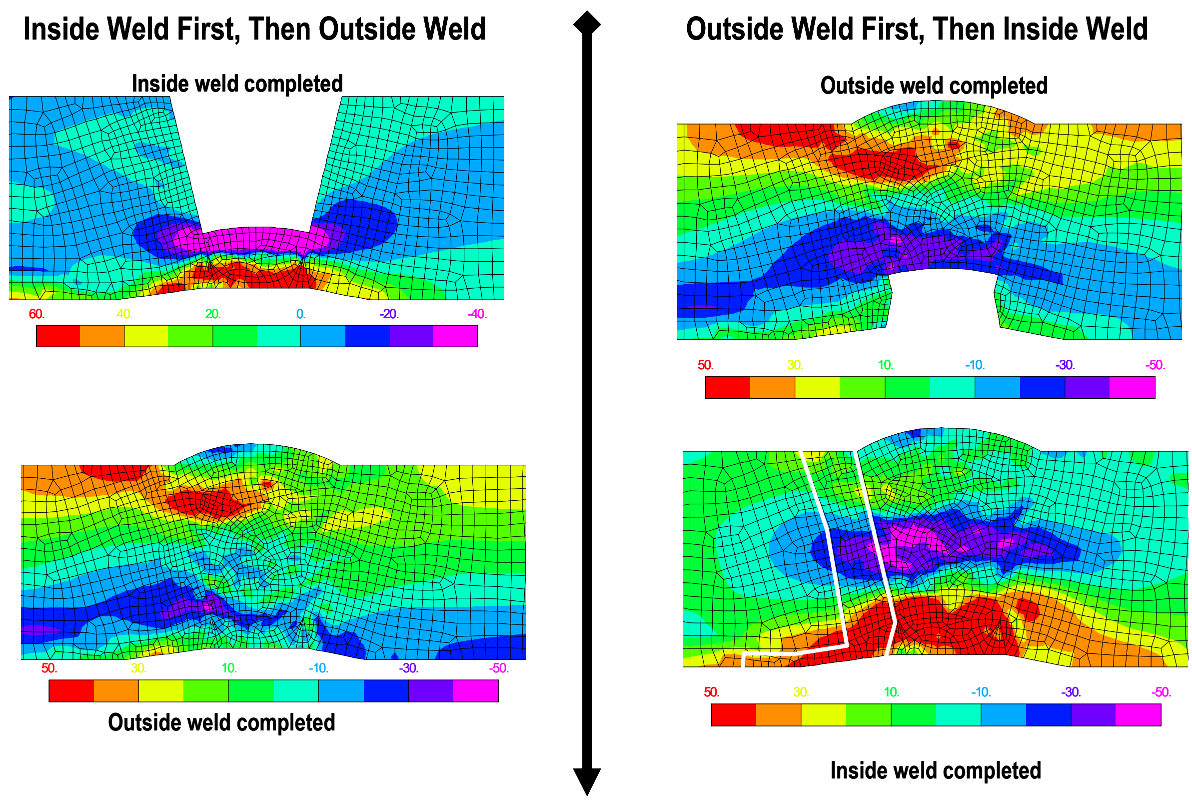

Figure G.30 Axial stress comparison between two sequences

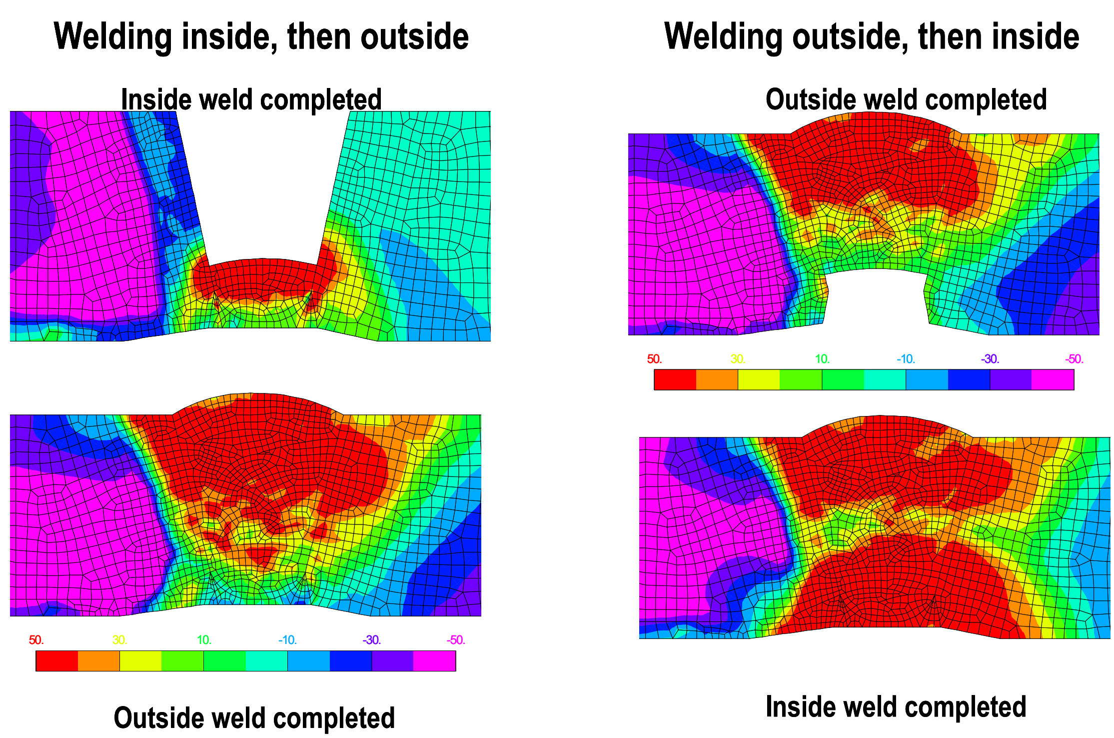

Figure G.31 Hoop stress comparison between two sequences

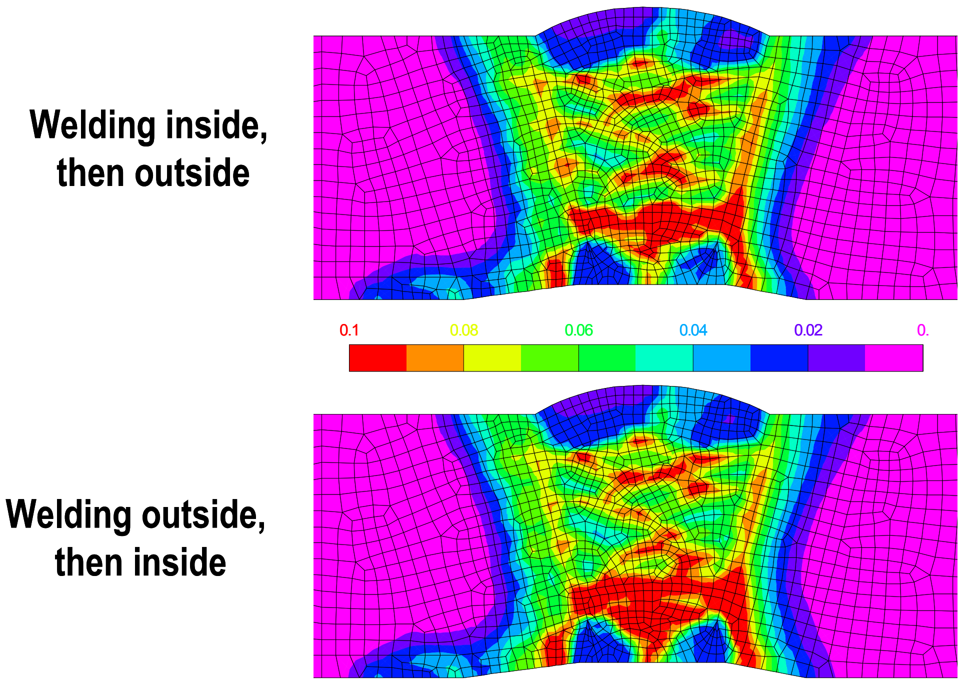

Figure G.32 Effective plastic strain comparison between two sequences

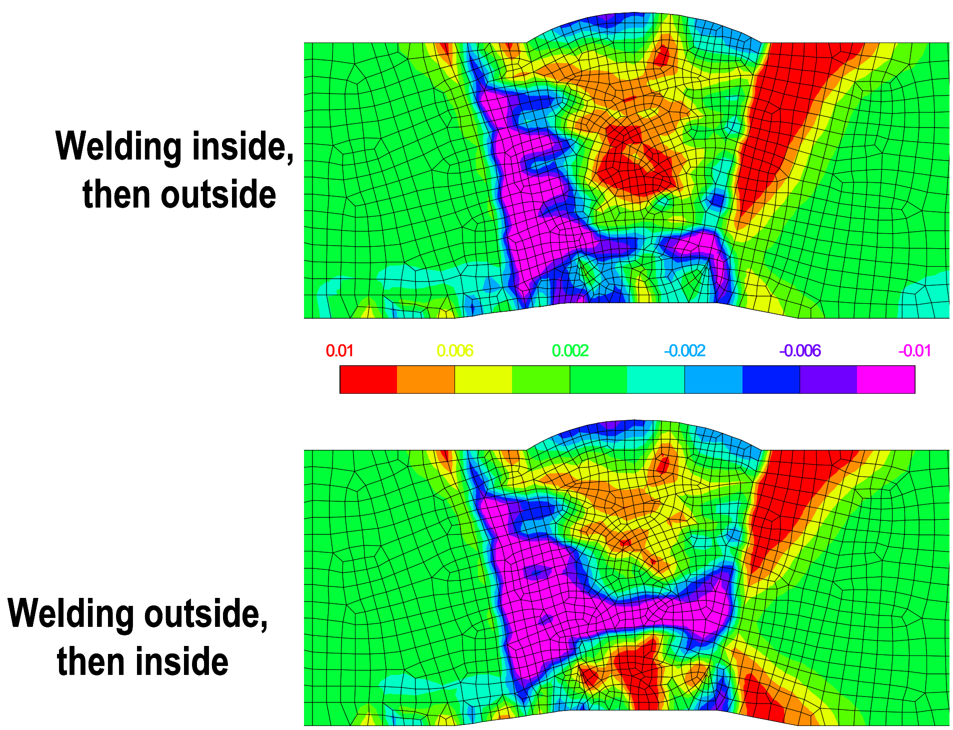

Figure G.33 Axial plastic strain comparison between two sequences

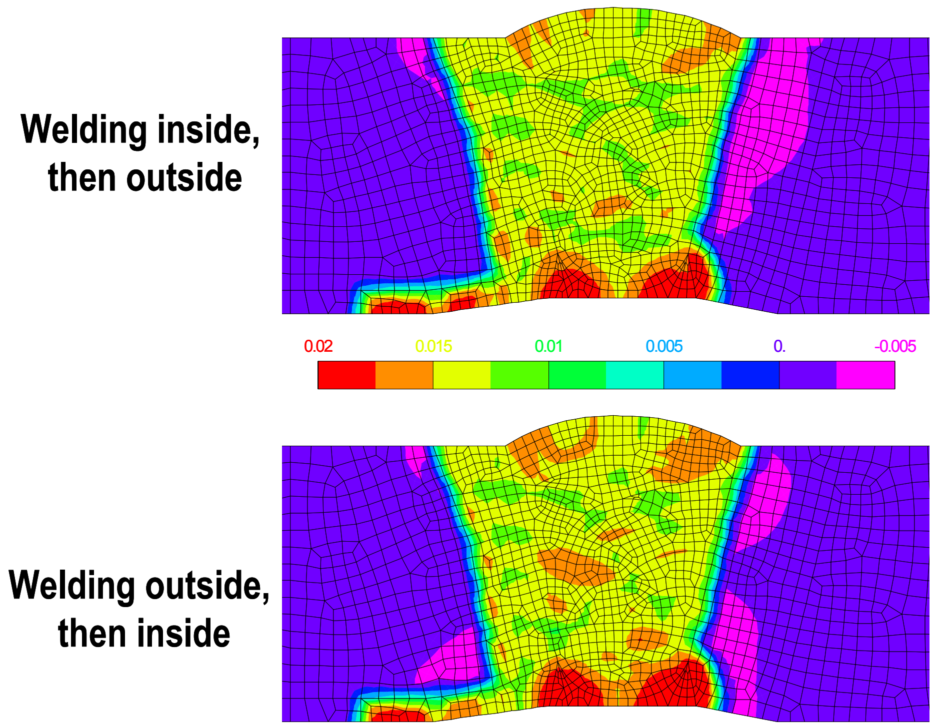

Figure G.34 Hoop plastic strain comparison between two sequences

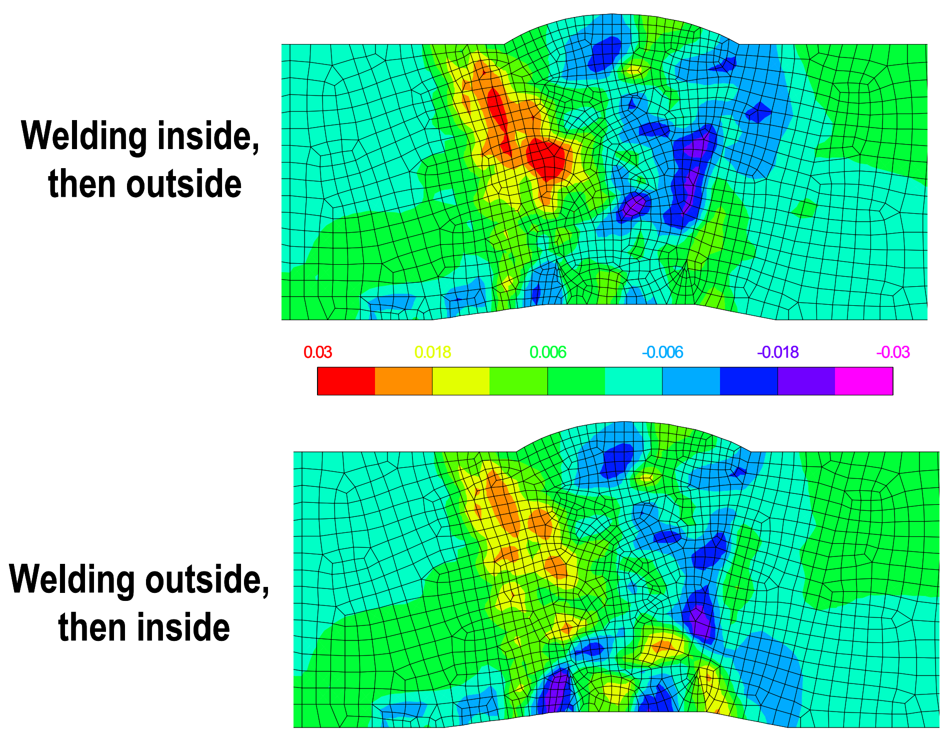

