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In this quarter, focuses were made on (1) sample preparation for both short-term and long-term durability study of interfacial strength between fusion bonded epoxy (FBE) and steel substrate, (2) experimental determination of residual stresses developed at the interface between FBE and steel substrate, and (3) analytical and numerical modeling to predict residual stress development in one-layer and 3-layer pipeline coatings.

Extensive analytical residual stress analyses have been conducted on 3LPE coating systems. The analytical results were correlated with both finite element method (FEM) modeling and experimental findings. Good correlation has been observed. Material properties of the coating materials required for FEM modeling were measured by Dow Chemical and were used to calculate thermal residual stresses. For the pipeline coatings in the mid-section of the pipe (i.e., away from the cutback), the radial stresses are small. Also, the hoop stresses of FBE, which decrease with an increase of FBE dry film thickness (DFT), are not likely to cause immediate disbondment in service. With an increase in PE topcoat DFT, the FBE hoop stresses decrease slightly. FEM was carried out to analyze the stresses at the coating cutback, which is difficult for analytical stress analysis. According to FEM findings, the maximum principal stress and in-plane shear

stress increase with the increase of FBE DFT at the coating cutback. The stress concentration factor becomes even higher with higher PE DFT. Therefore, disbondment will most likely occur at the coating cutback. FBE coating disbondment can occur once its residual interfacial strength upon exposure to moisture is reduced to that of the residual stress value.