

# EXHALE BLADELESS FAN TESTING

## Executive summary report

November 30, 2013

A prototype bladeless fan from Exhale Fans was tested in the indoor environment lab of Herrick Labs at Purdue University in November 2013. The fan was mounted on the ceiling of a typical room with dimensions 4.5m x 4.5m and height of 2.5m. A picture of the installed fan with sensors installed (vertical pole) and a close view of the accurate (SENSOR type) air velocity sensor is shown in Fig. 1.



Figure 1. Exhale bladeless fan installed in the test space and air velocity sensor.

Three types of testing were completed:

1. Measurements of air velocity at different heights and distances from the fan.
2. Estimation of overall air movement through the chamber and temperature stabilization/uniformity.
3. Estimation of air flow through the fan.

## 1. Measurements of air velocity at different heights and distances from the fan

- Air velocity was measured at 11 locations inside the room, as shown in Fig. 2 (left), to capture the air flow near the floor, near the ceiling, near the walls and in the room interior. For each of these locations, air velocity was measured at 5 different heights (from ankle height to above head height), as shown in Fig. 2 (right). The fan was at the maximum speed (scale 6) during these measurements.

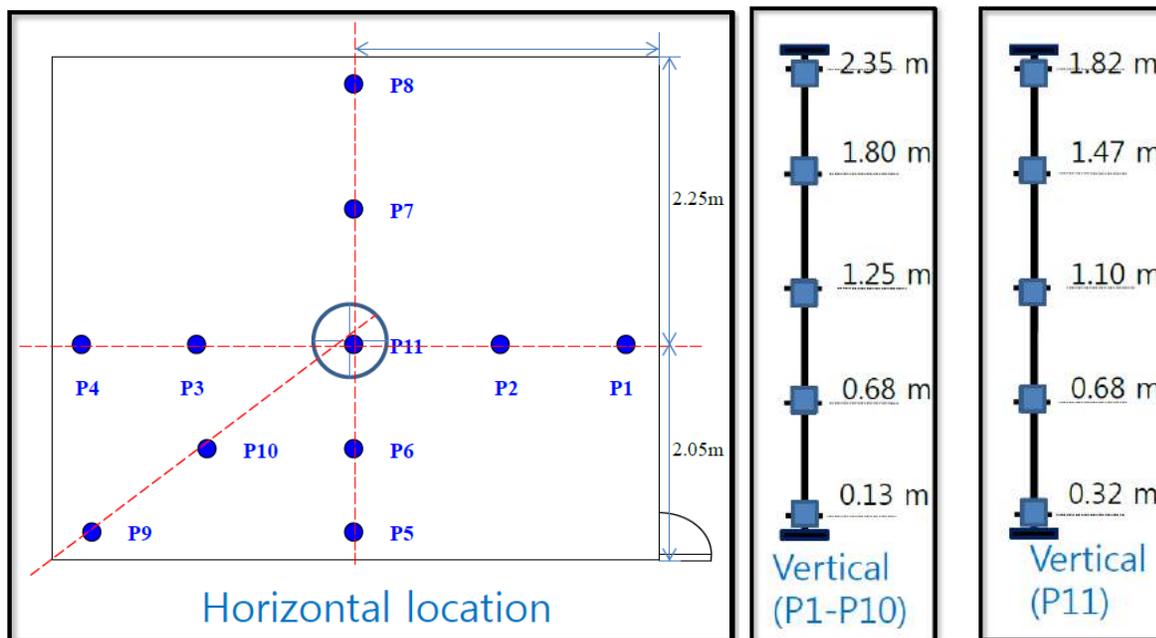


Figure 2. Air velocity measurement locations and sensor points at different heights.

The results are shown in Fig. 3. The fan results in very good air circulation in the room, with increased air velocity along the ceiling and near the walls, and smaller velocity inside the occupied space. The maximum air velocity occurs at the ceiling level near the fan, ranging between 1-1.24 m/s. At the height of seated occupants inside the space (P2, P3, P6, P7, P10), the air velocity varies between **0.22-0.35 m/s**.

### Comfort conditions and fan performance:

According to *ASHRAE Standard 55*, the typical air velocity to ensure thermal comfort is around 0.2 m/s. Also, when there is an increase in air temperature (summer conditions), elevated air speeds without draft problems are allowed (up to **0.3m/s**), depending on temperature variations and turbulence intensity. Finally, in order to avoid discomfort with increased temperature, increased air velocity (up to **0.8 m/s** for 5 °F increase in temperature) are allowed.

The results of the testing show that the Exhale fan can comply with these requirements. The typical limit of 0.2 m/s can be achieved with any of the lower scales of the fan, while for summer conditions with slightly increased temperatures, the maximum scale will result in good air movement without causing thermal discomfort. These results depend on the size of the room; for larger rooms more than one fan may be needed.

