



Standard Test Method for Grease Particle Capture Efficiency of Commercial Kitchen Filters and Extractors¹

This standard is issued under the fixed designation F2519; 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 determine the grease particle capture efficiency of components and systems used in commercial kitchens to capture grease effluent prior to entering the exhaust duct. The results can be used to select a filter system best suited to a particular application.

1.2 This test method is applicable to filter components and systems. The performance information is obtained for new or clean filters and does not include the performance of used or loaded filters.

1.3 The filter can be evaluated with respect to the following (where applicable):

1.3.1 Pressure drop as a function of airflow through the filter (10.3), and

1.3.2 Particulate capture efficiency by particle size (10.4).

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 *This test method may involve hazardous materials, 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASHRAE Standard:²

ANSI/ASHRAE Standard 52.2-1999, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

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 Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329.

2.2 ISO Standard:³

ISO Standard 3966, Measurement of Fluid Flow in Closed Conduits—Velocity Area Method Using Pitot Static Tubes

3. Terminology

3.1 Definitions:

3.1.1 *airflow rate, n*—volumetric flow rate of air that passes through a filter or a bank of filters.

3.1.2 *capture efficiency, n*—proportion of aerosol particles removed by a filter as a function of particle size, usually expressed as a percentage.

3.1.3 *cartridge filter, n—removable extractor*, a removable, integral component of listed exhaust hoods, which is typically constructed of stainless steel and containing a series of horizontal baffles designed to remove grease and drain it into a container.

3.1.4 *fixed extractor, n—water-wash hood or linear slot hood*, a fixed, integral component of listed exhaust hoods, which is typically constructed of stainless steel and containing a series of horizontal baffles that run the full length of the hood.

3.1.5 *grease filter, n*—device installed into a hood to capture grease effluent before it enters the exhaust duct. Several identical devices may be installed in parallel in a hood. The device may consist of more than one component or section.

3.1.6 *pressure drop, n*—change in static pressure between the front surface of the grease filter and its rear surface under the rated airflow rate conditions.

3.1.7 *reference hood, n*—Type I exhaust hood used for the “no extractors” condition when measuring the efficiency and pressure drop of fixed extractor hoods. This is typically the same hood that is used for testing removable grease filters and removable cartridge filters.

3.2 Symbols:

E = capture efficiency
 n = number of sample sets

³ Available from International Organization for Standardization (ISO), 1 rue de Varembe, Case postale 56, CH-1211, Geneva 20, Switzerland.

P	= penetration
t	= t distribution variable
T	= sampling time
W	= counts of each size range (or channel) with test device(s) installed
WO	= counts of each size range (or channel) without test device(s)
δ	= standard deviation of a sample

3.3 Subscripts:

b	= background
c	= correlation
e	= estimated
i	= sample number
lcl	= lower confidence limit
n	= number of sample sets
o	= observed
t	= testing a filter
ucl	= upper confidence limit
w	= with test device(s) installed
wo	= without test device(s) installed

4. Summary of Test Method

4.1 There are three predominant classes of filters in kitchen ventilation grease extraction systems: removable baffle filters, removable cartridge filters, and fixed extractors.

4.2 Removable baffle and cartridge filters to be tested are installed into the test system.

4.2.1 Identical filters to be tested are installed into a standard 4-ft canopy hood connected to a nominal 12-in. round duct exhaust system. The filters should fit tightly together and into the opening and any bypasses larger than 1/8-in. wide on the ends are sealed.

4.2.2 For fixed-extractor systems, a reference hood shall be used for testing conditions that call for no filters to be installed in the hood. Testing requires switching between the reference hood and the fixed extractor hood.

4.2.3 A filter system to be used in a non-standard canopy hood is installed at the height of actual application above the floor and connected to a nominal 12-in. round duct exhaust system.

