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DENTON,H.R. Office of Nuclear Reactor Regulation, Director

SUBJECT: Forwards description of drywell/torus vacuum breaker mods, per 830523 commitment to submit plant-unique calculations & schedule in response to Generic Ltr 83-08.

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TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

November 5, 1984

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Denton:

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

By letter from D. G. Eisenhut to Listed dated February 2, 1983, subject, Modification of Vacuum Breakers on Mark I Containments (Generic Letter 83-08), we were requested to provide a commitment to submit plant unique calculations on vacuum breaker modifications and implementation schedule. Our commitment to submit the calculations and schedule for the Browns Ferry Nuclear Plant was made in L. M. Mills' letter to you dated May 23, 1983. In response we are submitting as an enclosure a description of the Browns Ferry drywell/torus vacuum breaker modifications.

The enclosed modifications have been completed on Browns Ferry unit 3. The modifications will be implemented on unit 2 during the current outage, and on unit 1 during the next outage.

If you have any questions, please get in touch with us through the Browns Ferry Project Manager.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

James A. Domer

James A. Domer
Nuclear Engineer

Subscribed and sworn to before
me this 5th day of Nov. 1984.

Paulette H. White
Notary Public
My Commission Expires 8-24-88

Enclosure
cc: See page 2

A001
1/1

Mr. Harold R. Denton November 5, 1984

cc (Enclosure):

U.S. Nuclear Regulatory Commission
Region II
ATTN: James P. O'Reilly, Regional Administrator
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Mr. R. J. Clark
Browns Ferry Project Manager
U.S. Nuclear Regulatory Commission
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Bethesda, Maryland 20814

ENCLOSURE
DRY/WELL TORUS VACUUM BREAKER MODIFICATIONS
BROWNS FERRY NUCLEAR PLANT

1.0 INTRODUCTION AND BACKGROUND

Each unit of the Browns Ferry Nuclear Plant (BFN) is equipped with a vent system which permits the drywell to communicate with the wetwell (torus). During normal plant operation, the drywell is maintained at a slightly higher pressure than the torus. In the event this differential pressure cannot be maintained due to abnormal plant transients which tend to pressurize the torus, vacuum breaker valves will open allowing torus air to flow into the drywell and cause the drywell and torus pressures to equalize. The vacuum breakers employed at BFN are located inside the torus as shown in figure 1.1. These valves were originally designed by and purchased from General Precision Engineering (GPE). Each unit is equipped with twelve such valves.

During full scale testing associated with the Mark I program, torus response to a loss of coolant accident (LOCA) was simulated. A GPE vacuum breaker sustained damage to its body, disk, and sealing gasket during this testing. A detailed evaluation revealed that this damage was caused by the valve disk repeatedly impacting with the valve seat. Furthermore, the damage occurred in conjunction with a cyclic load phenomenon known as chugging.

Chugging, a LOCA induced dynamic loading condition identified during the Mark I program, is characterized by an up and down movement of the water/steam interface within the downcomers as the steam volumes are condensed and replaced by surrounding pool water. Pressure oscillations occur within the vent system causing the vacuum breaker valves to open and close repeatedly. The valves were not designed for this cyclic loading condition.

The Mark I Owners and the Nuclear Regulatory Commission (NRC) became aware in 1980 of the vacuum breaker damage during full-scale test facility (FSTF) testing and the potential for damage during actual LOCAs. A GPE Owners Group was formed to develop an action plan for resolving this issue. NUTECH was awarded a contract to serve as overall program coordinator. The NRC issued generic letter 83-08(1) in February 1983, requesting commitments from utilities to provide analytical results and projected vacuum breaker modification implementation schedules.

NUTECH performed a two-phase program in support of this effort(2,3). Phase I dealt with the evaluation and selection of a modification concept. Phase II was a combination design and testing effort utilizing both an unmodified valve and a valve equipped with modifications proposed by NUTECH (the addition of a snubber to limit disk impact velocity and a structurally superior sealing gasket).

