a minimum) is used to determine an appropriate deviation from 12 hr. Areas that have been dressed by grinding to remove cracks or other stress risers shall be inspected using an NDE technique capable of detecting cracks to ensure that all cracks have been removed.

(h) Coating damaged during the repair process shall be removed and new coating applied in accordance with para. 461.1.2.

Replacement pieces of pipe, areas that are exposed for examination by removal of coating, and any appurtenances or components added for the purpose of repair shall be coated when installed in a coated line.

451.6.2 Limits and Disposition of Imperfections and Anomalies

451.6.2.1 Limits. Pipe containing leaks shall be removed or repaired.

451.6.2.2 Corrosion

(a) External or Internal Corrosion. Areas of external or internal metal loss with a maximum depth greater than 80% of the wall thickness shall be removed or repaired. An appropriate fitness-for-purpose criterion may be used to evaluate the longitudinal profile of corrosion-caused metal loss in base metal of the pipe or of nonpreferential corrosion-caused metal loss that crosses a girth weld or impinges on a submerged arc welded seam.

(b) External Corrosion. Externally corroded areas exposed for examination shall be cleaned to bare metal. In general, areas of corrosion with a maximum depth of 20% or less of the thickness required for design, t, need not be repaired. However, measures should be taken to prevent further corrosion. An area of corrosion with maximum depth greater than 20% but less than or equal to 80% of the wall thickness shall be permitted to remain in the pipeline un repaired, provided that safe operating pressure is established. Generally acceptable methods for calculating a safe operating pressure include ASME B31G, “modified B31G,” and an effective area method (e.g., RSTRENG).

For pipelines subjected to unusual axial loads, lateral movement, or settlement, or for pipelines comprised of materials with yield-to-tensile ratios exceeding 0.93, an engineering analysis shall be performed to establish a safe operating pressure.

If the safe operating pressure is less than the maximum operating pressure, the affected area shall be removed or repaired or the maximum operating pressure shall be reduced to the safe operating pressure or less.

(c) Internal Corrosion. The limitations for areas with internal corrosion and areas with a combination of internal and external corrosion are the same as for external corrosion. When dealing with internal corrosion, consideration should be given to the uncertainty related to the indirect measurement of wall thickness and the possibility that internal corrosion may require continuing mitigative efforts to prevent additional metal loss.

(d) Interaction of Corrosion-Caused Metal Loss Areas. Two or more areas of corrosion-caused metal loss that are separated by areas of full wall thickness may interact in a manner that reduces the remaining strength to a greater extent than the reduction resulting from the individual areas. Two types of interaction are possible and each should be assessed as follows:

1) Type I Interaction (see Figure 451.6.2.2-1). If the circumferential separation distance, C, is greater than or equal to 6 times the wall thickness required for design, the areas A₁ and A₂ should be evaluated as separate anomalies. If the circumferential separation distance is less than 6 times the wall thickness, the composite area (A₁ + A₂ − A₃) and the overall length, L, should be used.

2) Type II Interaction (see Figure 451.6.2.2-2). If the axial separation distance, L₃, is greater than or equal to 1 in. (25.4 mm), the areas A₁ and A₂ should be evaluated as separate anomalies. If the axial separation distance is less than 1 in. (25.4 mm), area A₁ plus A₂ should be used and the length, L, should be taken as L₁ + L₂ + L₃.

(e) Grooving, Selective, or Preferential Corrosion of Welds. Grooving, selective, or preferential corrosion of the longitudinal seam of any pipe manufactured by the electric resistance welding (ERW) process, electric induction welding process, or electric flash welding process shall be removed or repaired.

451.6.2.3 Gouges, Grooves, and Arc Burns. Gouges and grooves shall be evaluated by nondestructive examination. Superficial grinding may be necessary to provide a smooth surface for nondestructive examination. The remaining wall thickness after grinding shall not be less than the minimum permitted by the component specification. Upon completion of superficial grinding, the absence of any cracking shall be confirmed by using dye-penetrant or magnetic-particle inspection. If no cracking is present, the net remaining wall thickness shall be determined by ultrasonic measurement. Gouges and grooves that leave less than the minimum wall thickness permitted by the component specification shall be removed or evaluated for repair in accordance with para. 451.6.2.2(b).

Arc burns shall be removed or repaired by grinding. Burns repaired by grinding shall be etched to confirm removal of all of the metallurgically altered material. Suitable etchants include a 5% to 10% solution of nital or a 10% to 20% solution of ammonium persulfate. All dark-etching material shall be removed, and the remaining wall thickness shall be determined by ultrasonic measurement.

451.6.2.4 Dents. Anomalies identified by ILI with the potential to be dents shall be assessed using engineering evaluation and selected for excavation when the assessment indicates a serious risk for failure. API RP 1183 may be used for additional guidance.