Karagozian & Case

2550 North Hollywood Way, Suite 500

Burbank, CA 91505-5026

www.kcse.com

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BLAST EFFECTS ANALYSIS OF STEEL TANK INSTITUTE (STI) ABOVEGROUND STORAGE TANK (AST)

Leonardo M. Torres, P.E.
Yifan Zhang
Jason Yang
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November 30, 2010

Prepared for:

Steel Tank Institute
944 Donata Court
Lake Zurich, IL 60047

K&C Job No.: STI1038

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EXECUTIVE SUMMARY

Karagozian and Case (K&C) was tasked to perform the Blast Effects Analysis (BEA) for a 2,000 gallon cylindrical aboveground storage tank (AST) designed and manufactured by Steel Tank Institute (STI). The primary objective of the BEA was to determine the inherent blast resistance of STI's design for the AST and identify possible failure modes when it is subjected to various explosive threats.

As such, the response of the STI AST was analyzed for several blast threat scenarios, including: (1) a man-portable improvised explosive device (MPIED); (2) a vehicle-borne improvised explosive device (VBIED); (3) and loads representative of typical vapor cloud explosions (VCE). Various high-explosive (HE) weights and standoffs were considered for the improvised explosive devices, while the loads used to represent the effects of the VCE are applicable for an upper-bound and intense explosion.

Damage of AST was estimated based on the calculated results for: (1) failure of the anchorage resulting in rigid body displacement; (2) the damage computed for the exterior, secondary steel tank, and (3) the damage computed for the interior, primary steel tank.

For a majority of the analysis cases performed, the primary steel tank performed very well with little damage to its integrity. This is due, in large part, to the protection provided by having the secondary steel tank and mass of the thermal insulation layer act in conjunction to buffer the loading imparted onto the primary steel tank. The damage incurred by this exterior layer essentially attenuates the load imparted to the primary steel tank.

This technical report describes the assumptions, analytical methods and subsequent conclusions and recommendations of this BEA for the AST. Specifically, Section 2 describes the BEA analytic calculations, while Section 3 describes the analysis of the results. Finally, Section 4 provides recommendations based on the analyses performed.

Overall, the BEA indicates that the STI AST is resistant to the effects of the blast loads considered. The AST was found to resist with little damage to the primary steel tank, the effects of a 50-pound MPIED and 500-pound VBIED at the standoff distances of 5 feet and 20 feet, respectively. These results reflect the response of the AST when it is half-full of fluid. When subjected to loads representative of a typical VCE, the AST performed very well in the analysis with very minor damage to the secondary steel and only localized damage to the primary steel tank. In all three scenarios any minor steel tank damage is not expected to cause primary leakage.