The Mark I Owners felt that NUTECH incorporated unnecessary conservatism in their disk impact velocity estimating techniques. Hence, Continuum Dynamics, Incorporated (CDI), was awarded a contract to evaluate NUTECH's work and develop more realistic valve dynamic models as required. An improved analytical model of the vent system, inclusive of the vacuum breakers resulted from this effort. This model which yields reduced disk impact velocities relative to the earlier NUTECH work is discussed in reference 4. The overall CDI effort is summarized in reference 5. The CDI results were incorporated in reference 3 at the GPE Owners Group request.

A design impact velocity of 6.89 radians/sec was calculated for BFN. This value was inclusive of the 1.18 multiplication factor recommended by General Electric Company. Due to the magnitude of the design impact velocity, certain valve components needed to be replaced with components made of higher strength materials. This is consistent with NUTECH recommendations for design impact velocities in the 4.5 to 9.3 radians/sec range.[3]

The following pages describe TVA's BFN-specific valve modification design process. Three steps were involved in this process. Two additional steps are required to implement the design: (1) A BFN-specific analysis was conducted to determine which components required replacement and/or modification, (2) the appropriate materials were selected based on the analysis and engineering judgement, (3) design drawings were produced depicting the components to be replaced, (4) the components are being fabricated or procured per the drawings, and (5) valve modifications are being performed during refueling outages. The first three items are discussed in sections 2.0 and 3.0 which follow. Items 4 and 5 are discussed in conjunction with the proposed modification implementation schedule, section 4.0.

2.0 ANALYSIS OF GPE VACUUM BREAKER VALVES

As documented by reference 3, NUTECH has evaluated a generic 18-inch GPE vacuum breaker for the LOCA chugging event. Although the NUTECH analysis utilized an appropriate pallet closing velocity (6.89 radians per second) for the BFN application, it was found there were significant differences between the generic vacuum breaker and the TVA unit. For example:

1. The generic vacuum breaker has a dished pallet whereas the TVA pallet is essentially a flat plate.

2. The generic pallet has four impact points around the sealing perimeter whereas the TVA pallet impacts on a uniform surface. The generic configuration results in high localized stresses in the vicinity of the impact points.

3. The generic pallet is fabricated from SA-516 grade 70 material whereas the TVA pallet is T-1 type A steel. Material discrepancies were also identified for hinge arm, hinge shaft, and hinge arm-to-pallet bolts.

Because of the differences noted above, a unique structural evaluation of the Browns Ferry unit was deemed necessary. Basically, the approach utilized was to perform an impact/stress analysis of the pallet, hinge arm, hinge arm bolts, hinge shaft, and shaft ear attachment. Analysis of the pallet was based on a classical approach that equates deflection (strain energy) to the kinetic energy of the pallet prior to impact. Hinge assembly components were evaluated for applied loads from the pallet impact. Both stress level and original material selection were considered in the development of valve modifications. The following summary of design recommendations resulted from the vacuum breaker analysis.

1. Pallet - P/N 8 per GPE Drawing BD-0240-0030

   Calculated stress levels in the pallet due to a 6.89 radians per second impact indicate a large margin of safety with respect to the allowable stress intensity (1.5 Sm). The T-1 type A material, conforming to either A517 type B pressure vessel quality or A514 type B structural quality specifications, provides adequate strength and toughness to assure integrity under the predicted loading conditions. Thus, replacement of the pallet was not recommended.

   T-1 type A steel is not an approved material for fabrication of ASME B&PV Code, Section III, Class MC pressure boundary components. However, in this case, strict adherence to Section III of the Code is not a requirement since this is not a welded application.

2. Hinge Arm - P/N 9 per GPE Drawing BD-0240-0030

   The original hinge arm was fabricated from a "nodular iron" material. In light of the potential impact loading, it was recommended that the hinge arm be replaced by a similar item fabricated from a more ductile material. A316 stainless steel would provide greater strength, ductility and corrosion resistance. Design loads for a new hinge arm were defined from the dynamic analysis.

3. Hinge Arm-to-Pallet Bolts - Item 37 on GPE Drawing BD-0240-0030

   The original bolts utilized in this application were mild steel. Continued use of these bolts in combination with a stainless steel hinge arm could result in accelerated corrosion due to galvanic action. A 400-series stainless steel replacement was recommended, but a 300-series stainless would be acceptable with a controlled torque preload to minimize steady state stress in the bolt. A design tensile load for the bolt was calculated. Also, in light of GE service information letter 321, a positive locking feature was recommended to preclude nut loosening under impactive loading.

