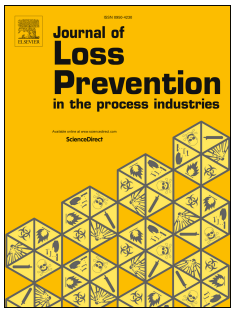
Accepted Manuscript



Comparison of large-scale vented deflagration tests to CFD simulations for partially congested enclosures

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PII: S0950-4230(18)30314-0

DOI: 10.1016/j.jlp.2018.07.012

Reference: JLPP 3739

To appear in: *Journal of Loss Prevention in the Process Industries*

Received Date: 30 March 2018

Revised Date: 29 June 2018

Accepted Date: 17 July 2018

Please cite this article as: Diakow, P.A., Thomas, J.K., Vivanco, E., Comparison of large-scale vented deflagration tests to CFD simulations for partially congested enclosures, *Journal of Loss Prevention in the Process Industries* (2018), doi: 10.1016/j.jlp.2018.07.012.

COMPARISON OF LARGE-SCALE VENTED DEFLAGRATION TESTS TO CFD SIMULATIONS FOR PARTIALLY CONGESTED ENCLOSURES

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Abstract

This paper presents a comparison between the results from a test program carried out to characterize the blast load environment within BakerRisk's Deflagration Load Generator (DLG) test rig, and predictions made using the FLACS computational fluid dynamics (CFD) code. The test data was also compared to internal peak pressure predictions made using the newest version (2018) of the National Fire Protection Association's Standard on Explosion Protection by Deflagration Venting (NFPA 68) [1]. The purpose of these tests was to provide data for comparison with standard methods used to predict internal blast loads in a vented deflagration. The tests also provided a characterization of the internal DLG blast load environment for equipment qualification testing.

The DLG test rig is 48 feet wide × 24 feet deep × 12 feet tall and is enclosed by three solid walls, a roof, and floor, with venting through one of the long walls (i.e., 48-foot × 12-foot). During testing, the venting face of the rig was sealed with a 6 mil (0.15 mm) thick plastic vapor barrier to allow for the formation of a near-stoichiometric propane-air mixture throughout the rig. The flammable gas cloud was ignited near the center of the rear wall. Congestion inside the rig was provided by a regular array of vertical cylinders (2-inch outer diameter) that occupied the rear half of the rig; the front half of the rig was uncongested (i.e., as would be the case for equipment qualification testing). Forty-three pressure transducers were deployed internal and external to the rig to measure blast pressure histories.

Three series of tests were conducted with congestion levels corresponding to area blockage ratios (ABR) of 11%, 7.6%, and 4.2% in test series A, B and C, respectively. The obstacle-to-enclosure surface area ratio (A_r), a parameter used within the NFPA 68 correlations to quantify congestion within the vented enclosure, was equal to 0.39, 0.27, and 0.15 for test series A, B, and C, respectively. The peak pressures and impulses for each test are provided, along with pressure histories internal and external to the rig for selected tests. Comparisons of the test data to predictions made using the FLACS CFD code and NFPA 68 (2018) venting correlations are also provided.