Definitions of B31 sustained, displacement, and peak stresses[1]

Ronald W. Haupt, (2004)

sustained stress: a sustained stress is a stress developed by an imposed loading which is necessary to satisfy the laws of equilibrium between external and internal forces and moments. The basic characteristic of a sustained stress is that it is not self-limiting. If a sustained stress exceeds the yield strength of the material through the entire thickness, the prevention of failure is entirely dependent on the strain-hardening properties of the material. A thermal stress is not classified as a sustained stress. Further, the sustained stresses calculated in this Code are "effective" stresses and are generally lower than those predicted by theory or measured in strain-gage tests.[2]

displacement stress: a displacement stress is a stress developed by the self-constraint of the structure. It must satisfy an imposed strain pattern rather than being in equilibrium with an external load. The basic characteristic of a displacement stress is that it is self-limiting. Local yielding and minor distortions can satisfy the displacement or expansion conditions which cause the stress to occur. Failure from one application of the stress is not to be expected. Further, the displacement stresses calculated in this Code are "effective" stresses and are generally lower than those predicted by theory or measured in strain-gage tests.[3, 4]

peak stress: a peak stress is the highest stress in the region under consideration. The basic characteristic of a peak stress is that it causes no significant distortion and is objectionable only as a possible source of a fatigue crack initiation or a brittle fracture. This code does not utilize peak stress as a design basis, but rather uses effective stress values for sustained stress and for displacement stress; the peak stress effect is combined with the displacement stress effect in the displacement stress range calculation.

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[1] These definitions have been incorporated into B31.1 - 2007 edition and are being considered for B31.3 - XXXX edition.

[2] The wording of the last sentence was clarified and simplified. However, the originally proposed wording may provide additional insight: "Further, a sustained stress is an "effective" stress and not equal in magnitude to a theoretical or "design by analysis" primary stress as defined in BPVC Section VIII, Division 2."

[3] The wording of the last sentence was clarified and simplified. However, the originally proposed wording may provide additional insight: "Further, a displacement stress is an "effective" stress and not equal in magnitude to a theoretical or "design by analysis" secondary stress as defined in BPVC Section VIII, Division 2."

[4] Normally the most significant *displacement stress* is encountered in the thermal expansion stress range from ambient to the normal operating condition. This stress range is also the stress range usually considered in a flexibility analysis. However, if other significant stress ranges occur, whether they are *displacement stress* ranges, such as from other thermal expansion or contraction events or differential support movements, or *sustained stress* ranges, such as from cyclic pressure, steam hammer, earthquake inertia forces, the fatigue (flexibility) rules of the respective B31 code may be used to combined the cyclic effects and evaluate the fatigue life.