3.6 THROUGH-WALL FLAWS IN GATE VALVE BODY ENDS

Through-wall flaws in gate valve body ends, as shown in Figure 9, may be evaluated using the straight pipe procedures given in 3.1 or 3.2(d). The pipe wall thickness used in the evaluation shall not exceed the wall thickness of the attached piping. Evaluation of flaws in the gate valve body beyond the valve body ends is outside the scope of this Case.

3.7 FLAW GROWTH EVALUATION

If a flaw growth analysis is performed, the growth analysis shall consider both corrosion and crack-growth mechanisms as relevant to the application.

In performing a flaw growth analysis, the procedures in Article C-3000 may be used as guidance. Relevant growth rate mechanisms shall be considered. When stress corrosion cracking (SCC) is active, the following growth rate equation shall be used:

$$da/dt = S_T C K_{max}^n \tag{17}$$

where da/dt is flaw growth rate in inches/hour, K_{max} is the maximum stress intensity factor under long-term steady state conditions in ksi in.$^{0.5}$, S_T is a temperature correction factor, and C and n are material constants.

For intergranular SCC in austenitic steels, where $T \le 200°F$ (93°C).

$C = 1.79 \times 10^{-8}$
$n = 2.161$
$S_T = 1$

For transgranular SCC in austenitic steels, where $T \le 200°F$ (93°C).

$C = 1.79 \times 10^{-7}$
$n = 2.161$
$S_T = 3.71 \times 10^8 \left[10^{(0.01842\ T\ -\ 12.25)}\right]$

The temperature, T, is the metal temperature in degrees Fahrenheit. The flaw growth rate curves for the above SCC growth mechanisms are shown in Figures 10 and 11. Other growth rate parameters in eq. (17) may be used, provided they are supported by appropriate data.

3.8 NONFERROUS MATERIALS

For nonferrous materials, nonplanar and planar flaws may be evaluated following the general approach of 3.1 through 3.7. For planar flaws in ductile materials, the approach given for austenitic pipe may be used; otherwise, the approach given for ferritic pipe should be applied. Structural factors provided in 4 shall be used. It is the responsibility of the evaluator to establish conservative estimates of strength and fracture toughness for the piping material.

4 ACCEPTANCE CRITERIA

Piping containing a circumferential planar flaw is acceptable for temporary service when flaw evaluation provides a margin using the structural factors in Nonmandatory Appendix C, C-2621. For axial planar flaws, the structural factors for temporary acceptance are as specified in Nonmandatory Appendix C, C-2622. Straight pipe containing a nonplanar part through-wall flaw is acceptable for temporary service if the remaining pipe section meets the longitudinal stress limits in the design Code for the piping and $t_p \ge t_{aloc}$, where t_{aloc} is determined from 3.2(b). Straight pipe containing a nonplanar part through-wall flaw is acceptable for temporary service when the flaw conditions of 3.2(c) or 3.2(d) are satisfied. An elbow or pipe bend containing a nonplanar through-wall flaw is acceptable for temporary service if the flaw conditions of 3.3 are satisfied. A reducer or expander containing a nonplanar through-wall flaw is acceptable for temporary service if the flaw conditions of 3.4 are satisfied. A branch tee containing a nonplanar through-wall flaw is acceptable for temporary service if the flaw conditions of 3.5 are satisfied. A gate valve body containing a through-wall flaw in the valve body end is acceptable for temporary service if the flaw conditions of 3.6 are satisfied.

5 AUGMENTED EXAMINATION

An augmented volumetric examination or physical measurement to assess degradation of the affected system shall be performed as follows:

(a) From the engineering evaluation, the most susceptible locations shall be identified. A sample size of at least five of the most susceptible and accessible locations, or, if fewer than five, all susceptible and accessible locations shall be examined within 30 days of detecting the flaw.

(b) When a flaw is detected, an additional sample of the same size as defined in (a) shall be examined.

(c) This process shall be repeated within 15 days for each successive sample, until no significant flaw is detected or until 100% of susceptible and accessible locations have been examined.