4. Hinge Bushing and Associated Sleeving, P/Ns 11 and 54 per GPE Drawing BD-0240-0030

   The GPE design incorporated an eccentric aluminum bushing in combination with a teflon sleeve to provide the rotational interface between the hinge arm and shaft and to allow pallet-to-seat alignment. Because of slippage problems that have occurred with this design, it was recommended that the assembly be modified to incorporate a concentric bushing with alignment adjustment provided by other means. Design loads for the hinge bushing were derived from the hinge arm analysis noted in item 2 above.

5. Hinge Pin - P/N 10 per GPE Drawing BD-0240-0030

The original hinge pin was fabricated from 303 stainless steel. To provide greater strength and hardness it was recommended that 410 stainless steel be utilized for a replacement shaft. Design loads were again derived from the hinge arm analysis per item 2 in this summary. It was also recommended that the redesign of hinge pin retainers incorporate a positive locking feature to preclude loosening.

6. Pallet Gasket - P/N 12 per GPE Drawing BD-0240-0030

Previously, the potential for gasket foldover with subsequent damage from pallet impact had been identified as a concern for the GPE vacuum breaker. For the TVA unit, it was determined that gasket foldover can be precluded if: (1) assurance is provided that the gasket to pallet cement bond is intact and (2) the gasket retainer ring is properly installed with positive locking fasteners.

3.0 SUMMARY OF MODIFICATIONS

Design modifications are being made to the 18-inch GPE vacuum breaker valves in order to comply with criteria resulting from the dynamic analysis. The following is a summary of the modifications which are depicted in figure 3.1.

Hinge Arms

Each existing nodular iron hinge arm was replaced with one made of type 316 stainless steel. This material was chosen for its enhanced corrosion resistance characteristics as well as increased strength and ductility.

Using loads provided from the dynamic analysis, stresses were calculated for the new part at the hinge pin hole and the bolt holes. These stresses were found to be well below the allowable stress for ASTM A240 Tp 316 plate material as given in ANSI/ASME B31.1, 1980 Edition.

Hinge Pins

The existing 303 stainless steel pins were replaced with 410 stainless steel in order to provide greater strength and hardness.

The threaded end of the pin was staked after assembly to prevent loosening of the retaining nut.

Using loads from the dynamic analysis, stresses in the pin were calculated to be well below the allowable stress for ASTM A193 GR B6 material as given in ANSI/ASME B31.1, 1980 Edition.

Hinge Bushing

The existing teflon sleeved eccentric aluminum bushing was replaced with a concentric solid brass bushing. This material was chosen for its self-lubricating and corrosion resistance properties. Also, the pin-bushing combination affords maximum resistance to galling. The alignment adjustment capability afforded by the eccentric bushing is now provided by shimming under the hinge arm to obtain pallet-to-seat alignment within 0.003 inch.

Using loads from the dynamic analysis, bearing stresses were calculated for the bushing which are well below allowable stresses for free machining yellow brass.

Hinge Arm to Pallet Bolts

The existing mild carbon steel bolts were replaced with bolts made of ASTM A193 GR B6, which is a 410 stainless steel material.

Using loads from the dynamic analysis, bolting stresses were calculated and found to be much less than ANSI/ASME B31.1 (1980 Edition) allowable stresses for this material. An initial torque was specified which is sufficient to provide for a friction fit between the pallet and hinge arm which will not allow slippage. The threads were staked after torquing to prevent loosening.

Pallet Gasket

The existing gasket retaining ring threaded fasteners were secured after assembly by staking the threads. In addition to this, existing assembly procedures require that the gasket be secured to the pallet using plant approved gasket cement.

LIST OF REFERENCES

1. "USNRC Generic Letter 83-08, Modification of Vacuum Breakers on Mark I Containment," February 2, 1983.

