

Draft Rate: A Determining Factor in the Quantification of Human Comfort

Application Note TSI-142

Heating, Ventilating and Air-Conditioning (HVAC) systems are designed essentially to create conditions of comfort, health and safety for the human occupants of enclosed spaces (dwellings, commercial spaces, vehicles, etc.). Many HVAC systems utilize the delivery of forced air into and out of occupied spaces. Oftentimes, the delivered air has been conditioned by the HVAC system to create within an occupied space the specific parameters of comfort for the human occupants.

Among the parameters which affect the comfort of humans are:

- air temperature
- relative humidity
- the activity level of the occupants
- how much and what type of clothing they are wearing, and
- the air movement that is coming in contact with the occupants.

Of course, not all humans perceive or would define “comfort” identically. However, scientific studies have been performed whose results indicate that “human comfort” can be defined in a statistical way. That is, given a set of human comfort parameters within an occupied space, it is possible to quantify a statistically-based prediction of what percentage of occupants will find the space to be acceptably comfortable.

Draft and Draft Rate Defined

ASHRAE Standard 55-2004 *Thermal Environmental Conditions for Human Occupancy* specifies the combinations of indoor thermal environmental factors that will produce comfort conditions that are acceptable to a majority of the occupants within the space.

ASHRAE Standard 55-2004 defines Draft as “unwanted local cooling of the body caused by air movement”. The sensation of draft depends on the speed of air, how much the air speed is fluctuating (turbulence), the air temperature and clothing conditions. Sensitivity to draft is greatest



where the skin is not covered by clothing, especially the neck and head region and the ankle and leg region.

ASHRAE Standard 55-2004 further defines a metric which quantifies Draft in terms of what percentage of occupants will be dissatisfied with a space due to annoyance by the local Draft conditions. This “predicted percentage of people dissatisfied due to annoyance by draft” is called the Draft Rate.

Draft Rate (DR) can be quantified in the following equations:

For metric units of measure:

$$DR = ([34 - t_a] * [v - 0.05]^{0.62}) * (0.37 * v * Tu + 3.14)$$

where **DR** = predicted percentage of people dissatisfied due to Draft [%];

t_a = local air temperature [°C];
v = local average air speed [m/s]; and
Tu = local turbulence intensity [%]

For Imperial units of measure:

$$DR = ([93.2 - t_a] * [v - 10]^{0.62}) * (0.00004 * v * Tu + 0.066)$$

where **DR** = predicted percentage of people dissatisfied due to Draft [%];

t_a = local air temperature [°F];
v = local average air speed [ft/min]; and
Tu = local turbulence intensity [%]

ASHRAE stipulates in Standard 55-2004 that DR must be <20%.

Measuring Draft Rate using the VELOCICALC

This is a brief summary of how to perform a Draft Rate measurement in an occupant location. Refer to ASHRAE Standard 55-2004 for complete information regarding measurement requirements to evaluate any particular thermal environment.

Prior to beginning the test, you may input a name for the test according to the instructions in the manual for the VELOCICALC.

The measurement locations for evaluation are to be defined with respect to the occupant. A minimum of three spatial locations are required to evaluate an occupant’s environment: head area, waist area and ankle area. For a standing occupant, these are defined to be 1.7, 1.1 and 0.1 m (67, 43 and 4 in.) above the floor. For a seated occupant, the levels are to be 1.1, 0.6 and 0.1 m (43, 24 and 4 in.) above the floor. Note: Measurements to be taken with no occupant present.

Locate the measuring end of the velocity probe in the location where you wish to measure the Draft Rate. Orient the probe in such a way that the maximum air speed at the particular location is displayed. Do not allow the support of the probe to interfere with the measured air movement.

After powering the instrument ON, select MENU and scroll down to the APPLICATIONS screen. Highlight DRAFT RATE. Press the Enter Key to begin a Draft Rate test.

The display will show Air Temperature and Velocity values, and a count-down time. Three minutes of sampling will occur, as required by ASHRAE Standard 55-2004. One sample per second will be accumulated for evaluation. Allow the probe to measure at each spatial location undisturbed for the full three minute time period.

Draft Rate Results

When the sample is complete, the display on the VELOCICALC will report the Draft Rate information for this sample. The reported values will include:

- Average Temperature [$^{\circ}\text{C}$ or $^{\circ}\text{F}$]
- Average Velocity [m/s or ft/min]
- Velocity Standard Deviation [m/s or ft/min]
- Turbulence Intensity [%]
- Draft Rate [%]

Save the results, and repeat according to the number of spatial locations you have decided to evaluate for each test location (ASHRAE stipulates a minimum of three per test location). Calculate the arithmetic average of the Draft Rates for the number of spatial locations within each test to determine the overall average Draft Rate for that test.

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