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An American National Standard

Standard Test Method for Measuring the Field Performance of Commercial Kitchen Ventilation Systems[1]

This standard is issued under the fixed designation F2975; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method can be used to measure and validate successful design, installation and commissioning of commercial kitchen HVAC and makeup air systems for specific installations.

1.2 This test method field evaluates commercial kitchen ventilation system airflows and pressures.

1.3 This test method field evaluates visual hood capture and containment performance.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are for information only.

1.5 The data generated is specific to the field conditions as installed.

1.6 *This test method may involve hazardous materials, gasses (for example, CO) operations, and equipment. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F1704 Test Method for Capture and Containment Performance of Commercial Kitchen Exhaust Ventilation Systems

2.2 *Other Standards:*

ANSI/ASHRAE Standard 111-2008 Measurement, Testing, Adjusting and Balancing of Building HVAC Systems[3]

ANSI/ASHRAE Standard 154 Ventilation for Commercial Cooking Operations[3]

Testing, Adjusting and Balancing, Chapter 37 2007 HVAC Applications Handbook[4]

Kitchen Ventilation, Chapter 31 2007 HVAC Applications Handbook[4]

3. Terminology

3.1 *Definitions:*

3.1.1 *airflow rate*—volumetric flow rate of air in units of ft^3/min (cfm) or m^3/s. When adjusted for standard air density the flow rate is designated by scfm.

3.1.2 *appliance*—cooking device used in kitchen and powered by gas, and/or electricity and/or solid fuel.

3.1.3 *barometric pressure*—absolute pressure of the air measured by a barometer or absolute pressure measuring device.

3.1.4 *capture and containment (C&C)*—the ability of a hood or other removal device to capture and contain all effluent generated by the appliances or processes during normal operation.

3.1.4.1 *Discussion*—For the purpose of this test method effluent may be simulated as defined in this test method.

3.1.4.2 *Discussion*—Successful C&C shall be demonstrated along the entire perimeter of the hood or removal device.

3.1.4.3 *Discussion*—Successful C&C may include rising effluent that when below the leading edge of the hood may extend out no more than 3 in. vertically beyond the leading edge of the hood and is completely recovered before reaching the leading edge of the hood or removal device and once inside the hood is completely contained. **F1704**

[1] This test method is under the jurisdiction of ASTM Committee F26 on Food Service Equipment and is the direct responsibility of Subcommittee F26.07 on Commercial Kitchen Ventilation.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329, http://www.ashrae.org.

3.1.4.4 *Discussion*—For backshelf or passover style hoods effluent shall not rise more than 3 in. above the exterior leading edge of the hood and shall not extend more than 3 in. beyond the open front or sides of the cooking surface and shall be completely contained once reaching the hood.

3.1.5 *differential pressure gauge*—instrument that measures pressure difference between the two inlet ports. This can be a mechanical type such as a Bourdon gauge with an indicator on a dial face or an electronic type with a digital readout.

3.1.6 *dry bulb temperature*—sensible temperature of air as measured by a shielded thermometer or an electronic temperature measuring device.

3.1.7 *effluent*—emissions from cooking, dishwasher or other ventilated processes such as convective hot air, steam, vapor, products of combustion, smoke and/or particulate matter.

3.1.8 *exhaust fan*—also called power roof ventilator or centrifugal blower. A fan used to exhaust cooking effluent including, grease, smoke, steam, heat, and/or vapor collected by a hood. The majority of these fans have a centrifugal fan wheel.

3.1.9 *exhaust hood*—a device designed to capture and contain cooking effluent including, grease, smoke, steam, hot air, and vapor.

3.1.10 *flow hood*—an instrument that measures air flow rate using a pyramid shaped hood that is used to contain the air to be measured and is connected to a velocity pressure measuring device positioned at the outlet end of the hood. A compensating baffle may be installed so that measurements with the baffle open and closed can be used to estimate the air flow rate through the device being measured when the pressure drop imposed by the flow hood is eliminated.

3.1.11 *hood overhang*—the horizontal distance the lower edge of the hood extends beyond the outer horizontal edge of the cooking surface or outer perimeter of the appliance body.

