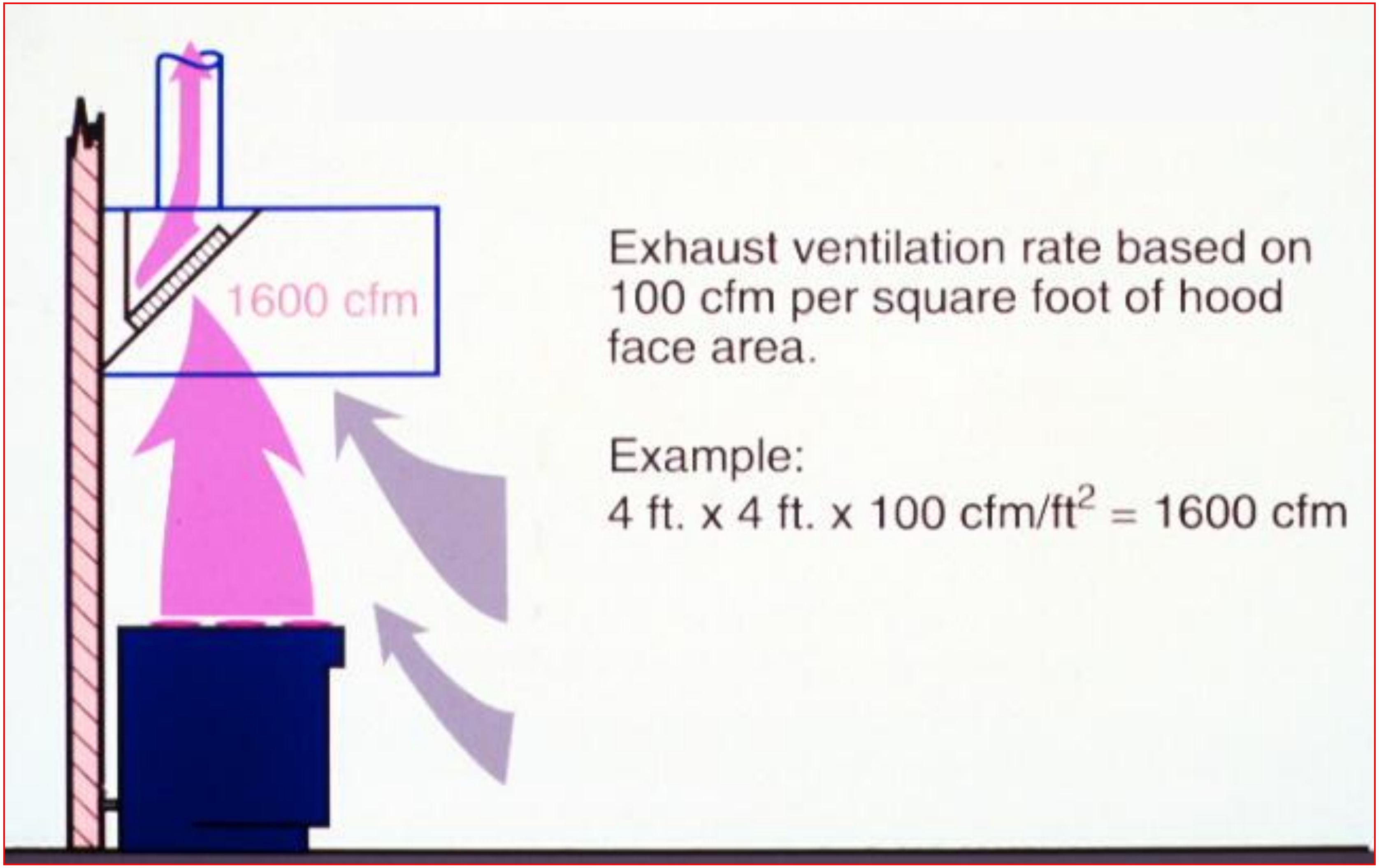
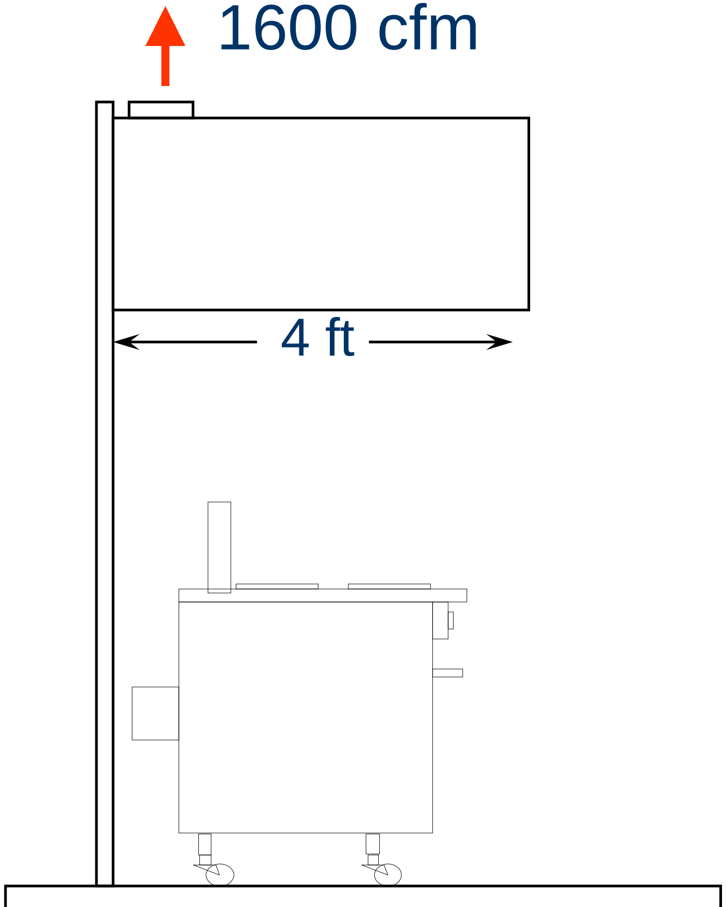