6 NOMENCLATURE

a = flaw depth
B_1, B_2 = Section III primary stress indices
c = half crack length
C = coefficient in the crack growth relationship
da/dt = flaw growth rate for stress corrosion cracking
d_{adj} = diameter equivalent circular hole at t_{adj}
D_i = inside pipe diameter
d_{min} = diameter of equivalent circular hole at t_{min}
D_o = outside pipe diameter

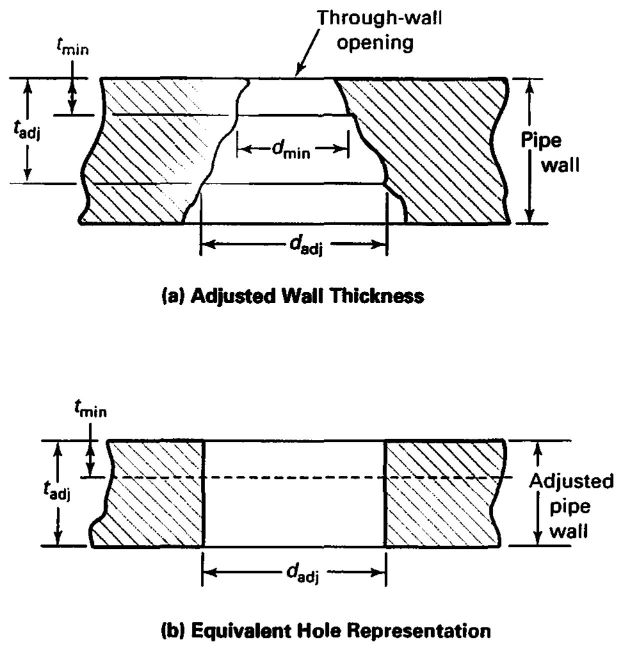
using the structural factors in Nonmandatory Appendix C, C-2621. For axial planar flaws, the structural factors for temporary acceptance are as specified in Nonmandatory Appendix C, C-2622. Straight pipe containing a nonplanar part through-wall flaw is acceptable for temporary service if the remaining pipe section meets the longitudinal stress limits in the design Code for the piping and $t_p \geq t_{aloc}$, where t_{aloc} is determined from 3.2(b). Straight pipe containing a nonplanar part through-wall flaw is acceptable for temporary service when the flaw conditions of 3.2(c) or 3.2(d) are satisfied. An elbow or bent pipepipe bend containing a nonplanar through-wall flaw is acceptable for temporary service if the flaw conditions of 3.3 are satisfied. A reducer or expander containing a nonplanar through-wall flaw is acceptable for temporary service if the flaw conditions of 3.4 are satisfied. A branch tee containing a nonplanar through-wall flaw is acceptable for temporary service if the flaw conditions of 3.5 are satisfied. A gate valve body containing a through-wall flaw in the valve body end is acceptable for temporary service if the flaw conditions of 3.6 are satisfied.

5 Augmented Examination

An augmented volumetric examination or physical measurement to assess degradation of the affected system shall be performed as follows:

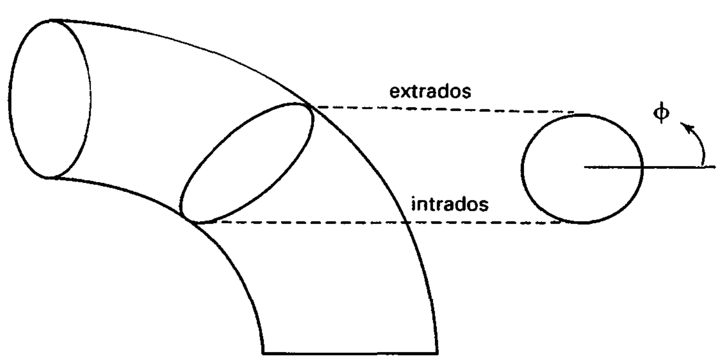
(a) From the engineering evaluation, the most susceptible locations shall be identified. A sample size of at least five of the most susceptible and accessible locations, or, if fewer than five, all susceptible and accessible locations shall be examined within 30 days of detecting the flaw.

Figure 6
Illustration of Adjusted Wall Thickness and Equivalent Hole Diameter



Nonmandatory Appendix C, C-2621. For axial planar flaws, the structural factors for temporary acceptance are as specified in Nonmandatory Appendix C, C-2622. Straight pipe containing a nonplanar part through-wall flaw is acceptable for temporary service if the remaining pipe section meets the longitudinal stress limits in the design Code for the piping and $t_p \geq t_{aloc}$, where t_{aloc} is determined from 3.2(b). Straight pipe containing a nonplanar part through-wall flaw is acceptable for temporary service when the flaw conditions of 3.2(c) or 3.2(d) are satisfied. An elbow or bent pipe containing a nonplanar through-wall flaw is acceptable for temporary service if the flaw conditions of 3.3 are satisfied. A reducer or expander containing a nonplanar through-wall flaw is acceptable for temporary service if the flaw conditions of 3.4 are satisfied. A branch tee containing a nonplanar through-wall flaw is acceptable for temporary service if the flaw conditions of 3.5 are satisfied.