Figure G.35 Shear plastic strain comparison between two sequences

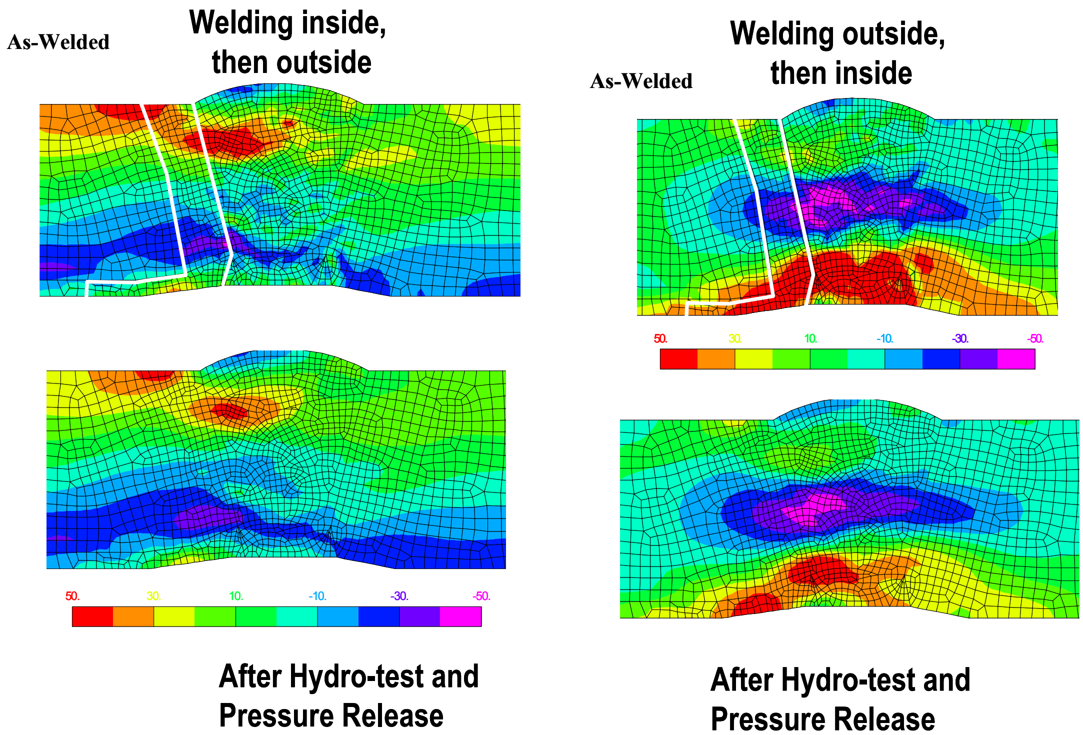

Figure G.36 Effect of hydro-test – axial stresses (pressure = 3.125 ksi, then unload)

are applied as well as pressure. The hydro-test pressure was 1.4 times the PWR operating pressure of 15.5 MPa (2.25 ksi). The hydro-test does reduce the axial residual stresses somewhat. Figure G.37 illustrates the effect of hydro testing on hoop residual stresses. It is seen that hoop residual stresses are not affected much by the hydro-test compared to the axial stresses.

