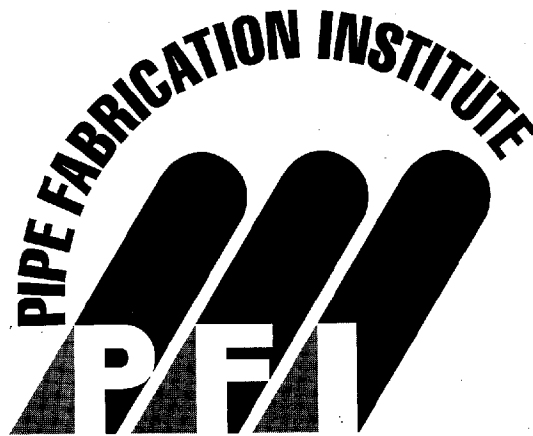


# Branch Reinforcement Work Sheets

*Prepared by*  
*Pipe Fabrication Institute Engineering Committee*



All PFI Standards are advisory only. There is no agreement to adhere to any PFI Standard and their use by anyone is entirely voluntary.

*Copyright by*  
**PIPE FABRICATION INSTITUTE**  
*Dedicated to Technical Advancement and Standardization in  
the Pipe Fabrication Industry*  
*Since — 1913*

P. O. Box 173     •     Springdale, PA 15144

|                        |        |        |
|------------------------|--------|--------|
| DESIGN CONDITIONS..... | psi    | F      |
|                        | HEADER | BRANCH |
| NOMINAL SIZE           |        |        |
| OUTSIDE DIAMETER       | $D_h$  | $D_b$  |
| NOMINAL WALL           |        |        |
| ACTUAL OR MIN. WALL    | $T_h$  | $T_b$  |
| MATERIAL SPEC.         |        |        |
| ALLOWABLE STRESS       | $S_h$  | $S_b$  |
| JOINT EFFICIENCY       | $E_h$  | $E_b$  |
| Y FACTOR               | $Y_h$  | $Y_b$  |
| ADDITIONAL THICKNESS   | $A_h$  | $A_b$  |
| *INTERSECTION ANGLE    | B      |        |

\* Angle to be 45° to 90° inclusive (see B31.1 Para. 104.3.1(A))

REQUIRED MINIMUM THICKNESS:

$$t_h = \frac{PD_{oh}}{2S_hE_h + 2Y_hP} + A_h = \frac{\dots X \dots}{2X \dots X \dots + 2X \dots X \dots} + \dots = \dots$$

$$t_b = \frac{PD_{ob}}{2S_bE_b + 2Y_bP} + A_b = \frac{\dots X \dots}{2X \dots X \dots + 2X \dots X \dots} + \dots = \dots$$

LIMITS OF REINFORCEMENT:

$$d_1 = \frac{D_{ob} - 2T_b}{\sin B} = \dots - 2X \dots = \dots$$

$$d_2 = d_1 \text{ or } T_b + T_h + 0.5d_1 = \dots + \dots + 0.5x \dots = \dots$$

Select larger of the values, but not to exceed  $D_h$   $d_2 = \dots$

$$L = 2.5 T_b + t_e = 2.5x \dots + \dots = \dots \text{ or } 2.5 T_h \text{ SELECT SMALLER OF THE VALUES}$$

REQUIRED AND AVAILABLE REINFORCEMENT AREA:

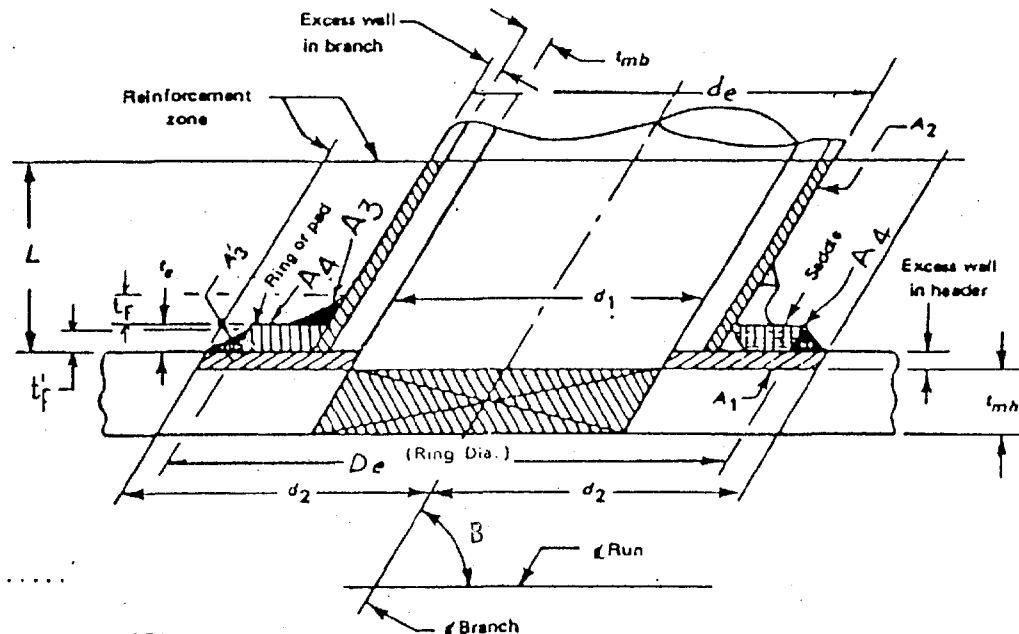
$$\text{Area} = t_{mh} d_1 (2 - \sin B) = \dots X \dots X (2 - \dots) = \dots \text{ SQ. IN. REQUIRED}$$