2. Status Report, GPE Wetwell to Drywell Vacuum Breaker Modification, NUTECH Report MK1-05-002, July 1981.

3. GPE Vacuum Breaker Modification Program Phase II Final Report, NUTECH Report MK1-05-045, October 1982.

4. Sullivan, J. M., Mark I Vacuum Breaker Improved Valve Dynamic Model, C.D.I Technical Note 82-31, August 1982.

5. Mark I Wetwell to Drywell Vacuum Breaker Load Methodology, C.D.I Report No. 84-3, February 1984.

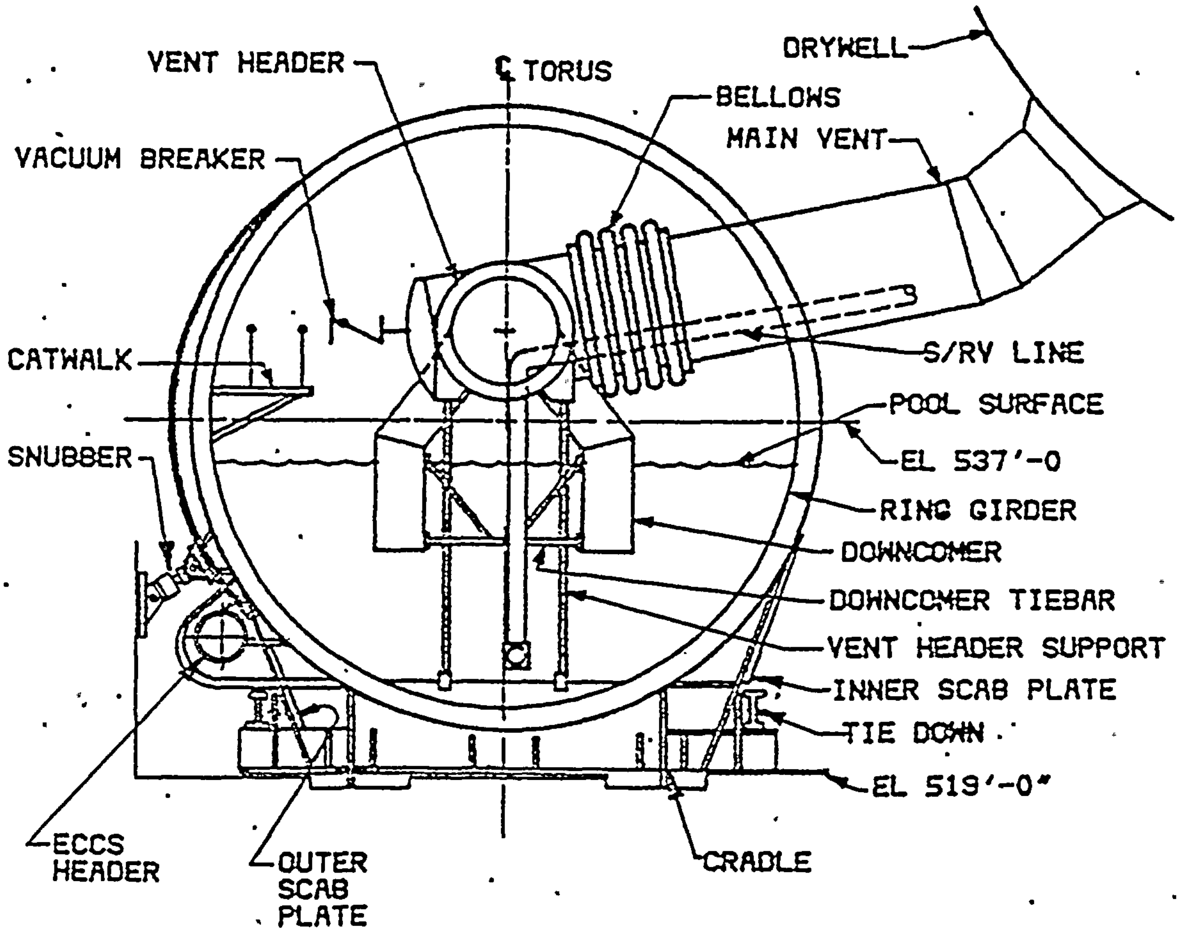

FIGURE 1.1
CROSS SECTION OF THE TORUS

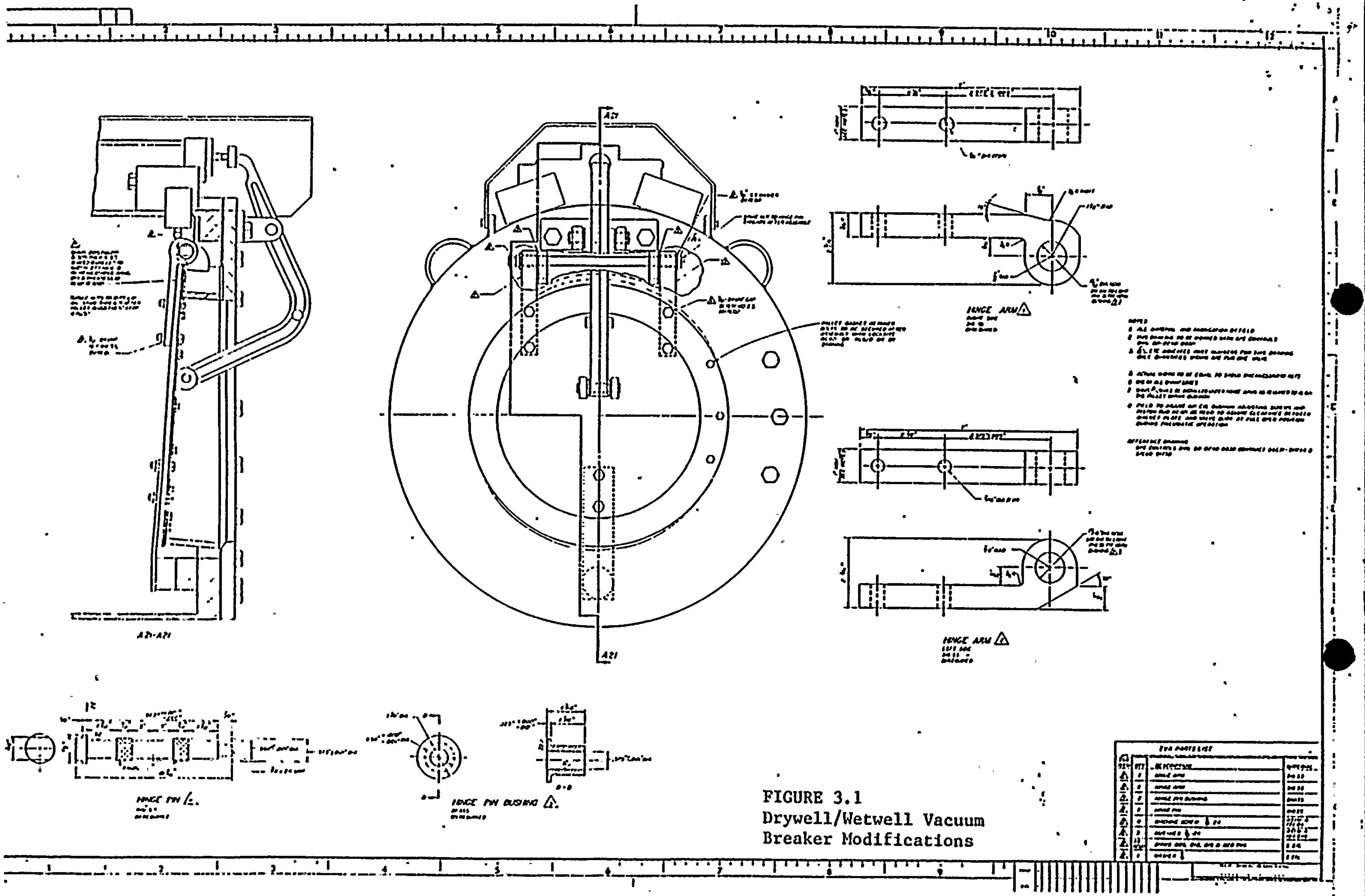

FIGURE 3.1
Drywell/Wetwell Vacuum Breaker Modifications