Figure 7
Circumferential Angle Defined



4 ACCEPTANCE CRITERIA

Piping containing a circumferential planar flaw is acceptable for temporary service when flaw evaluation provides a margin using the structural factors in Appendix C, C-2621. For axial planar flaws, the structural factors for temporary acceptance are as specified in Appendix C, C-2622. Straight p~~P~~ip~~eing~~ containing a nonplanar part-~~—~~through-wall flaw is acceptable for temporary service if the remaining pipe section meets the longitudinal stress limits in the design Code for the piping and $t_p \geq t_{aloc}$, where t_{aloc} is determined from 3.2(b). Straight p~~P~~ipe~~ing~~ containing a nonplanar through-wall flaw is acceptable for temporary service when the flaw conditions of 3.2(c) or 3.2(d) are satisfied. An elbow or bent pipe containing a nonplanar through-wall flaw is acceptable for temporary service if the flaw conditions of 3.3 are satisfied. A reducer or expander containing a nonplanar through-wall flaw is acceptable for temporary service if the flaw conditions of 3.4 are satisfied. A branch tee containing a nonplanar through-wall flaw is acceptable for temporary service if the flaw conditions of 3.5 are satisfied.

5 AUGMENTED EXAMINATION

An augmented volumetric examination or physical measurement to assess degradation of the affected system shall be performed as follows:

(a) From the engineering evaluation, the most susceptible locations shall be identified. A sample size of at least five of the most susceptible and accessible locations, or, if fewer than five, all susceptible and accessible locations shall be examined within 30 days of detecting the flaw.

(b) When a flaw is detected, an additional sample of the same size as defined in 5(a) shall be examined.

(c) This process shall be repeated within 15 days for each successive sample, until no significant flaw is detected or until 100% of susceptible and accessible locations have been examined.

6 NOMENCLATURE

B_1, B_2 = Section III primary stress indices
C = coefficient in the crack growth relationship
D_i = inside pipe diameter
D_o = outside pipe diameter
F = nondimensional stress intensity factor for through-wall axial flaw under hoop stress
F_b = nondimensional stress intensity factor for through-wall circumferential flaw under pipe bending stress
F_m = nondimensional stress intensity factor for through-wall circumferential flaw under membrane stress
I = moment of inertia based on evaluation thickness, t
$K_{\max}$ = maximum stress intensity factor under long term steady state conditions
L = maximum extent of a local thinned area with $t < t_{nom}$
L_{axial} = length of idealized through-wall planar flaw opening in the axial direction of the pipe, as illustrated in Fig. 5
L_{circ} = length of idealized through-wall planar flaw opening in the circumferential direction of the pipe, as illustrated in Fig. 5
L_m = maximum extent of a local thinned area with $t < t_{min}$
$L_{m(a)}$ = axial extent of wall thinning below t_{min}
$L_{m(t)}$ = circumferential extent of wall thinning below t_{min}
$L_{m,avg}$ = average of the extent of L_m below t_{min} for adjacent thinned areas
$L_{m,i}$ = maximum extent of thinned area, i
M_2 = bulging factor for axial flaw
M_b = resultant primary bending moment
M_e = resultant thermal expansion moment
R = mean pipe radius
R_{bend} = elbow or bent pipe centerline bend radius
R_o = outside pipe radius
S = allowable stress at operating temperature
SF_m = structural factor on primary membrane stress
S_T = coefficient for temperature dependence in the crack growth relationship
S_u = Code-specified ultimate tensile strength
S_y = Code-specified yield strength
T = metal temperature
W_m = maximum extent of a local thinned area perpendicular to L_m with $t < t_{min}$
$X_{i,j}$ = minimum distance between thinned areas i and j
Z = load multiplier for ductile flaw extension
a = flaw depth
c = half crack length
da/dt = flaw growth rate for stress corrosion cracking
d_{adj} = diameter equivalent circular hole at t_{adj}
d_{min} = diameter of equivalent circular hole at t_{min}
h = flexibility characteristic
i = stress intensification factor
ℓ = total crack length = $2c$
ℓ_{all} = allowable axial through-wall flaw length
n = exponent in the crack growth relationship