ILLINOIS POWER COMPANY

U-0558
L30-82(09-30)L
500 SOUTH 27TH STREET, DECATUR, ILLINOIS 62525
September 30, 1982

Mr. Cecil O. Thomas, Chief
Standardization & Special Projects Branch
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Reference: Clinton SER Confirmatory Issue #14

Dear Mr. Thomas:

Clinton Power Station Unit 1
Docket No. 50-461

This is in response to the referenced SER confirmatory issue which required an analysis to verify that the feedwater check valves will maintain leaktight integrity under all loading conditions. The attached analysis summary shows that the feedwater check valves will withstand the worst case loadings without losing their pressure boundary integrity. This information should close out the referenced SER issue.

Sincerely,

G. E. Wuller
G. E. Wuller
Supervisor-Licensing
Nuclear Station Engineering

GEW/ja

cc: J. H. Williams, NRC Clinton Project Manager
D. Terao, NRC Mechanical Engineering Branch
H. H. Livermore, NRC Resident Inspector
Illinois Department of Nuclear Safety

B001

ANALYSIS OF THE CLINTON FEEDWATER CHECK VALVES

I - Introduction

The 18 and 20 inch Anchor/Darling check valves (1B21-F010A/B and 1B21-F032A/B respectively) are designed to direct the flow of feedwater so that the flow is towards the reactor core. This is necessary to maintain a minimum amount of water in the core to remove the heat of fission.

Flow may reverse if there is a pressure drop in the feedwater lines (Clinton piping subsystems 1FW02JA-18/JB-18 (inside containment) and 1FW02KA-20/KB-20 (outside containment)). This may occur due to the loss of the Feedwater Pumping System and/or a rupture of the feedwater lines.

The most serious occurrence of these events may be due to an earthquake induced Loss of Coolant Accident (LOCA). The closing action due to a LOCA pipe rupture may subject the valve body, disk and ring seat to extremely high impact loads. A concern was raised by the NRC on the structural integrity of these valves, since some plastic deformation may occur during such an extreme loading event.

A study was conducted to determine the extent of plastic deformation and check whether the valves would maintain their structural integrity. The methodology, assumptions, results and conclusions are contained herein.

II - Methodology

To limit the amount of analysis, a bounding case was set up using the highest valve closure loads and the 'worst case' valve.

The disk closure velocities and impact energies were first calculated (see Ref. #1). Based on this analysis, it was determined that the

18 inch valves (1B21-F010A/B) would experience the higher velocities, and therefore the higher impact energy.

Due to the high degree of similarity between the 18 and 20 inch valves, a parametric investigation was conducted to determine the 'worst case valve'. Using classical thick shell theory, a hand calculation verified that the 20 inch valve would experience higher stresses per unit load in the critical valve regions (i.e. valve body/ring seat/disk region) than the 18 inch valve. (See Ref. #2).

A finite element model was developed for the 20 inch valve, using the impact energy determined for the 18 inch valve (see Assumptions below). The model consists of two-dimensional axisymmetric finite elements (see Fig. #1). The majority of elements were centered at the ring seat/valve body interface where the highest stress gradients occur. The computer analysis was performed using the computer code 'ADINA' (S&L Prog. #ADI09.7.199-1.0). The procedure utilized is a strain energy approach which consisted of applying a pressure load at the disk/ring seat interface (see Fig. #2). The applied pressure for the first case was set equal to and for the second case slightly higher than the yield stress of the material; this is the highest pressure the surface can support. The stresses were then examined to determine which elements were undergoing plastic deformation. The total volume of material undergoing plastic flow (i.e. the plastic work) was then compared with and shown to be greater than the amount of impact energy required to be dissipated during disk closure.

III - Assumptions

(1) The HYTRAN analysis predicts (Ref. #1, pg. 7), that the 20 inch valves (1B21F032A/B) will not close initially, due to the "vacuum" created by

the closing of the 18 inch valves. It is assumed that any subsequent closure of the 20 inch valves would involve a smaller disk velocity.

(2) The higher disk velocity of the 18 inch valve will produce higher impact energy than the slightly heavier 20 inch valve disk. This is because the impact energy is roughly proportional to the square of the angular velocity, whereas the impact energy is linearly proportional to the mass.

