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RECORD OF REVISIONS

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0108-0236-01	J Hibbard	R Robinson for R.B. Keating	

Revision	Affected Pages	Description
0	All	Initial Issue

Note: *The revision number found on each individual page of the calculation carries the revision level of the calculation in effect at the time that page was last revised.*

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1.0 PURPOSE

This calculation documents the size hole that can be tolerated in the Salem Unit 1 ITT 4-inch Nuclear Diaphragm Valve.

The analysis is conducted in accordance with the 1971 ASME Code, Section III, Subsection NB, with addenda through Winter 1971. Allowable stresses are for a Class 3 component.

2.0 SUMMARY

If reinforcement available in the valve body wall is considered due to a wall thickness thicker than required to meet minimum wall thickness requirements, then a postulated hole as large as:

$$d_{hole} = 0.75\ in$$

is permissible.

The margin, which is defined as the available reinforcement divided by the required reinforcement is:

$$M_{reinf\_a} = 6.4 \qquad M_{reinf\_b} = 9.3$$

The two margins are for the two requirements of the code, i.e., that 100% of the required reinforcement is to be within the distance L_{par1} from the axis of the opening, and that 2/3 of the required reinforcement is to be within the distance L_{par2} from the axis of the opening.

For information, the minimum size opening in the valve body adjacent to the valve body flange that does not require reinforcement is:

$$d_{open\_min} = 0.15\ in$$

3.0 Inputs

$P := 200psig$		Design pressure (Ref. 2, Note 3)
$T_{des} := 160F$		Design temperature (Ref. 2, Note 3)
$S := 0.8 \cdot 16.5ksi$	$S = 13.2ksi$	Design stress intensity for SA-351, Grade CF8M at 200°F, which bounds the design temperature; a casting factor of 0.8 is applied, which is the lowest value in Ref. 1, Table I-7.2, Note 4 (Ref. 1, Table I-7.2 for design stress intensity and Ref. 2 for material)
$t_{wall} := 0.25in$		Minimum thickness of valve body (Ref. 2, Note 6)
$d_o := 4.5 \cdot in$		Approximate outside diameter of valve; based on OD of 4" sch. 40 pipe (Ref. 3)
$r_m := \frac{d_o - t_{wall}}{2}$	$r_m = 2.13in$	Mean radius of valve body
$d_{hole} := 0.75 \cdot in$		Postulated hole diameter in valve body at the approximate location of the valve flange

4.0 Calculation

4.1 Minimum Wall Thickness

Per NB-3332.2, the required area of reinforcement is based on the required thickness of the valve body at the location in the absence of an opening. Per NB-3324.1, these required thickness is:

$$t_r := \frac{P \cdot d_o}{2(S + 0.5 \cdot P)} \qquad t_r = 0.0338\,in$$

where $P = 200\,psi$

$d_o = 4.5\,in$

$S = 13.2\,ksi$

4.2 Reinforcement of Opening

Openings meeting the requirements of NB-3332.1 do not require reinforcement. The maximum opening diameter not requiring reinforcement is:

$$d_{open\_min} := 0.2\sqrt{r_m \cdot t_{wall}} \qquad d_{open\_min} = 0.146\,in$$

where $r_m = 2.13\,in$

$t_{wall} = 0.25\,in$

4.3 Required Area of Reinforcement

The required area of reinforcement for an opening is defined by NB-3332.2:

$$A_{reinf\_req} := d_{hole} \cdot t_r \qquad A_{reinf\_req} = 0.0254\,in^2$$

where $d_{hole} = 0.75\,in$

$t_r = 0.0338\,in$

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4.4 Limits of Reinforcement

NB-3334.1 provides the distance from an opening within which 100% of the required reinforcement is to be located parallel to the vessel wall. NB-3334.1 also provides the distance from an opening within which 2/3 of the required reinforcement is to be located parallel to the vessel wall. These parallel distances (L_{par1} and L_{par2}, respectively) are calculated below. A corrosion allowance is not included in these calculations since the material is stainless steel.

$$L_{par1} := max\left(d_{hole}, \frac{d_{hole}}{2} + t_{wall}\right) \qquad L_{par1} = 0.750\,in$$

where $d_{hole} = 0.75\,in$

$t_{wall} = 0.25\,in$

$$L_{par2} := \frac{d_{hole}}{2} + 0.5\cdot\sqrt{r_m \cdot t_{wall}} \qquad L_{par2} = 0.739\,in$$

where $d_o = 4.5\,in$

$r_m = 2.13\,in$

4.5 Metal Available for Reinforcement

Per NB-3335, valve body metal available for reinforcement is that which is in excess of the minimum required wall thickness. The metal parallel to the vessel wall that is available for reinforcement based on NB-3334.1 is:

$$A_{par1} := \left(2L_{par1} - d_{hole}\right)\cdot\left(t_{wall} - t_r\right) \qquad A_{par1} = 0.162\,in^2$$

$$A_{par2} := \left(2L_{par2} - d_{hole}\right)\cdot\left(t_{wall} - t_r\right) \qquad A_{par2} = 0.158\,in^2$$

NB-3334.1 states that 100% of the required reinforcement is to be within the distance L_{par1} from the axis of the opening and that 2/3 of the required reinforcement is to be within the distance L_{par2} from the axis of the opening. The required reinforcement area is:

$$A_{reinf\_req} = 0.0254\,in^2$$

The margins of the actual to required reinforcements areas are:

$$M_{reinf\_a} := \frac{A_{par1}}{A_{reinf\_req}} \qquad M_{reinf\_b} := \frac{A_{par2}}{\frac{2}{3}A_{reinf\_req}}$$

$$M_{reinf\_a} = 6.39 \qquad M_{reinf\_b} = 9.31$$

5.0 References

1. 1971 ASME Code, Section III, Nuclear Power Plant Components, with addenda through Winter of 1971.

2. ITT Engineered Valves Drawing No. SD-C-101869, "4" Nuclear Diaphragm Valve, H. W. O., Revision G.

3. Crane Technical Paper No. 410, "Flow of Fluids through Valves, Fittings, and Pipe, 1991.