



CLOCK SPRING®

Application Note

Repair of Cracks, Gouges, Grooves and Arc Burns

The Canadian pipeline code, Z662 and the US pipeline code ASME B31.4 require that cracks, gouges, grooves and arc burns be repaired. Both codes allow these defects to be repaired by grinding them out of the pipe. Both codes provide equations to assess the grind depth and length to determine if the grind can remain in the pipe at the design pressure of the pipeline. If the grind depth and length are greater than allowed by the code then the grind defect is assessed the same way one would assess external corrosion. The repair alternatives allowed for external corrosion are allowed for the repair of the grind defect. Clock Spring® is an approved repair alternative for these defects.

Pipeline Operators in the United States and Canada have used the provisions of the respective codes to repair cracks (including stress corrosion cracking), gouges, grooves and arc burns with Clock Spring® composite repair sleeves. It is a common repair alternative for these defects and is approved by code.

Following is a summary of the applicable codes.

Z662 Canadian Standards Association "Oil and Gas Pipeline Systems"

"10.8.5.2 Grinding Repairs

10.8.5.2.1

Grinding in accordance with the requirements of Clauses 10.8.5.2.2 to 10.8.5.2.5 inclusive shall be permissible as a permanent repair of steel pipe.

10.8.5.2.2

Grinding repair procedures shall include

(a) for arc burns, confirming complete removal of the altered metallurgical structure by etching the ground area with a 10% solution of ammonium persulphate or a 5% solution of nital;

***Note:** The effectiveness of the etchant should be periodically tested by obtaining a positive indication from an arc burn, since lower metal temperatures and the age of the etchant may adversely affect the results obtained.*

(b) for gouges, grooves and cracks, confirming complete removal of the defect by using dye penetrant or magnetic particle inspection; and

(c) measuring the wall thickness in the ground area using mechanical or ultrasonic techniques, or both, to determine that the metal loss is in accordance with the requirements of Clause 10.8.5.2.3

10.8.5.2.3

The following shall apply to ground repairs:

(a) Areas to be repaired by grinding shall be thoroughly cleaned before grinding is initiated. Grinding shall be performed to produce a smooth transition between the surface contour of the repaired area and the surrounding pipe surface.

(b) External metal loss resulting from grinding to a depth of 40% of the nominal wall thickness shall be permitted, provided that the longitudinal length of the ground area does not exceed L, as determined by the following equation:

$$L = 1.12B_t \sqrt{Dt}$$

where

L = maximum allowable longitudinal length of the metal loss area resulting from a grinding repair, mm

D = nominal outside diameter of the pipe, mm

t = nominal wall thickness of pipe, mm

B_t = a value equal to 4.0 for maximum depth up to and including 13% of the nominal wall thickness

a value determined from the following equation for maximum depths greater than 13% up to and including 40% of the nominal wall thickness:

$$B_t = \sqrt{\left(\frac{c/t}{1.1c/t - 0.11} \right)^2 - 1}$$

where

c = maximum depth of the ground area, mm

Note: The relationship between B_t and c/t is shown in Figure 10.2.

10.8.5.2.4

Pipe with areas of external metal loss that do not exceed the length limits specified in Clause 10.8.5.2.3 shall be permitted for continued service.

10.8.5.2.5

Areas of external metal loss resulting from grinding beyond the depth or length limits specified in Clause 10.8.5.2.3 shall be considered to be grind defects. Pipe containing such defects shall be repaired using one or more of the acceptable repair methods given in Table 10.1"

From Table 10.1

Grind Defects (See Clause 10.8.5.2.5.) Fiberglass Reinforcement Sleeves are approved if the defect is less than 80% of nominal wall in depth.

Composite sleeves are approved for repairing cracks, gouges, grooves or arc burns in the body of the pipe if the crack, gouge, groove or arc burn is removed by grinding and assessed as a grind repair (Table 10.1).

ASME B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids

ASME B31.4 is similar to Z662.

"451.6.2 Disposition of Defects

(a) Limits and Dispositions of Imperfections

(1) Gouges and grooves shall be removed or repaired in accordance with para. 451.6.2(b).

(2) ...

(3) All arc burns shall be removed or repaired.

(4) All cracks shall be removed or repaired.

(5) ...

(6) ...

(7) ...

(8) Areas where grinding has reduced the remaining wall thickness to less than the design thickness calculated in accordance with para. 404.1.2 decreased by an amount equal to the manufacturing tolerance applicable to the pipe or component, may be analyzed the same as localized corrosion pitting [see para. 451.6.2(a)(7)] to determine if ground areas need to be replaced, repaired, or the operating pressure reduced (see para. 451.7). ASME B31G may be used for guidance."