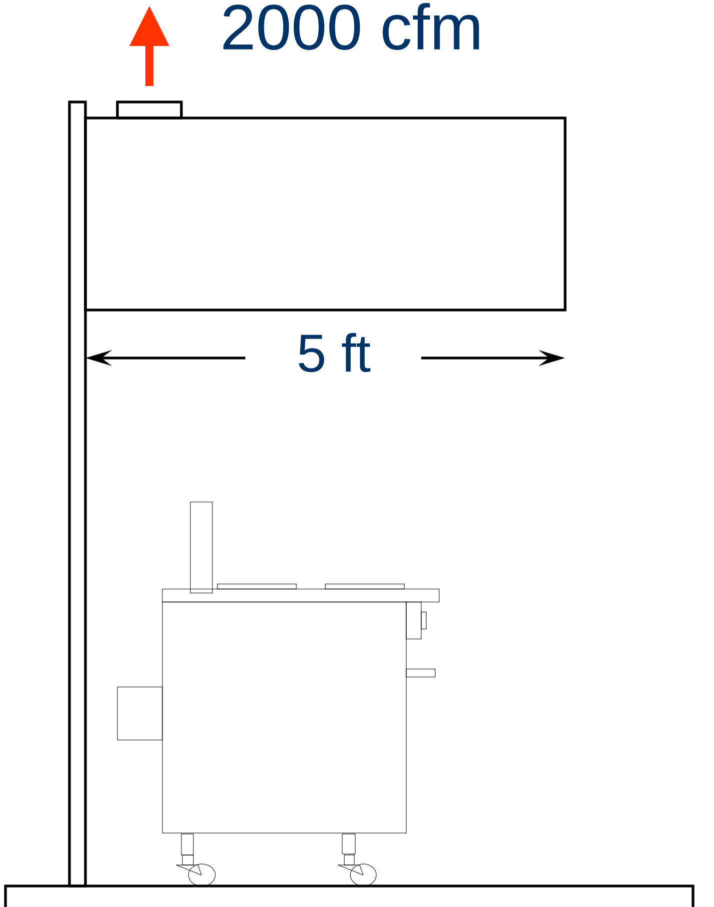
Unlisted Hood Calculation based on UMC!



