Large Scale Detonation Testing:
New Findings in the prediction of DDTs at large scales

Scott Davis¹, Mark Groethe², Derek Engel¹, Kees van Wingerden¹
¹Gexcon US, Bethesda, Maryland, USA
²SRI International, Menlo Park, CA, USA
sgdavis@gexcon.com

A large vapor cloud explosion (VCE) followed by a fire is one of the most dangerous and high-consequence events that can occur at petrochemical facilities. As the size and complexity of facilities increase, designs must consider the potential adverse effects associated with vapor cloud explosions in large congested areas and understand the potential for more devastating deflagration-to-detonation transitions (DDTs) on these facilities. While the likelihood of DDTs is lower than deflagrations, they have been identified in some of the most recent large-scale explosion incidents including: 2005 Buncefield explosion, 2009 San Juan explosion, and 2009 Jaipur event. The consequences of DDTs can be orders of magnitude larger than deflagration because they have the ability to self-propagate outside the region of high congestion/confinement. Hence, it is critical to understand how a facility’s geometry or equipment layout can affect explosion consequences and assist in their mitigation and/or prevention.

Due to the inability to predict such devastating phenomena on the large scale, owners and designers cannot evaluate installations for risk of DDTs and provide “inherently safer” layout or mitigation measures to significantly reduce or eliminate such hazards. However, there is a lack of data at the large scale to validate the necessary design tools used to predict the risk of DDT. One of the main goals of this research project is to provide large scale DDT explosion data and validate the tools necessary to predict vapor cloud explosions in early design phase.

This paper will present the results of large scale testing being conducted in a newly developed test rig of 50,000 ft³ (1,500 m³) gross volume under award Subcontract 12121-6403-01 provided by the Research Partnership to Secure Energy for America (RPSEA). These tests will involve evaluation of deflagrations and DDTs involving stoichiometric, lean and rich mixtures ethylene, propane and methane. The effectiveness of mitigation techniques such as solid inhibitors or deluge will be evaluated for preventing DDTs. In addition, updated tools will be presented to help predict such phenomena on the large scale.

Keywords: RPSEA, large-scale testing, DDT, vapour cloud explosions, industrial explosions, mitigation measures, deflagration to detonation transition, explosion risk