4.2.4 The static pressure drop across the filters is recorded at the test airflow.

4.2.4.1 For removable baffle or cartridge filters, the net filter pressure drop is determined by subtracting the pressure drop of the hood when the filters are removed from the pressure drop measured when the filters are installed. The total exhaust volumetric flow rate must be equal in both pressure drop measurements.

4.2.4.2 For fixed-extractor hood systems, the pressure drop is determined by subtracting the pressure drop of the reference hood when the filters are removed from the pressure drop measured on the fixed-extractor hood. The total exhaust volumetric flow rate must be equal in both pressure drop measurements.

4.3 The total airflow rate through the exhaust system is set so that the volumetric flow rate through the filter under test is

equivalent 250 cfm per linear foot (width) of filter (based on external filter dimensions).

4.3.1 Performance may also be evaluated at other airflows in accordance with manufacturer recommendations (see [Appendix X1](#)).

4.4 Balanced makeup air shall be provided at $75 \pm 5^\circ\text{F}$ and $50 \pm 20\% \text{ RH}$.

4.5 Particulate capture efficiency for removable grease filter or removable cartridges is determined by comparing particle concentration versus size in the exhaust duct with and without the filters installed.

4.5.1 Particulate capture efficiency for hoods with fixed extractors is determined by comparing particle concentration as a function of particle size in the exhaust duct with the fixed extractor hood and the reference hood without the filters installed.

4.5.2 The test aerosol is oleic acid that covers a size range from 0.3 to 10 μm in diameter or as specified by the manufacturer. Efficiency shall be reported as zero from 0.3 μm to the lower limit of the test conditions. Particulate concentration measurements (as a function of particle size) are taken in the exhaust duct using an isokinetic sampling probe and an optical particle counter. The particulate capture efficiency is determined by taking the difference between the particle concentration with and without the filters installed at each particle size range set on the particle counter.

5. Significance and Use

5.1 The pressure drop results can be added to the pressure drops of other components in an exhaust system to determine the total exhaust fan pressure requirement.

5.2 The particulate capture efficiency can be used with known particulate size emission data for a cooking appliance-food product combination to determine the total mass of grease particles captured by the filter, the total mass of grease particles that pass through the filter, and the particle size distribution of the grease particles that pass through the filter. [Fig. 1](#) shows an example particle capture efficiency curve.

6. Apparatus

6.1 *Mandatory and Discretionary Requirements*—Critical dimensions and arrangements of the test apparatus are shown in [Figs. 2-5](#). Vertical ductwork may also be used with the same critical dimensions (duct diameter, length, and so forth). All dimensions shown are mandatory unless otherwise indicated. Units shown are in inches unless otherwise indicated. The design of equipment not specified, including but not limited to exhaust fan, makeup air system, and external structural supports, is discretionary, but the equipment must have adequate capacity to meet the requirements of this test method.

6.2 Test Facility:

6.2.1 Exhaust Hood:

6.2.1.1 The test installation should have a canopy exhaust hood which meets these requirements: 4 ft (1.2 m) in width and depth, minimum 2 ft (0.61 m) in height, wall mounted with the lower edge of the hood 6½ ft (2.0 m) from the floor and with a 12 in. (0.305 m) diameter round duct connected to the top