Paragraph 451.6.2(a)(7) gives the equations to assess the depth and length of the corrosion or grind to determine if it is acceptable or requires further repair. These equations are very similar to the equations in Z662 discussed previously.

"451.6.2(a)(7) Localized Corrosion Pitting (or ground metal loss)

Pipe shall be repaired, replaced, or operated at a reduced pressure (see para. 451.7) if localized corrosion pitting (or grind metal loss) has reduced the wall thickness to less than the design thickness calculated in accordance with para. 404.1.2, decreased by an amount equal to the manufacturing tolerance applicable to the pipe or component. This applies if the length of the pitted area (or grind metal loss) is greater than permitted by the equations shown below. The following method applies only when the depth of the corrosion pit is less than 80% of the nominal wall thickness of the pipe. This method shall not be used to evaluate corrosion concentrated in electric resistance welded seams (ERW), electric induction welded seams or electric flash-welded seams, nor shall it be used to evaluate corrosion-caused metal loss which is circumferentially oriented

along or in a girth weld or its heat-affected zone. The method may be used, however, to evaluate the longitudinal profile of corrosion-caused metal loss which crosses a girth weld or impinges on a submerged arc welded seam. The corroded area must be clean to bare metal. Care shall be taken in cleaning corroded areas of a pressurized pipeline when the degree of corrosion is significant."

$$L = 1.12B_t \sqrt{Dt}$$

Where

$$B = \sqrt{\left(\frac{c/t_n}{1.1 c/t_n - 0.15} \right)^2 - 1}$$

L = maximum allowable longitudinal extent of the corroded area as shown in Figure 451.6.2(a)(7), in mm.

B = a value not to exceed 4.0 which may be determined from the above equation or Fig. 451.6.2(a)(7)

D = nominal outside diameter of the pipe, in mm

t_n = nominal wall thickness of the pipe, in mm

c = maximum depth of corroded area, in mm"

451.6.2(b) Allowable Pipeline Repairs,

451.6.2(b)(3) If not practical to take the pipeline out of service, defects may be removed by grinding or hot tapping. Sharp imperfections may be rendered blunt by grinding, but the absence of a sharp imperfection must be verified by visual and nondestructive examination. When grinding, the ground area shall be smoothly contoured and be in accordance with para. 451.6.2(a)(8)

451.6.2(b)(7) If not practical to take the pipeline out of service, nonleaking corroded areas may be repaired by installation of a mechanically applied composite material wrap used to reinforce the pipeline in accordance with para. 451.6.2(c)(14)

451.6.2(c) Repair Methods

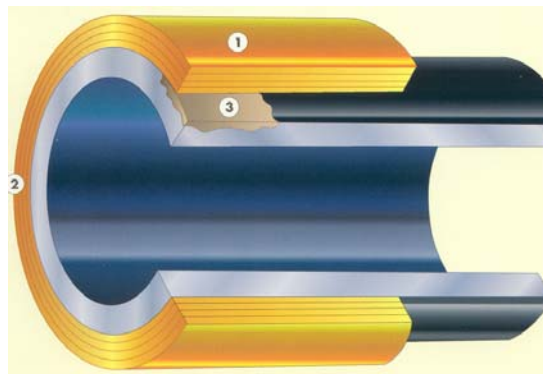
451.6.2(c)(14) Mechanically applied composite material wrap may be used to reinforce the pipeline provided that design and installation methods are proven for the intended service prior to application. The user is cautioned that a qualified written procedure performed by trained personnel is a requirement and records shall be retained in accordance with para. 455.

Note that the two codes (Z662, B31.4) allow assessment of the grind defect as metal loss. B31.4 uses the term 0.15 in the denominator of the "B" equation while Z662 uses the term 0.11 when assessing grind defects.

Both codes use the 0.15 term when assessing corrosion defects. In Z662, the value of "B" is slightly different for assessing corrosion than for grind defects. For corrosion defects, the limit of B=4 applies to defects with a depth up to and including 17.5% of nominal wall as opposed to 13% for grind defects.

Code of Federal Regulations 49 CFR Parts 192 and 195

Federal regulations governing gas and liquid pipelines in the United States changed from prescriptive language to performance based language. Federal regulation allow an operator flexibility in the method of repair but stipulate that whatever method is used must be appropriate for the defect being repaired and that the repair method must be assessed using proper engineering testing and analyses. Federal regulations also incorporate the ASME B31 codes by reference. In the US, operators will follow the guidelines outlined in the previous discussion.



Simply the smartest pipeline repair decision you can make!

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