3.1.11.1 *hood setback*—the horizontal distance between the lower front edge of the hood and the front of the edge of the cooking surface or outer perimeter of the cooking appliance. Setback is used for hood styles such as backshelf and/or passover that do not fully cover the entire cooking surface or appliance.

3.1.12 *hot-film anemometer*—an instrument for measuring air velocity at a single point. The instrument measures velocity past a heated sensor and requires calibration to correlate heat loss to air velocity.

3.1.13 *humidity measuring device*—an instrument for measuring the amount of moisture in the air. The instrument shall provide the moisture level as either a) relative humidity, b) wet bulb temperature or c) and/or dew point temperature.

3.1.14 *pitot tube*—a double walled probe with a 90 degree bend near the measuring end. The measuring end of the probe is oriented toward the oncoming air flow. The center opening, facing the oncoming airstream senses total pressure. Small holes located around the circumference of the outer tube sense static pressure. When connected to a differential pressure instrument the velocity pressure of the air is y measured as the difference between the total pressure sensed by the central tube and the static pressure sensed by the outer tube.

3.1.15 *replacement air*—outdoor air that is used to replace air removed from a building through an exhaust system. Replacement air may be derived from one or more of the following: Kitchen Supply, Makeup Air and/or Transfer Air. However, the ultimate source of all replacement air is outdoor air.

3.1.15.1 *kitchen supply*—air entering a space that contains hoods and originates from an air-handling device that serves both purposes of supplying replacement air as well as space conditioning. Supply air is generally filtered, fan-forced, and either heated and/or cooled and/or humidified and/ or dehumidified as necessary to maintain specified space temperature and/or humidity conditions.

3.1.15.2 *makeup air (dedicated replacement air)*—outdoor air supplied directly to a compensating hood or to supply air devices located in the immediate vicinity of the hood to replace air being exhausted through the hood. Makeup air is generally filtered and fan-forced, and it may be heated and/or cooled depending on the requirements of the application. Makeup air may be delivered through outlets integral to the exhaust hood or through outlets in the same room that are typically in the immediate vicinity of the hood.

3.1.15.3 *transfer air*—outdoor that has been conditioned to maintain comfort of and ventilate a space adjacent to the space in which the hood is located. Movement of this air may be caused by pressure differential between spaces, that are separated by adequately sized openings, or by fans and or grills connected by ductwork above ceilings and or through walls, and shall be used to supplement the comfort conditioning of the space in which the hood is located and to replace air exhausted through the hood.

3.1.16 *rotating vane anemometer (RVA)*—an instrument that measures air velocity using an electronic pickup to measure the rotating speed of the vane or propeller. The body of the anemometer is positioned perpendicular to the expected direction of the air velocity.

3.1.17 *smoke emitter*—device that produces smoke particles from a chemical reaction. The rate of smoke production is sufficient to be followed with the naked eye.

3.1.18 *standard air*—air with a density of 0.075 lb/ft^3.

3.1.19 *velocity grid*—a velocity measuring device that consists of an array of holes on both sides of a matrix. The holes serve as pressure taps on the upstream and downstream sides of the device. When connected to a differential pressure monitor and calibrated, it will provide the average air velocity across the matrix.

4. Summary of Test Method

4.1 All systems that supply comfort conditioning, replacement air and/or supply air, makeup air, exhaust systems and cooking appliances in the kitchen shall be installed and operational.

4.2 The general ventilation system or systems for any portion or portions of the building that are adjacent to the

kitchen and/or supply transfer air to the kitchen shall be installed and operation during the test procedure and shall maintain the design air pressure in adjacent spaces and shall supply the necessary transfer air.

4.3 The airflow rates for HVAC, Replacement Air and kitchen exhaust shall be those specified.

4.4 All ventilation systems associated with the kitchen and spaces adjacent to the kitchen shall be turned on and operated as under full load cooking conditions.

4.5 The flow rate of air exhausted through the kitchen hood shall be measured and computed using the apparatus and methods defined in this test method. Results shall be adjusted and reported in standard cubic feet per minute (scfm).

4.6 When the computed air flow rate is not within 5 % of the specified value from 4.3, adjustments, such as changing fan speed shall be made until the measured computed air flow rates are within 5 % of specified values.

