atmospheric pressure plus submerged head pressures. Because of the installation and operation, pumped fluids within the bowl and column assemblies may transfer through the flanged connections back to the fluid source. This fluid transfer does not affect the integrity of the overall pressure boundary.

Type L pumps shall be designed in accordance with the requirements of ND-3400 and with those given in (a) through (e) below. Alternatively, the configuration may be designed in accordance with Section III Appendices, Mandatory Appendix II, Design by Experimental Stress Analysis, or Section III Appendices, Mandatory Appendix XIII, Design Based on Stress Analysis.

(a) Flanged Joints. Except for flanged joints conforming to (5) below, flanged joints may be analyzed and the stresses evaluated by using methods given in Section III Appendices, Mandatory Appendix XI if of the “RF” type and in accordance with Section III Appendices, Nonmandatory Appendix L if of the “FF” type, as modified by (1) through (4) below.

(1) The Design Pressure to be used for the calculation of H in Section III Appendices, Mandatory Appendix XI or Section III Appendices, Nonmandatory Appendix L shall be replaced by the flange design pressure

\[ P_{FD} = P + P_{eq} \]  

(1)

where

- \( P \) = Design or Service Condition Pressure as defined in NCA-2140, psi (MPa)
- \( P_{eq} \) = equivalent pressure to account for the moments applied to the flange joint, psi (MPa)

The equivalent pressure \( P_{eq} \), shall be determined from the seismic and external loads acting on the flanged joint using the equation

\[ P_{eq} = \frac{KM_f}{\pi G^2} \frac{PB}{4E} \]  

(2)

where

- \( F \) = the axial load at the flange, lb (N)
- \( G \) = the diameter at the location of the gasket load reaction, in. (mm)
- \( K \) = If the loads include dynamic loads the value of this coefficient shall be 8. If the loads are static the value shall be 16.
- \( M_f \) = the resultant bending moment on the flange as taken from ND-3658, in.-lbf (N-mm)

(3) Section III Appendices, Mandatory Appendix XI, XI-3240, eq. (6) for longitudinal hub stress shall be revised to include primary axial membrane stress as follows:

\[ S_H = \frac{FM_f}{L_{R1} B} + \frac{PB}{4g_0} \]  

(3)

where \( P \) is the Design or Service Pressure as defined in NCA-2140, [psi (MPa)]. Other terms are defined in Section III Appendices, Mandatory Appendix XI, XI-3130.

(4) The allowable stress limits \( S_H, S_R, \) and \( S_T \) shall not be greater than 1.55.

(5) If the flanged joint conforms to one of the standards listed in Table NCA-7100-1 and if each \( P_{FD} \) as calculated by eq. ND-3441.9(a)(1)(1) is less than the rated pressure at the Design or Service Temperature utilized, the requirements of this subparagraph are satisfied.

(b) Head Waterway. The Design Pressure for portions of the head which form the pressure boundary between the outlet pressure and the atmosphere shall be the outlet pressure or as otherwise stated in the Design Specification. In no case shall it be less than the maximum pressure at the pump outlet under any Service Condition. The minimum thickness of the head waterway required for Design Pressure and for temperatures not exceeding those for various materials in Section II, Part D, Subpart 1, Tables 1A and 1B shall be not less than that determined by the equation

\[ t_m = \frac{PD_{Do}}{2(Se + Py)} + A \]  

(4)

where

- \( A \) = corrosion or erosion allowance as specified by the Design Specification. If both surfaces are wetted, the corrosion allowance must be applied to both surfaces.
- \( D_o \) = the outside diameter of the head waterway, in. (mm)
- \( d \) = inside diameter of the head waterway, in. (mm)
- \( E \) = the joint efficiency for the type of longitudinal joint used, as given in ND-3350 or casting quality factor as given in the notes to Section II, Part D, Subpart 1, Tables 1A and 1B
- \( S \) = the allowable stress for the material at the design temperature (Section II, Part D, Subpart 1, Tables 1A and 1B), psi (MPa)
- \( t_m \) = minimum required wall thickness of the head waterway in its finished form, in. (mm)
- \( y = 0.4 \) for \( D_o/t_m \geq 6.0 \)
- \( \frac{d}{d + D_o} \) for \( D_o/t_m < 6.0 \)