Which hood needs more exhaust?

UMC specifies:





Minimum CFM for Unlisted Hoods
(per 2001 International Mechanical Code)

Type of Hood	IMC Minimum Exhaust Flow Rate for Unlisted Hoods (cfm per linear foot of hood)			
	Light Duty Equipment	Medium Duty Equipment	Heavy Duty Equipment	Extra Heavy Duty Equipment
Wall-mounted canopy	200	300	400	550
Single island canopy	400	500	600	700
Double island canopy	250	300	400	550
Eyebrow	250	250	not allowed	not allowed
Backshelf/Passover	250	300	400	not allowed

* Conversion from cfm per ft^2 to cfm per lin. ft. assumed a 4 ft. deep canopy hood

Light Duty Appliances
(ASHRAE Standard 154 & IMC)

- Gas and electric ovens (including standard, bake, roasting, revolving, retherm, convection, combination convection/steamer, conveyor, deck or deck-style pizza, and pastry)
- Electric and gas steam-jacketed kettles
- Electric and gas compartment steamers (both pressure and atmospheric)
- Electric and gas cheesemelters.
- Electric and gas rethermalizers

Medium Duty Appliances

(ASHRAE Standard 154 & IMC)

- Electric discrete element ranges (with or without oven)
- Electric and gas hot-top ranges
- Electric and gas griddles
- Electric and gas double-sided griddles
- Electric and gas fryers (including open deep-fat fryers, donut fryers, kettle fryers, and pressure fryers)
- Electric and gas pasta cookers
- Electric and gas conveyor (pizza) ovens
- Electric and gas tilting skillets/braising pans
- Electric and gas rotisseries

Heavy Duty Appliances

(ASHRAE Standard 154 & IMC)

- Electric and gas underfired broilers
- Electric and gas chain (conveyor) broilers
- Gas open-burner ranges (with or without oven)
- Electric and gas wok ranges
- Electric and gas overfired (upright) broilers
- Salamanders

Extra-Heavy Duty Appliances

(ASHRAE Standard 154 & IMC)

- Appliances using solid fuel such as wood, charcoal, briquettes, and mesquite to provide all or part of the heat source for cooking.

Exemption (both IMC and UMC):

Listed exhaust hoods are to be installed in accordance with the terms of their listing and the manufacture’s installation instructions.

Underwriters Laboratories (UL) Standard 710

Exhaust hoods for commercial cooking equipment.

Part of this UL Standard is a "cooking smoke and flare up" test. This test is essentially a capture and containment (C&C) test where "no evidence of smoke or flame escaping outside the exhaust hood" must be observed.

Hoods bearing a recognized laboratory mark are called listed hoods, while those constructed to the prescriptive requirements of the building code are called unlisted hoods. Generally, a listed hood can be operated at a lower exhaust rate than an unlisted hood of comparable style and size over the same cook line.

UL clearly states that under the application of UL 710 "air flow rates are established under draft free laboratory conditions with the appliance cooking surface temperatures as noted. Greater exhaust and/or lesser supply air flow rates may be required for each specific installation to obtain complete vapor and smoke removal."

Typical Minimum Exhaust Flow Rates for Listed Hoods by Cooking Equipment Type*

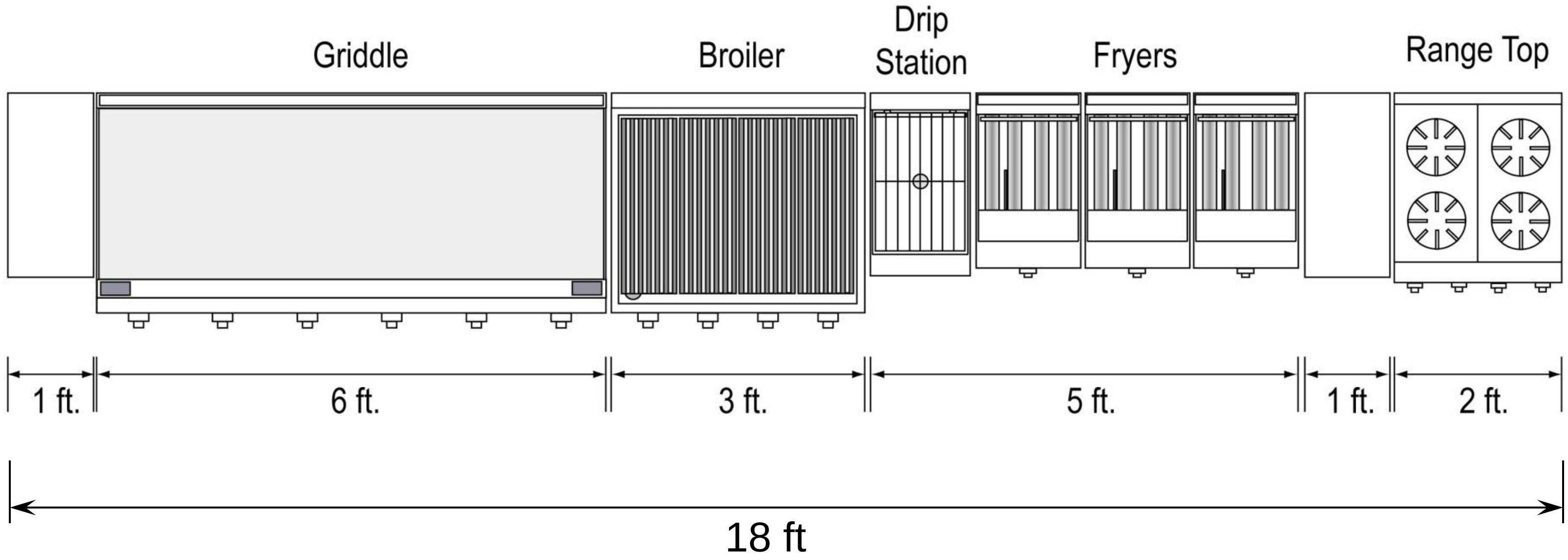
Type of Hood	Minimum Exhaust Flow Rate (cfm per linear foot of hood) Light Duty Equipment	Medium Duty Equipment	Heavy Duty Equipment	Extra Heavy Duty Equipment
Wall-mounted canopy	150 - 200	200 - 300	200 - 400	350+
Single island canopy	250 - 300	300 - 400	300 - 600	550+
Double island canopy	150 - 200	200 - 300	250 - 400	500+
Eyebrow	150 - 250	150 - 250	N/A	N/A
Backshelf/Passover	100 - 200	200 - 300	300 - 400	not recommended

