The Development of Target Flaw Sizes and Acceptance Flaw Sizes for CANDU Ferritic Piping

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Abstract:
Target Flaw Sizes (TFS) and Acceptance Flaw Sizes (AFS) are established for a wide variety of CANDU ferritic piping systems. Flaws of either TFS or AFS size would be unconditionally stable and fit for continued service until next inspection. TFS are for the purpose of qualification of NDE system (technology, procedure and personnel). AFS are for flaw disposition purpose. Both TFS and AFS are grouped in pipe size (outer diameter and nominal wall thickness), local weld counter-bore depth, flaw aspect ratio and flaw orientation (i.e. skew angle). AFS were calculated from Critical Flaw Sizes (CFS). All three flaw sizes (TFS, AFS and CFS) were established by extensive flaw stability analyses and fatigue flaw growth analyses under bounding loading conditions. CFS are critical flaw sizes larger than which pipe rupture would take place. AFS flaw sizes are smaller than respective CFS flaw sizes to allow flaw growth while maintaining flaw stability. The growth of AFS due to fatigue loadings is taken into account and the post-fatigue flaw sizes are demonstrated to be stable. Both TFS depths and TFS lengths are the smallest of all AFS depths and lengths of all flaw aspect ratios analyzed for a pipe and weld geometry. Skew angle is the absolute angle spanning between flaw surface plane and piping cross-section plane. Skew angle is introduced for non-circumferential flaws for which the TFS and AFS are applicable. Both the TFS and AFS are semi-elliptical planar flaws on either pipe base material or weldment, in either inner diameter or outer diameter of a pipe. Both TFS and AFS are dependent on piping geometry (i.e. outer diameter and nominal wall thickness) and flaw orientation (i.e. circumferential or non-circumferential with a skew angle less than the maximum skew angle). The AFS are also dependent on the weld counter-bore depth and flaw aspect ratios. TFS depth as a functions of pipe nominal wall thickness are provided. The TFS length is six times of the TFS depth. The TFS should be placed in either circumferential direction or non-circumferential direction with a skew angle not larger than 50°. The AFS are established as functions of nominal and local wall thickness and flaw aspect ratio. The process of flaw disposition is similar to that of Section XI IWB-3500 and IWB-3600 when the new AFS are to replace Section XI IWB-3514-1.

Keywords: