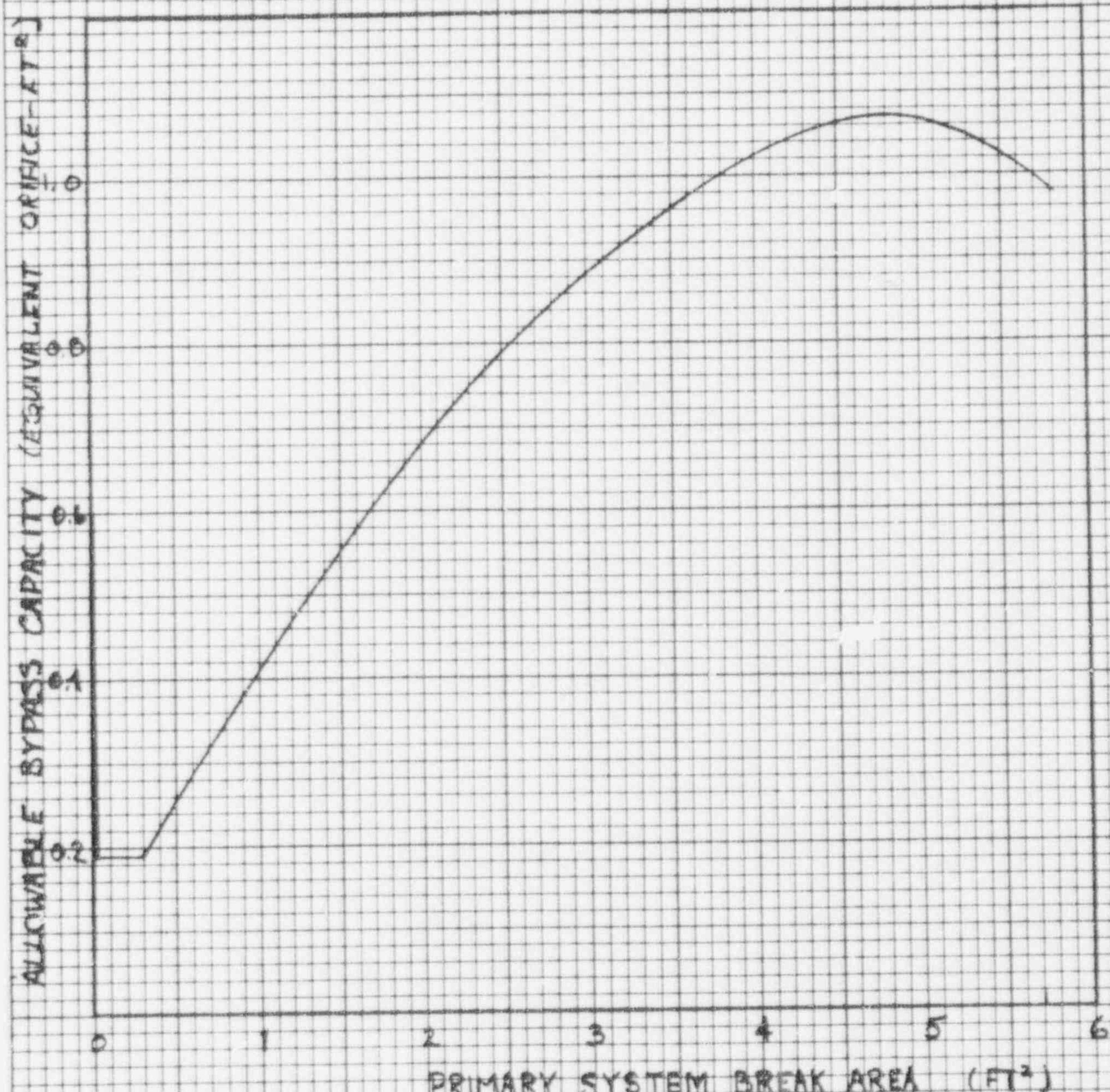

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FIGURE 6

CONTAINMENT RESPONSE TO LARGE PRIMARY SYSTEM BREAKS WHEN THE ALLOWABE DRYWELL-TO-WETWELL LEAKAGE CAPACITY EXISTS