Particle Capture Efficiency (%) versus Particle Size

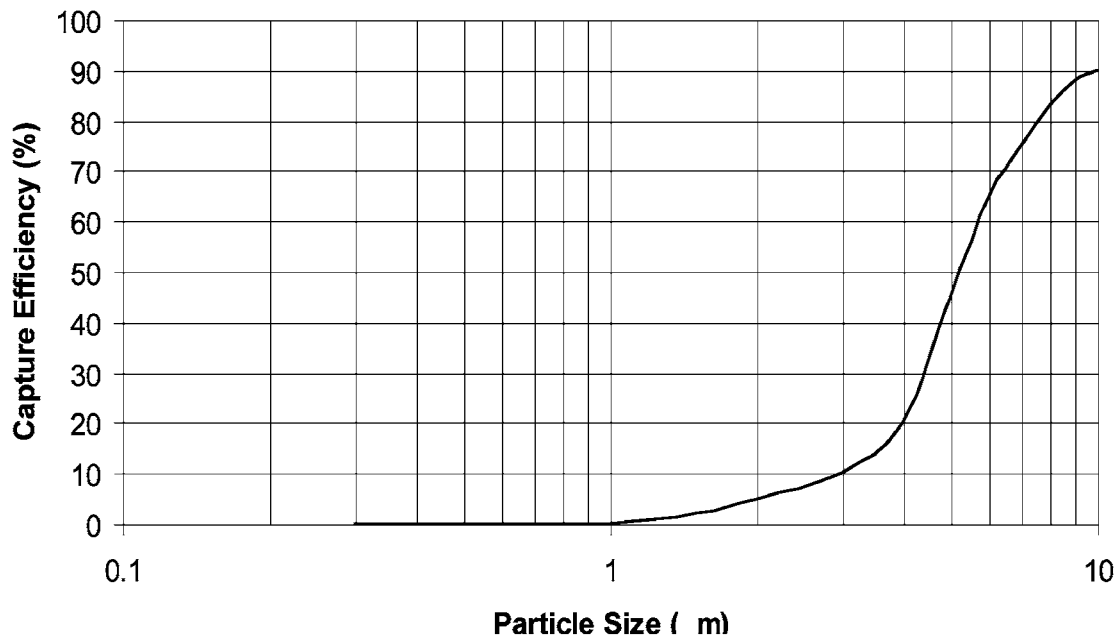


FIG. 1 Particle Capture Efficiency Example Curve

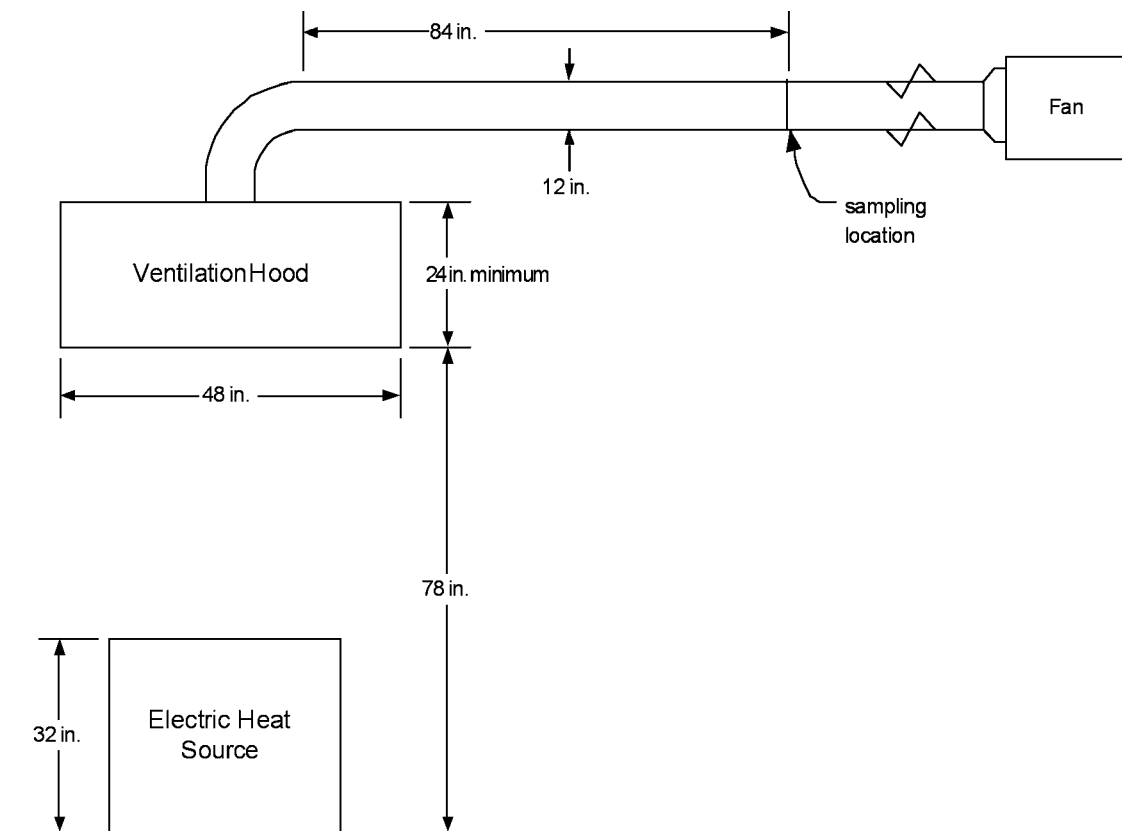


FIG. 2 Schematic Diagram of Test Apparatus—Front Elevation View of Horizontal Test Setup