IV - Results

The valve must resist an impact force of approximately 36,400 lb-in of kinetic energy. Based upon the procedure outlined above, the valve body/ring seat interface can absorb approximately 75,000 lb-in of energy. Plastic deformation due to this impact force occurs in a highly localized region (see Fig. #3).

V - Conclusions

This analysis is based upon a 'worst case' qualification for the valve. The analysis shows that the amount of plastic deformation will not produce gross failure of the valve and ring seat.

References

(1) "Analysis of Check Valve Closure Due to Feedwater Line Break"; EMD File No. EMD-037055, Rev. 00, 6-8-82; 'HYTRAN' Analysis used to provide loads for valve analysis.

(2) CQD File No. CQD-003238, Rev. 00, Analysis of 18" and 20" Feedwater Check Valves 1B21-F010A/B & 1B21-F032A/B.

FIG. 1

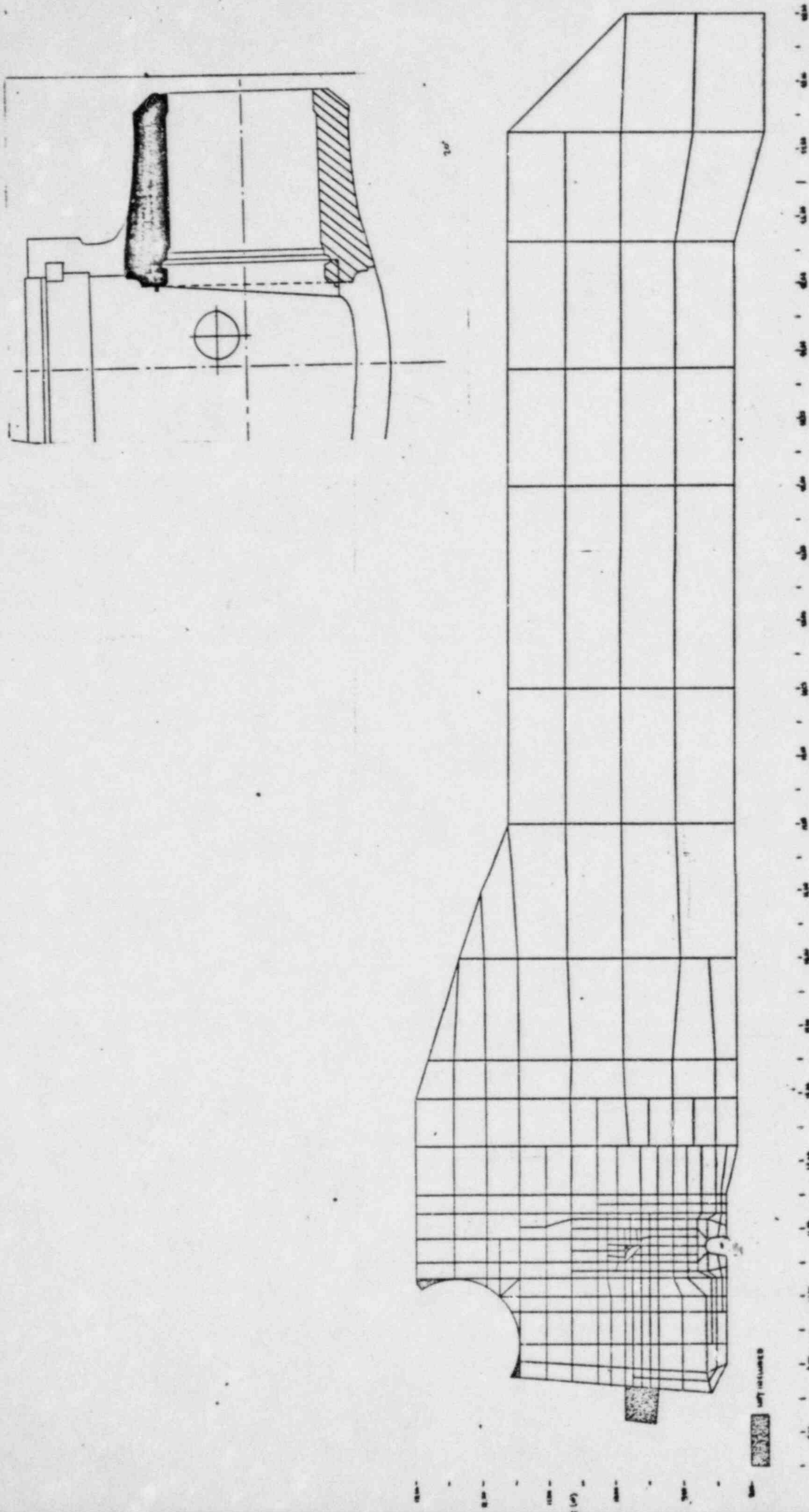
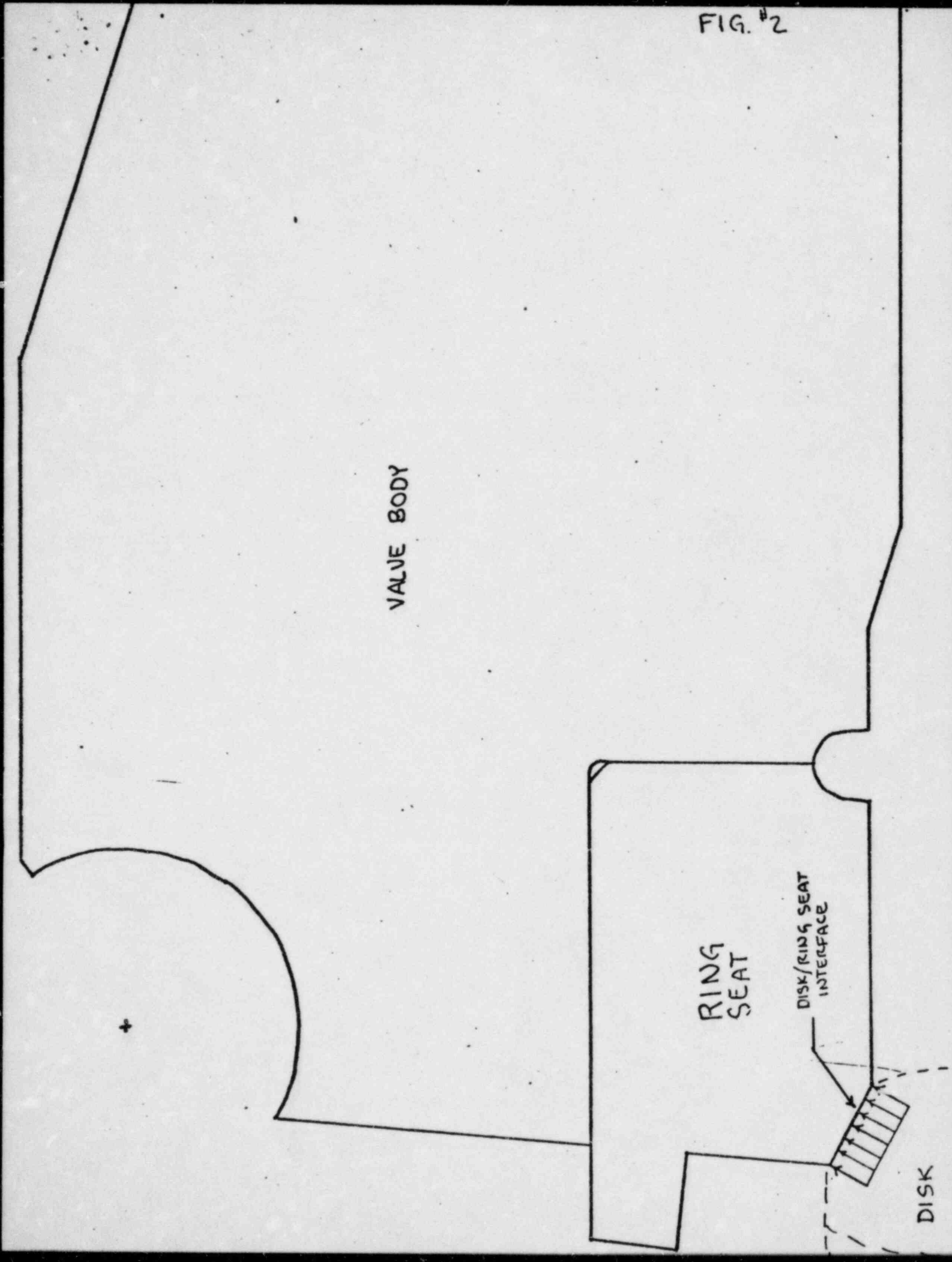