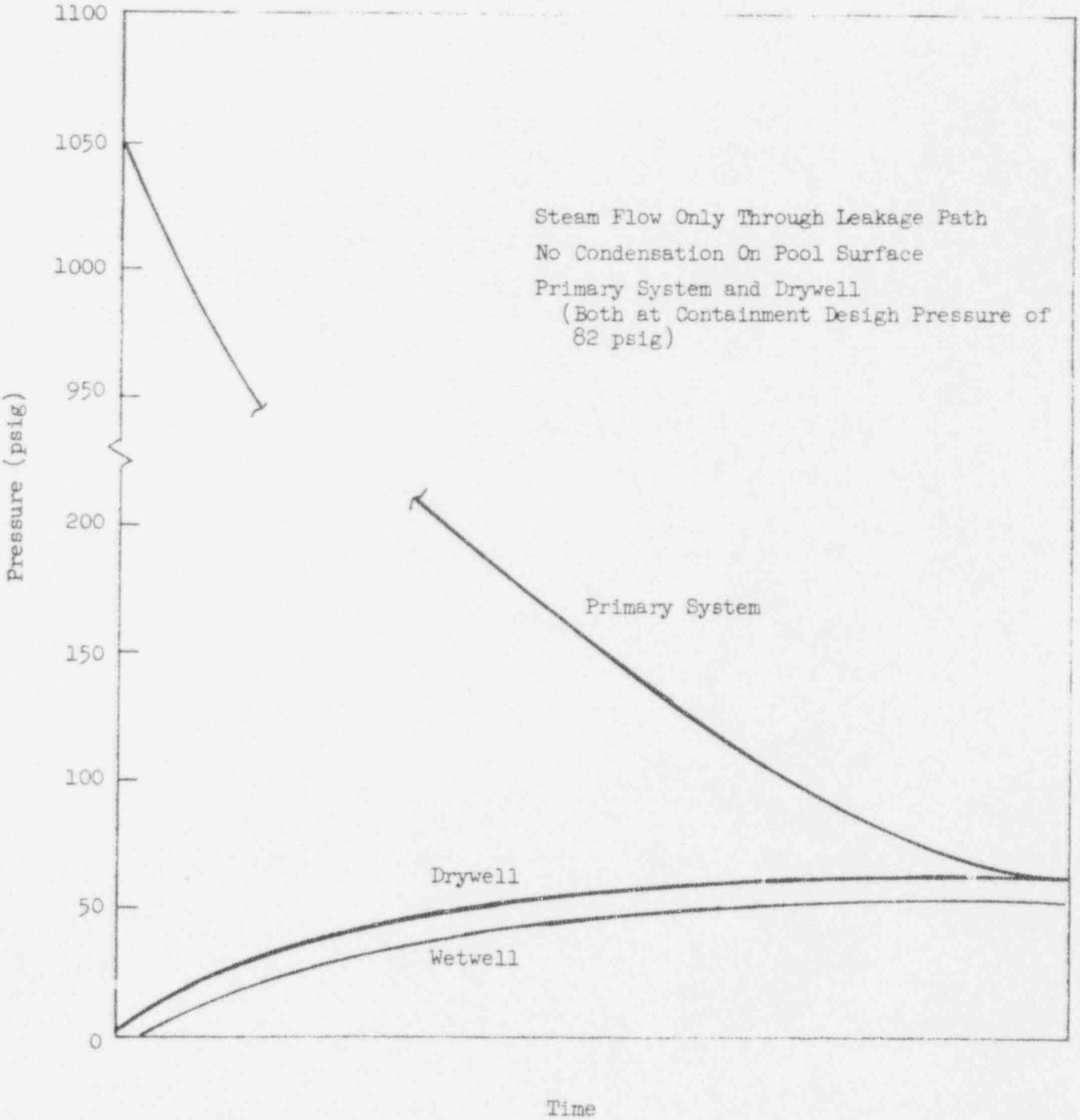

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FIGURE 7
CONTAINMENT RESPONSE TO A SMALL
STEAM BREAK WITH A DRYWELL TO WETWELL
LEAKAGE PATH EQUIVALENT TO A ONE-INCH ORIFICE

