CONCLUSIONS

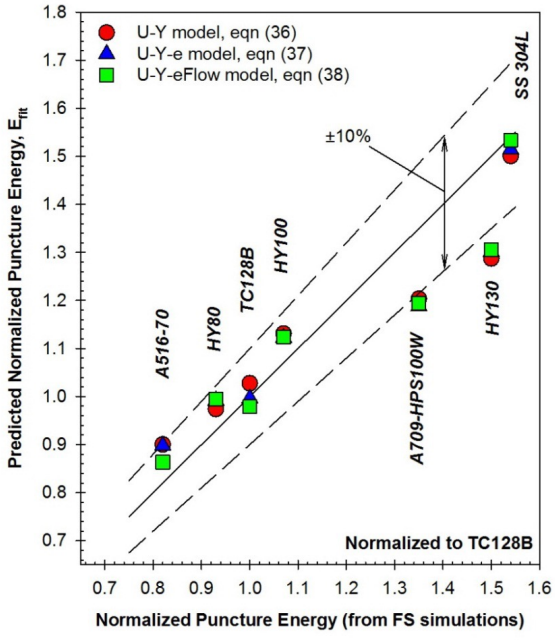
Some of the significant conclusions resulting from the ATCCRP and supporting tank car safety research efforts are:

1. The understanding of tank impact and puncture behaviors has greatly improved and a wealth of new experimental data and analytical results to support ongoing and future tank car safety efforts has been developed.

2. No new high technology design or material that produced significant new protection levels (e.g. composites, crushable foams, advanced engineered energy absorbing sandwich panels) has been identified. Traditional tank car designs with monolithic layers of good quality steel are relatively efficient structures for resisting the impact threats in the railroad safety environment.

3. The HM-246 interim specification cars provide a significant level of improvement over the legacy designs. The HM-246 interim specification car puncture energy improvements were on average 90%, 100%, and 45% for the anhydrous ammonia (AA), ethylene oxide (EO), and chlorine (Cl) cars respectively. Empirically-derived probabilities of lading release for interim specification cars were 51% to 61% lower than those of legacy cars.

4. The only option identified for possible improvements in puncture protection over the HM-246 interim specification car designs are potential optimized sandwich designs, requiring alternative steels in the jacket (outer tank) for enhanced puncture protection. This conclusion is based on puncture analyses performed for various tank design configurations. Functional tank car designs for these sandwich cars were not developed in the research and the protection levels have not been proven by testing.



Normalized Puncture Energies of Various Steels

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