$$A_1 = (2d_2 - d_1)(T_h - t_{mh}) = (2x \dots) (\dots) = \dots$$

$$A_2 = \frac{2L(T_b - t_{mb})}{\sin B} = 2x \dots (\dots) = \dots$$

$$A_3 = (t_f)^2 = (\dots)^2 = \dots$$

$$A_1 + A_2 + A_3 = \dots + \dots + \dots = \dots \text{ sq. in. available. Additional Required: Yes } \square \text{ No } \square$$



Required reinforcement area



Area A1 - Excess wall in header



Area A2 - Excess wall in branch



Area A3 & A3' - fillet weld metal



Area A4 - metal in ring, pad or integral reinforcement

ADDITIONAL REINFORCEMENT:

$$A'_3 = (t'_f)^2 = (\dots)^2 = \dots$$

$$d_e = \frac{D_b}{\sin B} = \dots = \dots$$

$$A_4 = (D_e - d_e) t_e = (\dots) \times \dots = \dots$$

$$(A_1 + A_2 + A_3) + A'_3 + A_4 =$$

$$= \dots + \dots + \dots = \dots$$

Additional reinforcement adequate: Yes ☐ No ☐

CALC. BY \_\_\_\_\_  
 DATE \_\_\_\_\_

CH. BY \_\_\_\_\_  
 DATE \_\_\_\_\_

APP. BY \_\_\_\_\_  
 DATE \_\_\_\_\_

ORDER # \_\_\_\_\_ FOR \_\_\_\_\_  
 LOCATION \_\_\_\_\_ SYSTEM \_\_\_\_\_

Nozzle Reinforcement  
 Worksheet W S1-B  
 ASME B 31.1  
 Revised 1995



|                        |                 |                 |
|------------------------|-----------------|-----------------|
| DESIGN CONDITIONS..... | psi .....       | F .....         |
|                        | HEADER          | BRANCH          |
| NOMINAL SIZE           |                 |                 |
| OUTSIDE DIAMETER       | D <sub>oh</sub> | D <sub>ob</sub> |
| NOMINAL WALL           |                 |                 |
| ACTUAL OR MIN. WALL    | T <sub>h</sub>  | T <sub>b</sub>  |
| MATERIAL SPEC.         |                 |                 |
| ALLOWABLE STRESS       | S <sub>h</sub>  | S <sub>b</sub>  |
| JOINT EFFICIENCY       | E <sub>h</sub>  | E <sub>b</sub>  |
| Y COEFFICIENT          | Y <sub>h</sub>  | Y <sub>b</sub>  |
| ADDITIONAL THICKNESS   | C <sub>h</sub>  | C <sub>b</sub>  |
| INTERSECTION ANGLE     | B               |                 |

REQUIRED MINIMUM THICKNESS:

$$t_h = \frac{PD_{oh}}{2S_hE_h + 2Y_hP} = \frac{X}{2X \dots X + 2X \dots X} = \dots$$

$$t_b = \frac{PD_{ob}}{2S_bE_b + 2Y_bP} = \frac{X}{2X \dots X + 2X \dots X} = \dots$$

LIMITS OF REINFORCEMENT:

$$d_1 = \frac{D_{ob} - 2(T_b - C_b)}{\sin B} = \dots - 2X(\dots - \dots) = \dots$$

$$d_2 = d_1 \text{ or } (T_b - C_b) + (T_h - C_h) + 0.5d_1 = \dots + \dots + 0.5x \dots = \dots$$

Select larger of the values, but not to exceed D<sub>oh</sub>      d<sub>2</sub> = .....

$$L_4 = 2.5(T_h - C_h) = 2.5x(\dots) \text{ or } 2.5(T_b - C_b) + t_e = 2.5(\dots) + \dots$$

Select lesser of the values (t<sub>e</sub> = 0 if pad or saddle is not used) L<sub>4</sub> = .....