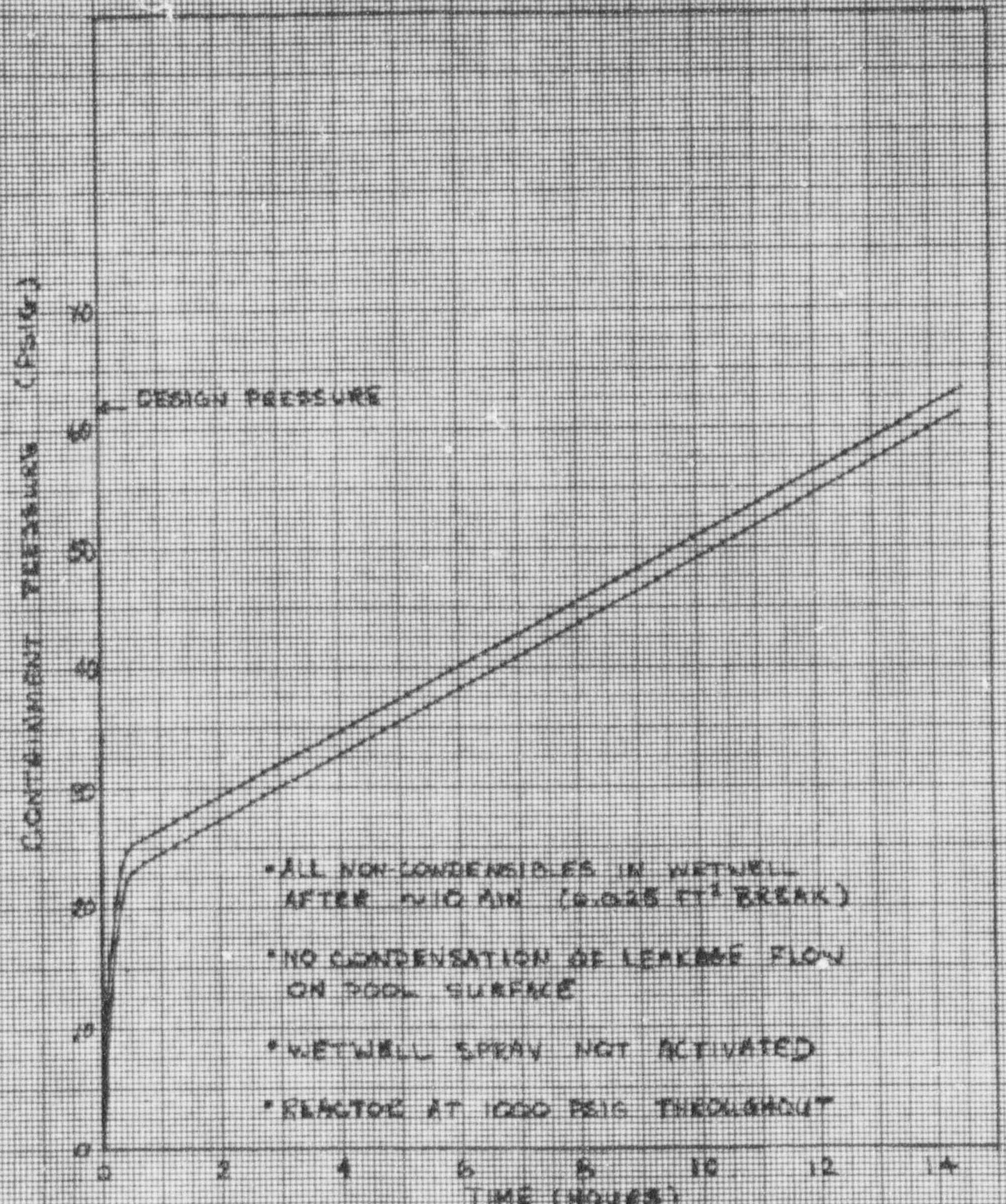

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FIGURE 8

CONTAINMENT RESPONSE TO SMALL PRIMARY SYSTEM BREAKS WHEN THE ALLOWABLE