SAND2007-4915P

Sandia Barrier Wall Test Summary

The first two tests to characterize the effectiveness of barrier walls as a flame mitigation technique were carried out in June, 2007 at the SRI International Coral Hollow test site in Tracy, CA. A schematic of the first test setup and instrumentation is shown in Fig. 1. The test consisted of a horizontal hydrogen flame impinging on a 2.4 m x 2.4 m (8 ft x 8 ft) cinderblock wall. The jet exit and flame centerline was located 1.2 m (4 feet) above the ground such that the jet impinged on the exact center of the wall. The source of the H_2 was a six pack of cylinders at an initial pressure of 170 Bar (2500 psi), which provided a 400 second blow down period before the cylinders are empty. The horizontal jet issued through a 3.175-mm diameter tube. The main emphasis of this first test series is characterizing the effectiveness of the barrier wall at deflecting the flame and thus mitigating hazards such as radiative heat transfer. Thus the radiometers (heat flux gauges) located around the flame will characterize heat flux from the deflected flame and thermocouples in the wall and along the flame centerline will provide data for model validation of gas and wall heat transfer.

Although the emphasis in these tests was not originally on transient overpressure measurements, we decided to add some pressure transducers to make an initial effort at measuring overpressure during the early period immediately after the flame is ignited by a spark. A high speed Phantom camera should also allow us the see the initial ignition event, and subsequent propagation of the flame, that likely will result in significant overpressures.

A second test was carried out with the same cinderblock wall, but the H_2 jet and flame centerline were moved up to 8 feet above the ground, so that the height of the flame centerline equaled the wall height. The object of this test was to characterize the effect of wall height relative to the flame height. In particular, it represents a flame that impacts closer to the top of the wall and is thus more likely to lead to a recirculation zone, and flame stabilization, behind the barrier wall. The data from both of these completed tests is currently being reduced.

The next set of tests (3 to five in number) will be carried out sometime in late July or August. The exact conditions for the remaining tests will depend on the results of the first two tests and the scoping CFD calculations we are doing to look at the effects of different flame/wall orientations. Thus we will select test conditions that appear to be the most interesting. Possible variables are jet flow rate, distance from jet exit to wall, angle of the H_2 jet relative to the wall, and wall orientation (non vertical).

The next set of tests, planned for FY2008, will concentrate on the transient overpressure phenomena. We will vary the delay between jet startup and ignition to see the effect of delay time on overpressure. Measurements will again include pressure transducers and heat flux sensors. In the lab we will also try to characterize the transient H_2 (or He) concentration field as a function of time. Such data will be used for the development and validation of a CFR model for the overpressure phenomena.