FIG. #2



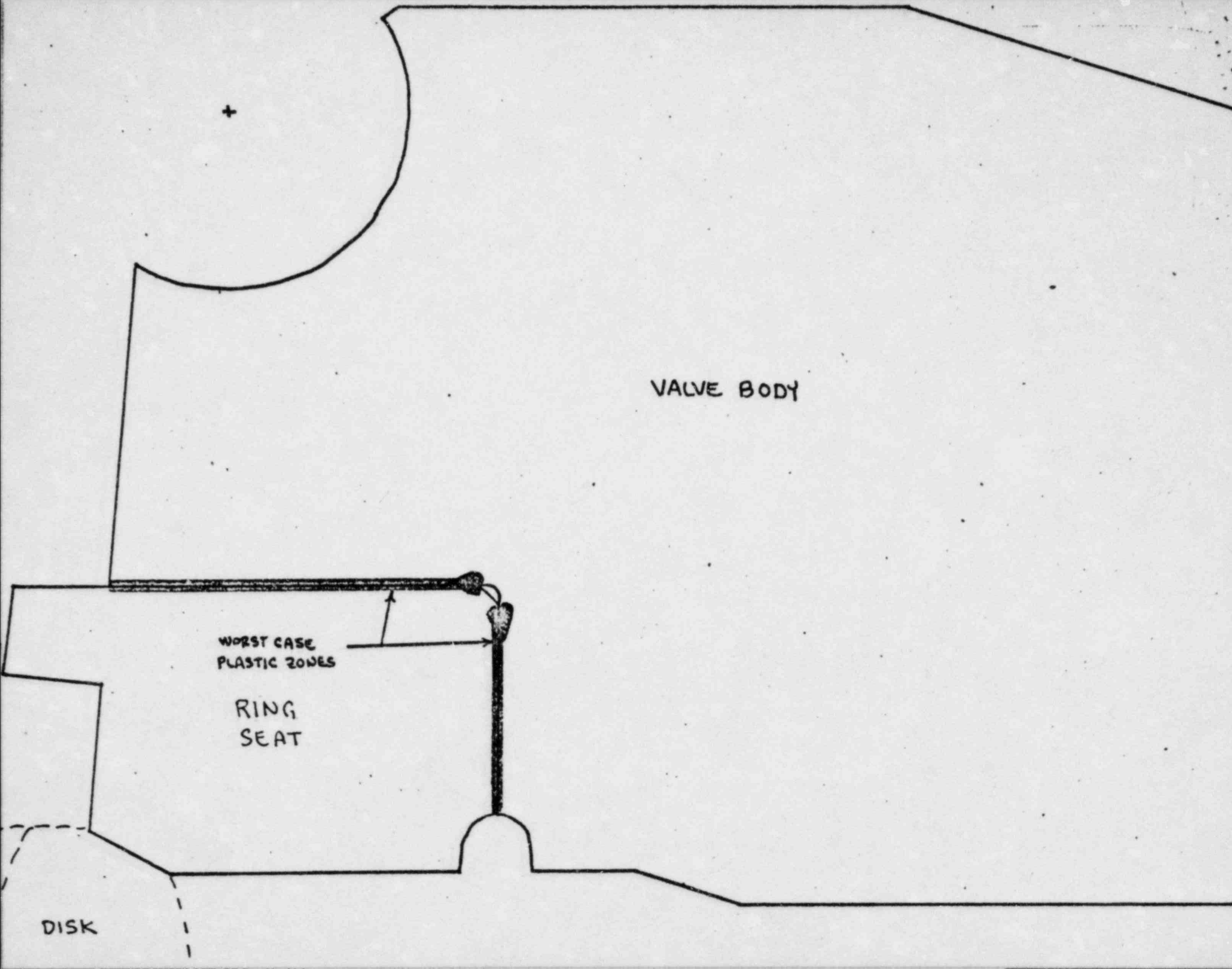


FIG. #3