in the center of the hood with the rear surface of the opening 1.0 in. from the back side of the hood.

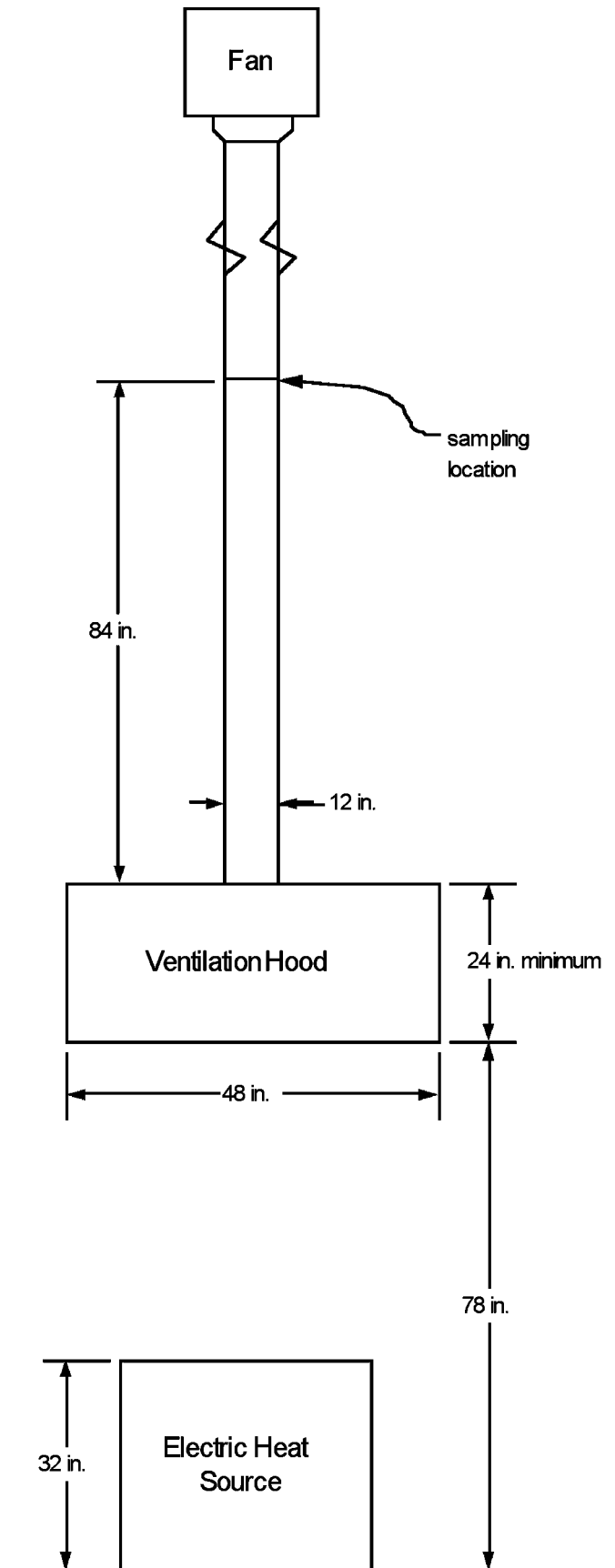


FIG. 3 Schematic Diagram of Test Apparatus—Front Elevation of Vertical Test Setup