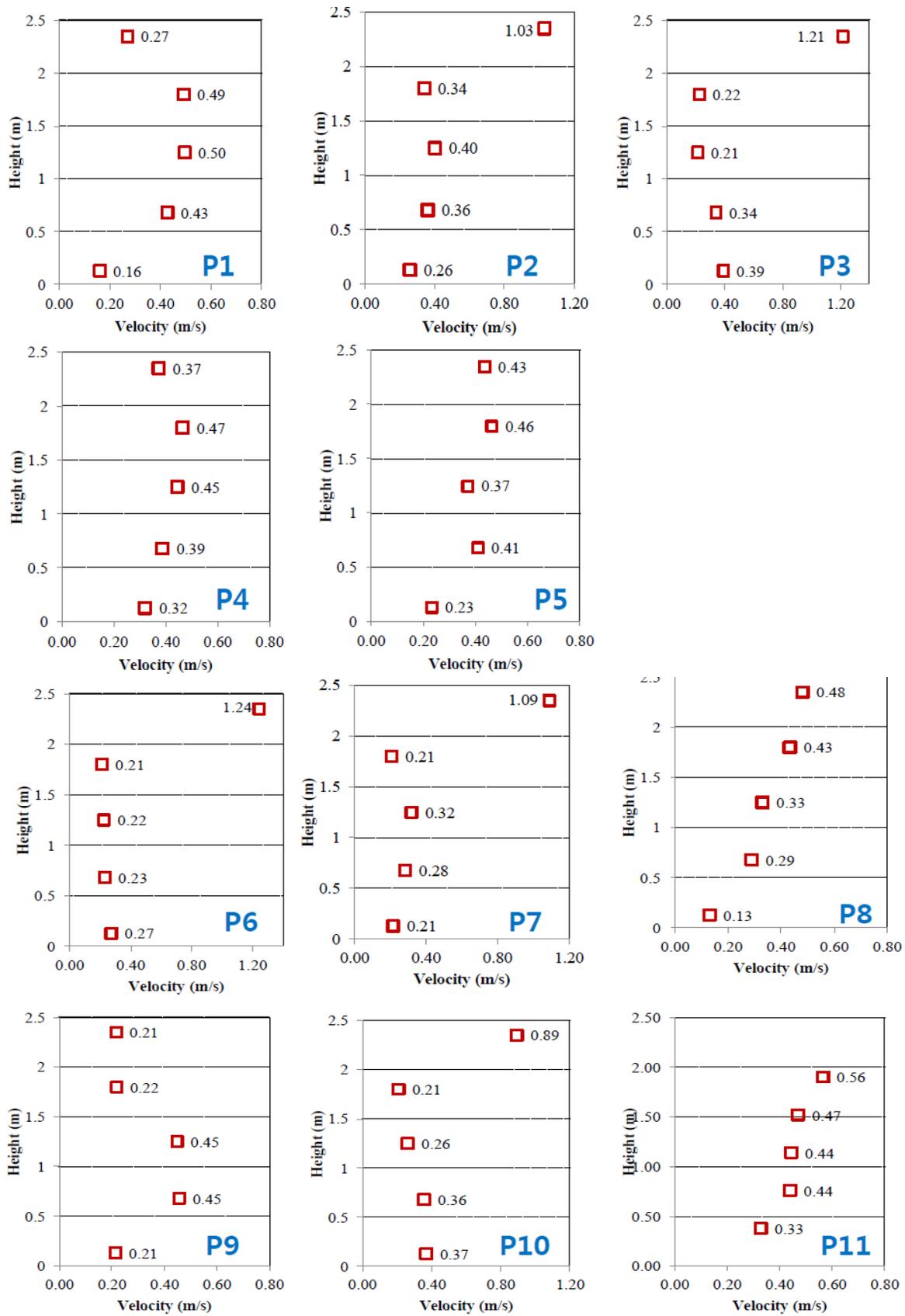


Figure 3. Air velocity measurements for the 55 measurement points (fan at full speed).

## 2. Estimation of overall air movement through the chamber and temperature stabilization/uniformity

The ability of the fan to circulate air efficiently was studied next. A heat source was used to create small temperature stratification and the air temperature was measured at locations P1-P5 at all different heights. The results are shown in Fig. 4, where the average temperature of each location is plotted as a function of elapsed time.

**It is clearly shown that the fan is able to mix room air efficiently and temperature stabilization can be achieved in less than 2 minutes. Larger rooms could require slightly higher times (3 minutes) for good air circulation and temperature stabilization.**