As discussed in Section G.5 regarding the cold leg analysis, the residual stress measurements performed using the trepanning method were somewhat disappointing. During the metallurgical investigation into the PWSCC cracking reported in Reference G.12, residual stress measurements were made on sectioned pieces of the hot leg bimetallic pipe weld. Since the measurements were made on the pipe that was already cut up and sectioned, all component residual stresses are expected to be lower than in the intact pipe. However, from Table 2 of Reference G.12 the measured hoop residual stresses ranged from -59 to 161 MPa (–8.6 to 23.4 ksi) and the measured axial residual stresses ranged from 56 to 373 MPa (8.1 to 54.1 ksi). By comparing these numbers to the predicted residual stress plots in Figures G.36 and G.37 (after hydro-test and unloading), it is seen that the numbers are qualitatively similar. The hoop stresses measured from the cut pipe are expected to be most inaccurate since the weld bead (hoop) tension is relieved when the axial cuts are made to the pipe, and the hoop stress measurements are expected to be quite low. However, axial stresses are expected to be closer to the intact pipe. The ranges of measured axial stresses, when compared to Figure G.36, compare reasonably well and provide some validity to the predictive methodology used here.

G.6.4 Hot Leg Computational Weld Model Results – With Operational Loads

The next step before calculating stress intensity factors for the PWSCC analyses is to obtain operating stresses. For the PWSCC analysis, we consider crack growth for both residual stress only and residual stresses with operational loading. The operational loading consists of temperature, which is 324°C (615°F), followed by a bending moment and the pressure/tension load case.