DRYWELL-TO-WETWELL LEAKAGE CAPACITY EXISTS

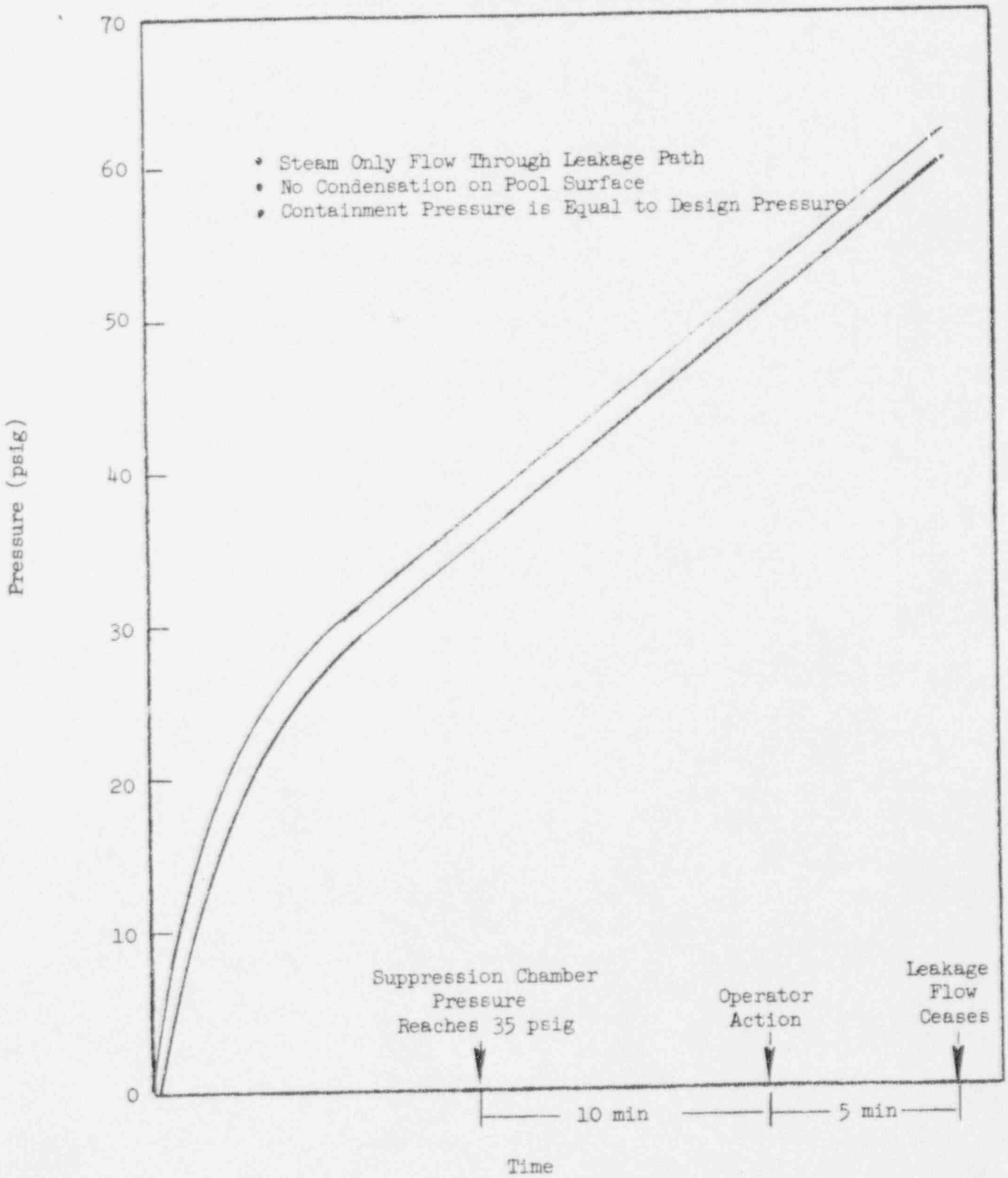

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FIGURE 9

VACUUM BREAKER BYPASS AREA