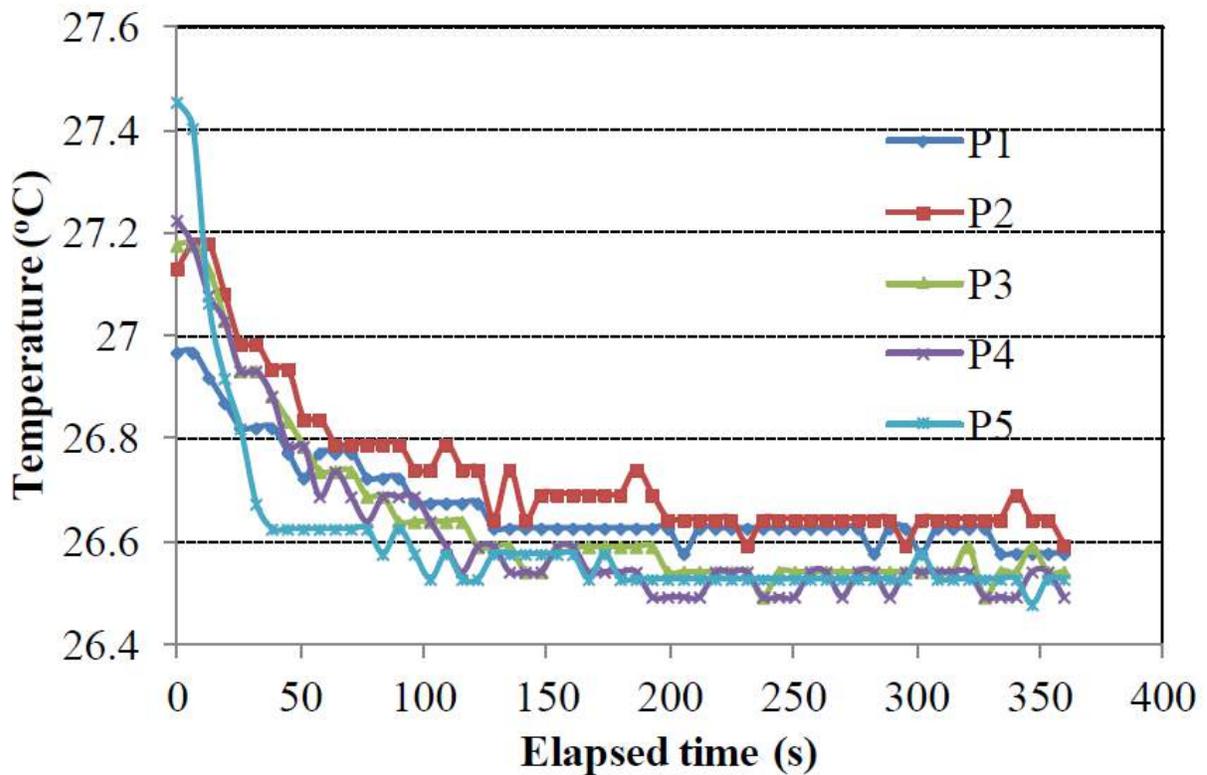


Figure 4. Air temperature variation at different location as a function of elapsed time (fan at maximum scale).

### 3. Estimation of air flow through the fan.

An approximate estimation of the airflow rate of the fan was made using measurements of the face air velocity (under the fan) in different directions and positions (Fig. 5) and the fan face area. **The estimated ventilation (air flow) rate is about 400 cfm.**

**Note that this number is approximate and there is no standard method of measuring the air flow accurately.**

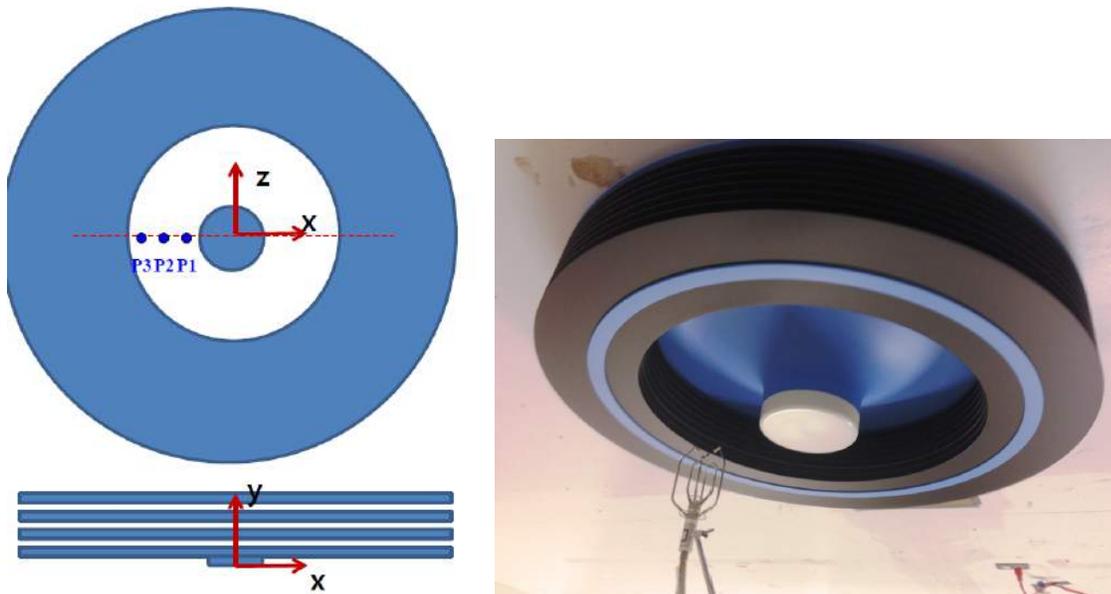


Figure 5. Measurement of air axial speed at the face of the fan in different directions.

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