



MPR Associates, Inc.  
320 King Street  
Alexandria, VA 22314

### RECORD OF REVISIONS

Calculation No. 0108-0236-01		Prepared By <i>J. Libbey</i>	Checked By <i>R. B. Keating</i>	Page: 2
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.



MPR Associates, Inc.  
320 King Street  
Alexandria, VA 22314

Calculation No. 0108-0236-01	Prepared By <i>J. H. [Signature]</i>	Checked By <i>R. B. Keating</i>	Page: 3 Revision: 0
---------------------------------	---	------------------------------------	------------------------

## Table of Contents

---

<b>1.0 Purpose</b> .....	<b>4</b>
<b>2.0 Summary</b> .....	<b>4</b>
<b>3.0 Inputs</b> .....	<b>5</b>
<b>4.0 Calculation</b> .....	<b>6</b>
4.1 Minimum Wall Thickness .....	6
4.2 Reinforcement of Opening.....	6
4.3 Required Area of Reinforcement.....	6
4.4 Limits of Reinforcement.....	7
4.5 Metal Available for Reinforcement .....	7
<b>5.0 References</b> .....	<b>9</b>



MPR Associates, Inc.  
320 King Street  
Alexandria VA 22314

Prepared By:

*J. Hubbard*

Checked By:

*R. O. V. ... for  
R. B. Keating*

Calculation No.:  
0108-0236-01

Revision No.: 0

Page No.: 4

## 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:

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

is permissible.

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

$$M_{reinf\_a} = 6.4$$

$$M_{reinf\_b} = 9.3$$

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:

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



MPR Associates, Inc.  
320 King Street  
Alexandria VA 22314

Prepared By: *J. Hillard*  
Checked By: *Reviewed for R. B. Keating*

Calculation No.:  
0108-0236-01  
Revision No.: 0  
Page No.: 5

### 3.0 Inputs

$$P := 200 \text{ psig}$$

Design pressure (Ref. 2, Note 3)

$$T_{des} := 160F$$

Design temperature (Ref. 2, Note 3)

$$S := 0.8 \cdot 16.5 \text{ ksi}$$

$$S = 13.2 \text{ ksi}$$

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)

$$t_{wall} := 0.25 \text{ in}$$

Minimum thickness of valve body (Ref. 2, Note 6)

$$d_o := 4.5 \text{ in}$$

Approximate outside diameter of valve; based on OD of 4" sch. 40 pipe (Ref. 3)

$$r_m := \frac{d_o - t_{wall}}{2}$$

$$r_m = 2.13 \text{ in}$$

Mean radius of valve body

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

Postulated hole diameter in valve body at the approximate location of the valve flange



MPR Associates, Inc.  
320 King Street  
Alexandria VA 22314

Prepared By: *J. Libbard*

Checked By: *R. B. Keating*

Calculation No.:  
0108-0236-01

Revision No.: 0

Page No.: 6

## 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:

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

where  $P = 200 \text{ psi}$

$d_o = 4.5 \text{ in}$

$S = 13.2 \text{ ksi}$

### 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:

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

where  $r_m = 2.13 \text{ in}$

$t_{wall} = 0.25 \text{ in}$

### 4.3 Required Area of Reinforcement

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

$$A_{rein\_req} := d_{hole} \cdot t_r \quad A_{rein\_req} = 0.0254 \text{ in}^2$$

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

$t_r = 0.0338 \text{ in}$



MPR Associates, Inc.  
320 King Street  
Alexandria VA 22314

Prepared By: *JL Hibbard*

Checked By: *Revellman Ar*  
*R B Keating*

Calculation No.:  
0108-0236-01

Revision No.: 0

Page No.: 7

#### 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.

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

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

$t_{wall} = 0.25 \text{ in}$

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

where  $d_o = 4.5 \text{ in}$

$r_m = 2.13 \text{ in}$

#### 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:

$$A_{par1} := (2L_{par1} - d_{hole}) \cdot (t_{wall} - t_r) \quad A_{par1} = 0.162 \text{ in}^2$$

$$A_{par2} := (2L_{par2} - d_{hole}) \cdot (t_{wall} - t_r) \quad A_{par2} = 0.158 \text{ in}^2$$

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:

$$A_{rein\_req} = 0.0254 \text{ in}^2$$



MPR Associates, Inc.  
320 King Street  
Alexandria VA 22314

Prepared By: *J. L. Hibbard*

Checked By: *Reviewed for  
R. B. Keating*

Calculation No.:  
0108-0236-01

Revision No.: 0

Page No.: 8

The margins of the actual to required reinforcements areas are:

$$M_{\text{reinf}_a} = \frac{A_{\text{par1}}}{A_{\text{reinf}_\text{req}}}$$

$$M_{\text{reinf}_b} = \frac{A_{\text{par2}}}{\frac{2}{3} A_{\text{reinf}_\text{req}}}$$

$$M_{\text{reinf}_a} = 6.39$$

$$M_{\text{reinf}_b} = 9.31$$



MPR Associates, Inc.  
320 King Street  
Alexandria VA 22314

Prepared By: *J. Hillman*

Checked By: *Reviewed for  
R.E. Keating*

Calculation No.:  
0108-0236-01

Revision No.: 0

Page No.: 9

## 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.