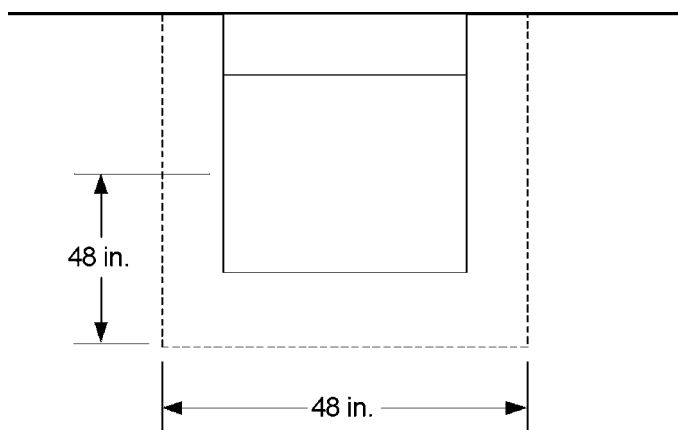


FIG. 4 Schematic Diagram of Test Apparatus—Plan View

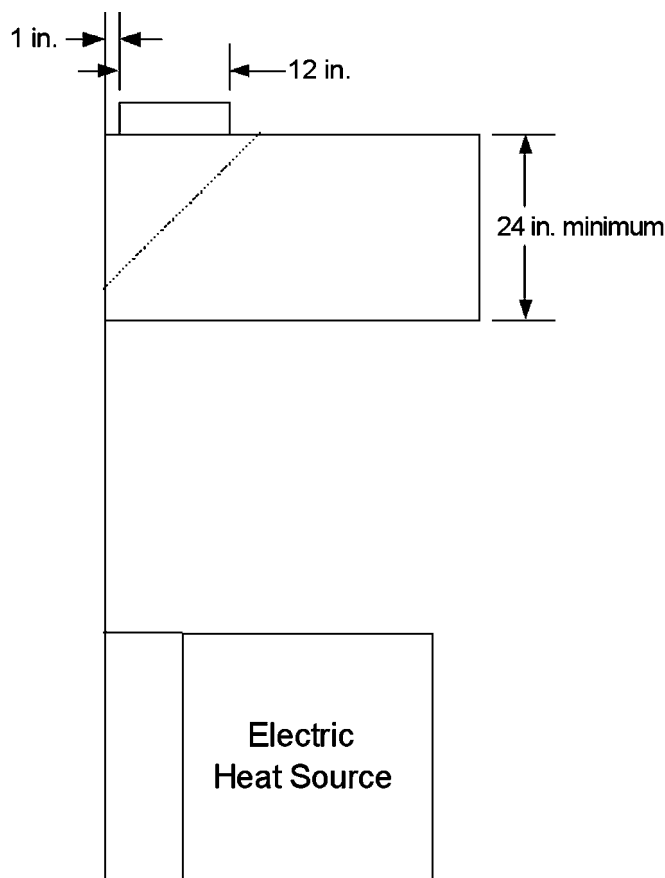


FIG. 5 Schematic Diagram of Test Apparatus—Side Elevation View

at a different height, a distance of 46 in. must be maintained between the appliance surface and bottom of the hood. The hood shall contain means for securing grease filters under test in a position typical in application.

6.2.1.2 Hoods with fixed extractors should be built to match the description given in 6.2.1.1 as closely as possible without affecting the hood's extraction efficiency.

6.2.1.3 The typical reference hood will be a canopy exhaust hood matching the one described in 6.2.1.1 and shown in Fig.

6. If the hood with fixed extractors cannot be built to match 6.2.1.1, then the reference hood shall be built to match the hood with fixed extractors.