VERSUS ANGULAR DISPLACEMENT OF THE SHAFT FROM FULL CLOSED

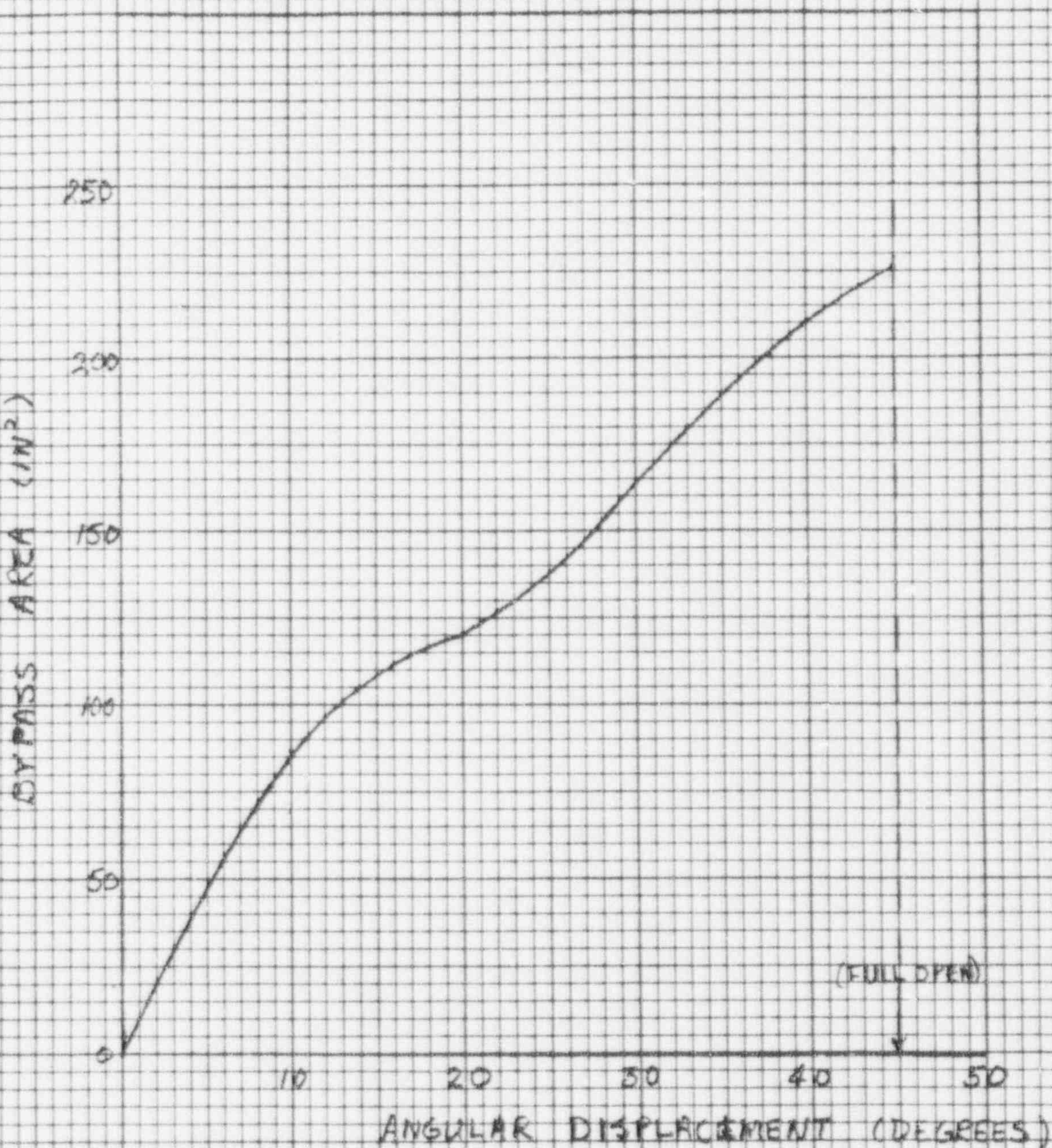

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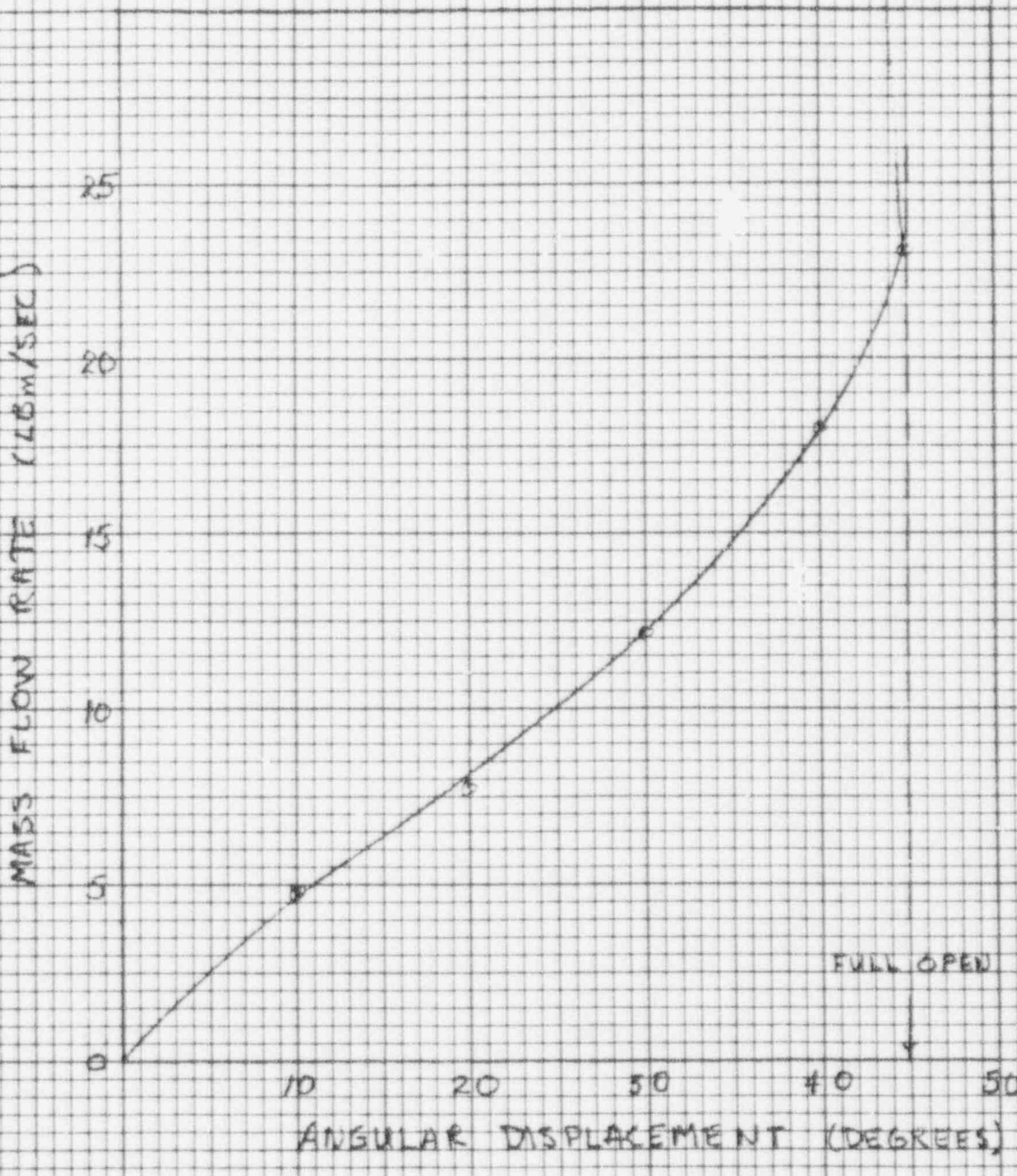
FIGURE 10

MASSFLOW RATE VERSUS ANGULAR DISPLACEMENT OF SHAFT FROM FULL CLOSED (PER VACUUM BREAKER)



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