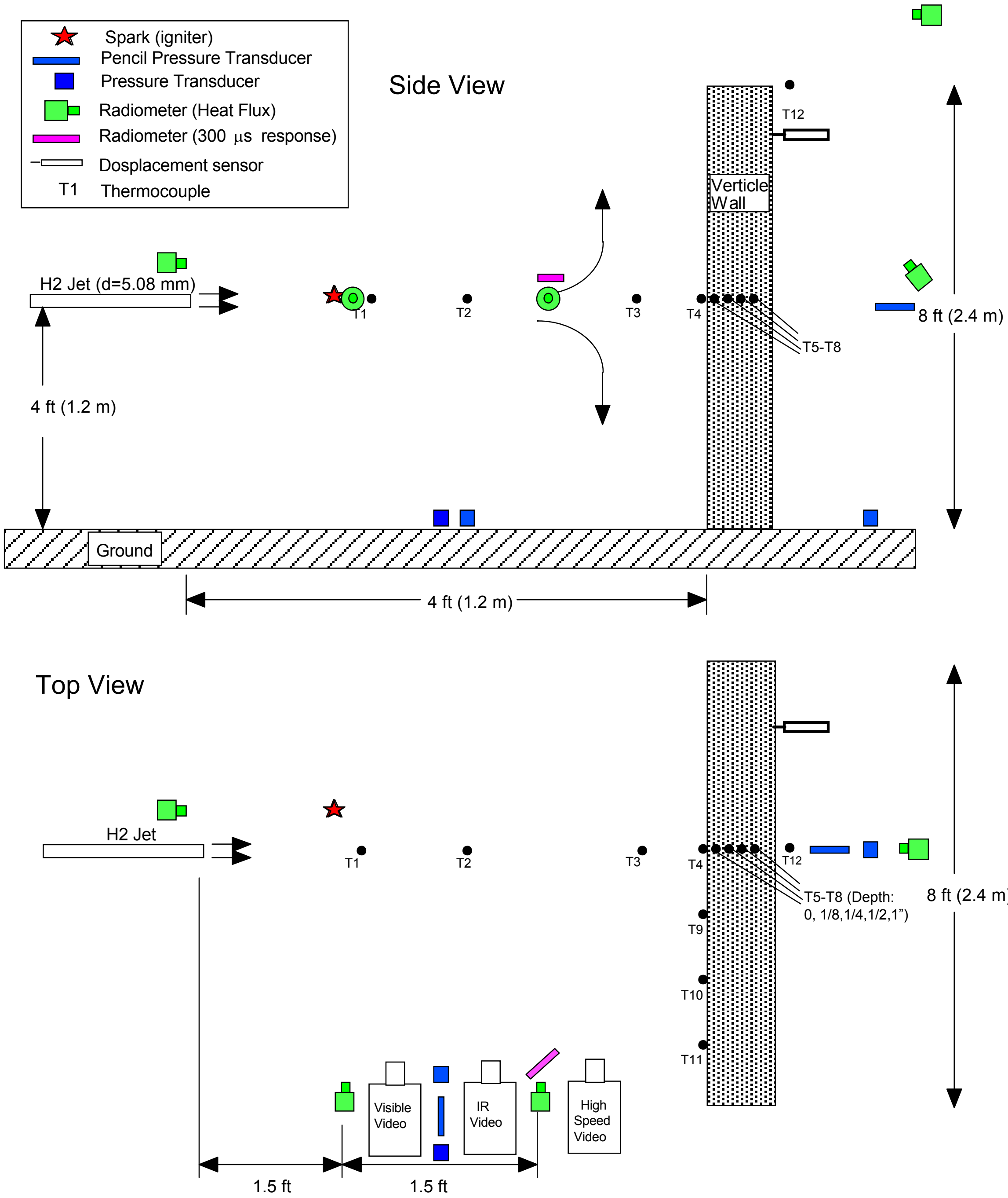

Fig. 1. Schematic of barrier/flame test setup.

Appendix A. Experimental Equipment List for Figure 1.

1. Four thermocouples (T1 through T4) along the jet flame centerline at approximately 1 ft (0.3 m) increments. T4 is is on the surface of the wall.

2. Four thermocouples along the wall surface: the one on-axis at four feet (1.2 m) from the nozzle as mentioned above, and 1 ft, 2 ft, and 3 ft from the jet axis.

3. Four thermocouples inside the wall (T5-T8) at 3.18 mm, 6.35 mm, 12.7 mm and 25.4 mm (1/8", 1/4", 1/2" and 1") from the surface.

4. One thermocouple behind the wall.

5. Two pressure sensors on the ground in front of the wall.

6. One pressure transducer on the ground behind the wall and two pencil probe pressure transducers behind the wall at an elevation to be determined.

7. One displacement sensor attached to the backside of the wall (to measure any wall displacement due to overpressure).

8. One SRI fast responding heat flux gauge.

9. Six Sandia heat flux gauges.

10. One IR DV camera.

11. One standard DV camera.

12. One high-speed Phantom video camera.

13. Ignite the mixture with a spark or sparks at 1.2 m from the nozzle.

14. We will release from a hydrogen cylinder six pack at an initial pressure of 170 Bar (2500 psi). This will provide a blow down time of about 400 seconds. We will flow the gas through a stagnation chamber located just upstream of the 3.175-mm diameter pipe that the H_2 jet flows out of. The stagnation chamber is instrumented with a pressure sensor and a thermocouple so we can calculate the jet flow rate (assuming isentropic flow).