REQUIRED AND AVAILABLE REINFORCEMENT AREA:

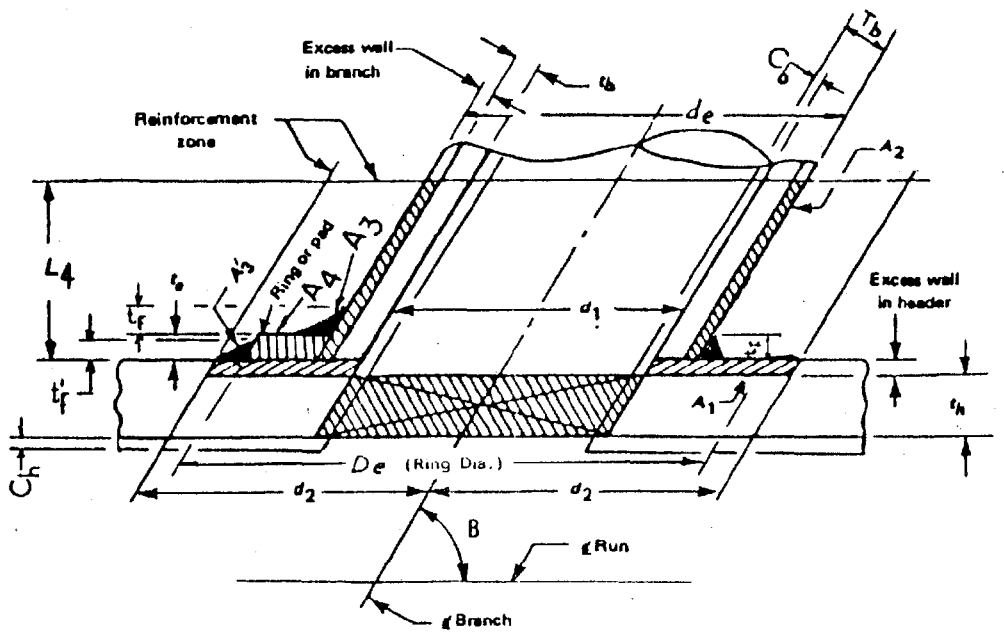
Area = t<sub>h</sub>d<sub>1</sub>(2 - sin B) = ..... X ..... X (2 - ..... ) = ..... SQ. IN. REQUIRED

A<sub>1</sub> = (2 d<sub>2</sub> - d<sub>1</sub>)(T<sub>h</sub> - t<sub>h</sub> - C<sub>h</sub>) = (2x..... - .....)(.....) = .....

$$A_2 = \frac{2L_4(T_b - t_b - C_b)}{\sin B} = \frac{2x.....(\dots - \dots - \dots)}{\dots} = \dots$$

A<sub>3</sub> = (t<sub>f</sub>)<sup>2</sup> = (.....)<sup>2</sup> = .....

A<sub>1</sub>+A<sub>2</sub>+A<sub>3</sub> = ..... + ..... + ..... = ..... sq. in. available. Additional Required: Yes ☐ No ☐



- Required reinforcement area
- Area A<sub>1</sub> - Excess wall in header
- Area A<sub>2</sub> - Excess wall in branch
- Area A<sub>3</sub> & A<sub>3'</sub> - fillet weld metal
- Area A<sub>4</sub> - metal in ring or pad

ADDITIONAL REINFORCEMENT:

A'<sub>3</sub> = (t'<sub>f</sub>)<sup>2</sup> = (.....)<sup>2</sup> = .....

A<sub>4</sub> = (D<sub>e</sub> - d<sub>e</sub>) x t<sub>e</sub> = (.....) x ..... = .....

$$d_e = \frac{D_{ob}}{\sin B} = \frac{\dots}{\dots} = \dots$$

(A<sub>1</sub>+A<sub>2</sub>+A<sub>3</sub>) + A'<sub>3</sub> + A<sub>4</sub> = ..... + ..... + ..... = .....

Additional reinforcement adequate: Yes ☐ No ☐

CALC. BY .....  
DATE .....

CH. BY .....  
DATE .....

APP. BY .....  
DATE .....

ORDER # ..... FOR .....  
LOCATION ..... SYSTEM .....

Nozzle Reinforcement  
Worksheet WS3  
ASME B 31.3  
Revised 1995



A current index of the latest revised ES Standards and Technical Bulletins is available from the Pipe Fabrication Institute.

PFI Standards and Technical Bulletins are published to serve proven needs of the pipe fabricating industry at the design level and in actual shop operations. Hence, such needs are continually considered and reviewed by the Engineering Committee of the Pipe Fabrication Institute to provide recommended procedures which have been demonstrated by collective experiences to fulfill requirements in a manner for Code compliance. However, as the PFI Standards are for minimum requirements the designer or fabricator always has the option of specifying supplementary conditions in the form of requirements beyond the scope of the PFI publications.