6.2.1.4 To facilitate switching hoods, the lab may build rolling stands for each reference hood and the current hood being tested. These stands may be rolled in and out of the test rig. Care should be taken to insure that both hoods are installed in the same location at the same height (6½ ft) each time.

6.2.1.5 The test apparatus shown in Figs. 2-5 is designed for test filters with a nominal height of 20 in. It is permitted to test a bank of several filters in parallel if the width of an individual filtration device is less than 50 % of the width of the hood. Spacers may be added symmetrically on both ends of the filter under test if the filter does not span the entire width of the hood.

6.2.2 *Round Exhaust Duct*, 12 in. (0.305 m) in diameter, connected to the duct collar on the top of the exhaust hood and leading to an exhaust fan. All duct connections shall be sealed. The duct may be horizontal or vertical. If horizontal, it must have a 90-degree elbow configured as shown in Fig. 7. The elbow must have a centerline duct radius of 14-in.

NOTE 1—The r/D ratio is 1.167 for this configuration.

6.2.2.1 The distance from the duct collar for a vertical exhaust duct or from the end of the 90 degree elbow for a horizontal exhaust duct to the sampling location shall be 84 in. If a different sampling location is used, or a different exhaust configuration is used, an aerosol uniformity test shall be conducted.

6.2.2.2 The minimum distance from the sampling location to the nearest duct fitting or fan inlet shall be 24 in.

6.2.3 *Exhaust Fan*, capable of moving 1000 ft³/min (472 L/s) through the filters under test and the additional exhaust system components at the test static pressure condition. The fan shall have a variable frequency drive or other means to control the airflow rate. The exhaust shall be discharged outdoors.

6.2.4 *Makeup Air System*, a means for providing makeup air at 75 ± 5°F and 50 ± 20 % relative humidity to match exhaust rate without disturbing the airflow pattern near the exhaust hood.

6.2.5 *Heat Source*, a uniform electric heat source with a solid metal surface, a minimum 2 ft. deep by 3 ft. wide, maintained at an average surface temperature of 375 ± 5°F.

NOTE 2—A commercial electric griddle with a rated input between 7 and 10 kW and been shown to work well as a heat source.

6.2.5.1 The cooking surface of the heat source shall be 32 in. (0.81 m) above the floor. The heat source shall be centered under the hood from side to side and from front to back. Any air gap between the rear of the heat source and the back wall shall be sealed with a horizontal sheet of stainless steel positioned at the same height as the rear of the heat source.

6.3 Instrumentation:

6.3.1 *Flow Metering Station*, installed in the exhaust duct for measuring the airflow rate through the filters under test. Options include a grid of local velocity measurements using the log-Tchebycheff method, a flow nozzle, or a flow plate.