4.7 The total flow rate of air supplied to the kitchen shall be determined by measuring the flow rate through each supply diffuser and makeup air unit and reporting the corresponding air flow rates as standard cubic feet per minute (scfm). The total amount of air supplied to the kitchen shall be the sum of the measurements from the individual units.

4.8 When the measured air flow rate through any of the supply or makeup air units is less than 95 % of the specified value from 4.3, adjustments shall be made such as increasing fan speed and/or adjusting damper positions until the computed and specified air flow rates are within 5 % for each supply and makeup air unit.

4.9 With the supply air, makeup air, and exhaust air flow rates set to within 5 % of their design values, the ability of all exhaust hoods to capture and contain cooking effluent shall be evaluated. All cooking appliances shall be turned on to idle conditions and allowed to warm up for one hour. Smoke emitters shall be used to ensure that the smoke enters all the hoods without spillage around the entire perimeter of each exhaust hood.

4.10 If spillage occurs, the exhaust air flow rate in the hood must be increased, or the replacement air redirected, and the test repeated until no spillage is observed. The increase in exhaust flow rate is usually accomplished by increasing the fan speed.

4.11 The differential static pressure shall be measured between the kitchen and adjacent areas in the same building such as the dining area and dry storage areas, and the kitchen and outdoors.

4.12 When the kitchen static pressure is within 0.02–0.05 ± 0.005 of the static pressure of the dining area or any adjacent occupied area in the building, at least one kitchen exhaust system shall be adjusted to exhaust a larger amount of air until the pressure in the kitchen is a minimum of 0.005 in. water less than the surrounding areas.

4.13 When the total exhaust air flow rate from the kitchen has been increased more than 10 % above the design value to provide adequate capture and containment of the effluent, and the air pressure in the kitchen is more than 0.200 in. water less than the air pressure in adjacent spaces, the makeup air flow rate or supply air flow rate to the kitchen must be increased until the pressure differential is reduced to between 0.050 and 0.200 in. water.

5. Significance and Use

5.1 Successful kitchen exhaust hood performance requires the complete capture and containment of the effluent plume along the hood's entire perimeter. Any effluent leakage moving beyond 3 in. from the hood face will be deemed as having escaped from the hood, even if it may appear to be have been drawn back into the hood. If effluent spills from the hood, hot and greasy kitchens may be the result and the cause of the performance failure needs to be determined and corrected. Oftentimes, the exhaust flow rate needs to be increased to achieve proper hood performance for particular field conditions. As a result, the supply air to the kitchen will need to be increased to maintain the air balance. However, drafty room conditions due to incorrectly placed supply diffusers, cross drafts from windows and doors, return and supply at opposite ends of the kitchen, etc. could also severely degrade hood performance. Incorrectly designed supply systems may not be corrected by increasing the exhaust rate and could be corrected in a much more efficient and economical manner, such as by replacing a 4-way diffuser with a 3-way diffuser directed away from the hood. Likewise, if the plume is strongly captured, the hood may be over-exhausting and reducing the exhaust rate could be considered, along with a corresponding reduction of room supply air to maintain the building's air balance.

5.2 An appropriate airflow balance ensures adequate replacement air for the necessary exhaust conditions and allows the desired air pressure distribution to be maintained.

5.3 Negative air pressure in the kitchen with respect to the adjacent indoor spaces ensures that the air flow is from these spaces into the kitchen so that odors and cooking effluent are contained within the kitchen. However, too great a pressure imbalance will severely degrade hood performance by creating a wind tunnel effect. Negative air pressure in the dining area with respect to the outside is usually an indication that the supply air rate is inadequate and as a result the exhaust air system is not performing as specified.

6. Apparatus

6.1 *Velocity Grid,* for measuring average velocity across the face of a grease filter or extractor mounted in an exhaust hood and makeup air devices with a range of 25 to 2500 fpm and an uncertainty of ±3 % of reading.

6.2 *Barometer—Direct Reading or Electronic,* for measuring barometric or atmospheric pressure which is required to correct airflow readings to standard air density conditions. The instrument may be either a Bourdon tube type or an electronic type with accuracy of ±1 % of full scale.

6.3 *Differential Pressure Gauge,* for measuring the pressure difference across filter banks, supply air diffusers, makeup air devices or between rooms and for reading the velocity pressure