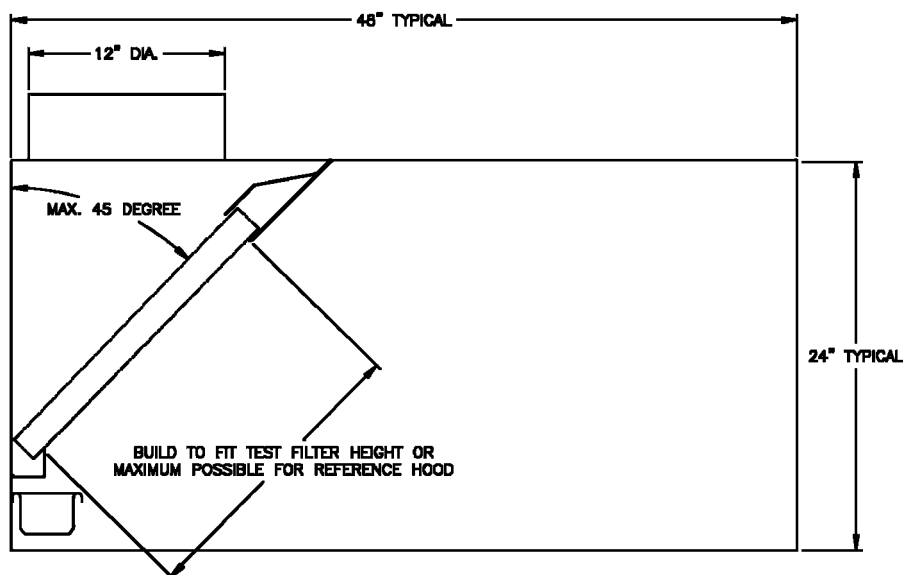


FIG. 6 Schematic Diagram of Reference Hood

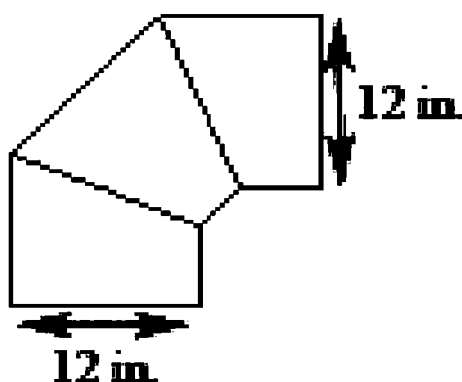


FIG. 7 Schematic Diagram of 90-Degree Elbow to Connect the Duct Collar on the Canopy Hood to a Horizontal 12 in. Diameter Round Exhaust Duct

If a nozzle or orifice plate is used, it must be mounted downstream from the particle sampling location.

6.3.1.1 Airflow rate may be determined using velocity traverse measurements according to the log-Tchebycheff method (ISO Standard 3966). Local velocities shall be measured at the particle sampling location using a pitot tube, hot film anemometer, or hot wire anemometer. Velocity profiles shall be measured without filters installed in the hood and with test filters installed. Results shall be used to determine airflow rate versus fan speed with and without filters installed to set the fan speed for proper airflow rate. The airflow and filter static pressure shall be continuously monitored.

6.3.1.2 Airflow rate may be determined by means of ASME long-radius flow nozzles with static taps. The dry bulb temperature, absolute pressure, and relative humidity of the exhaust airflow shall be measured in the duct immediately upstream of the flow-measuring device. These values shall be used for calculation of airflow rate. Measurements shall be

made with and without the test filters installed to set the fan speed for proper airflow rate at each test condition.

6.3.2 *Barometer*, for measuring absolute pressure of the air entering the exhaust hood. The barometer shall have a resolution of 0.2 in. Hg (670 Pa).

6.3.3 *Differential Pressure Gage*, for measuring the pressure drop across the filters under test. The pressure gage shall have a range from 0 to 5 in. water (0 to 2.5 kPa), and have an accuracy of 1 % at full scale.

6.3.4 *Temperature Sensors*, industry standard Type T or K thermocouples, one mounted at the inlet to the particle sampling probe in the exhaust duct to measure the temperature of the exhaust, the other located 6½ ft from the floor and 6 ft in front of the center of the exhaust hood with radiation shielding to measure the dry bulb temperature of the makeup air.

6.3.5 *Humidity Sensor*, relative humidity sensor or dew point hygrometer to determine the relative humidity of the makeup air at a height of 6½ ft above the floor and 6 ft in front of the center of the exhaust hood.

6.4 Aerosol Generation System:

6.4.1 Other than the requirements of the following subsections, design features of the aerosol generator are discretionary. Refer to [Appendix X2](#) for guidance.

6.4.2 The test aerosol shall be polydisperse liquid-phase oleic acid particles generated from a solution. The solution may be pure reagent grade oleic acid or a mixture of reagent grade oleic acid and isopropyl alcohol. The aerosol generator shall provide a stable test aerosol of sufficient concentration over the diameter size range to meet the requirements of Section 12 without overloading the aerosol particle counter. See 8.4. The aerosol generator shall be designed to ensure that all alcohol is evaporated from the particles prior to being introduced into the test section.

6.4.3 After any alcohol evaporation necessary, the aerosol shall be brought to a Boltzman electrostatic charge distribution by a beta or gamma radiation generator.