* ASHRAE Applications Handbook

Note: many hood manufacturers have software tools to select an appropriate exhaust rate for a given cook line!

Real-World Hood Selection & Sizing

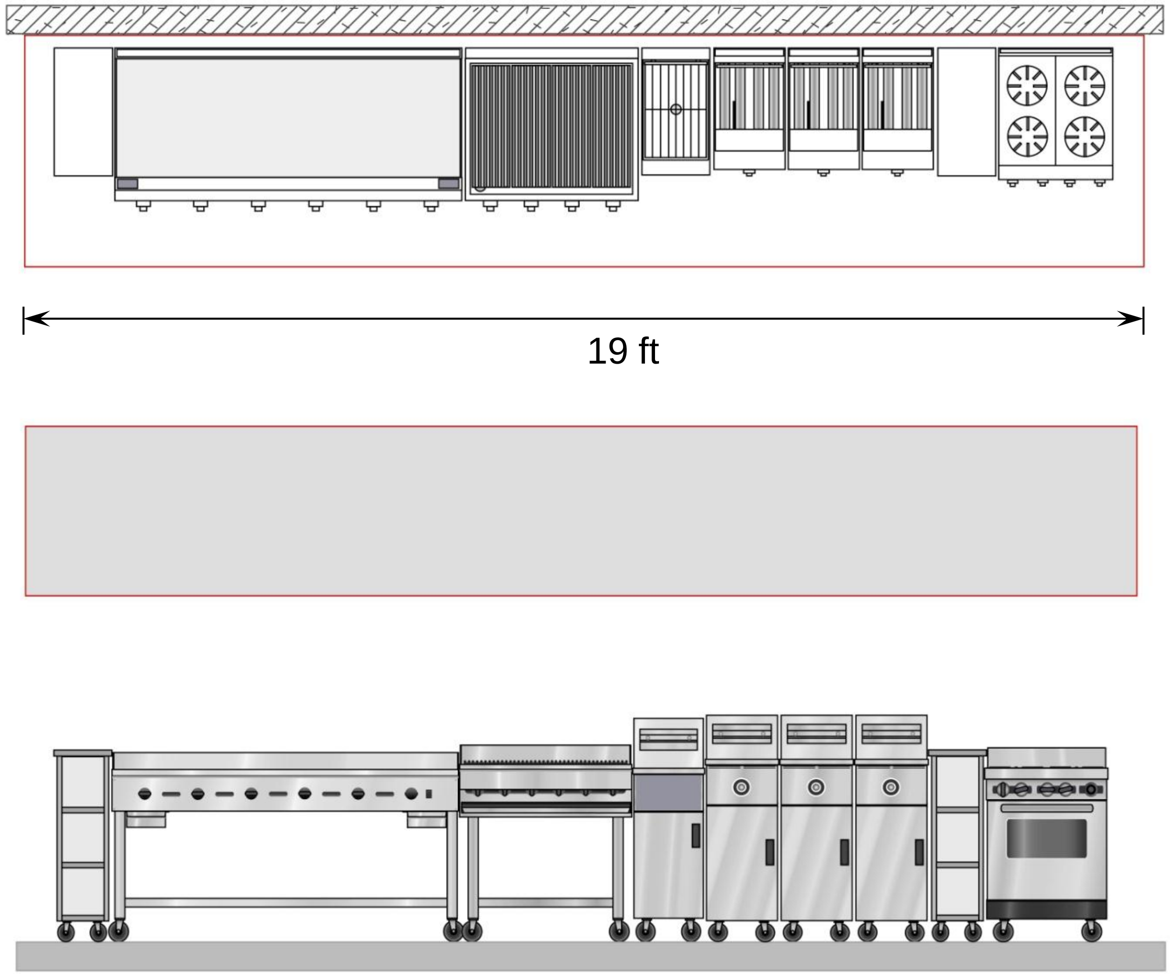
- Casual dining/short-order style appliance line
- Appliance located approx. 6 in. off the back wall



Hood Type? ______________ Hood features?_________________

Min. Hood length?_________ Design Exhaust rate?__________

Unlisted Wall Mounted Canopy Hood



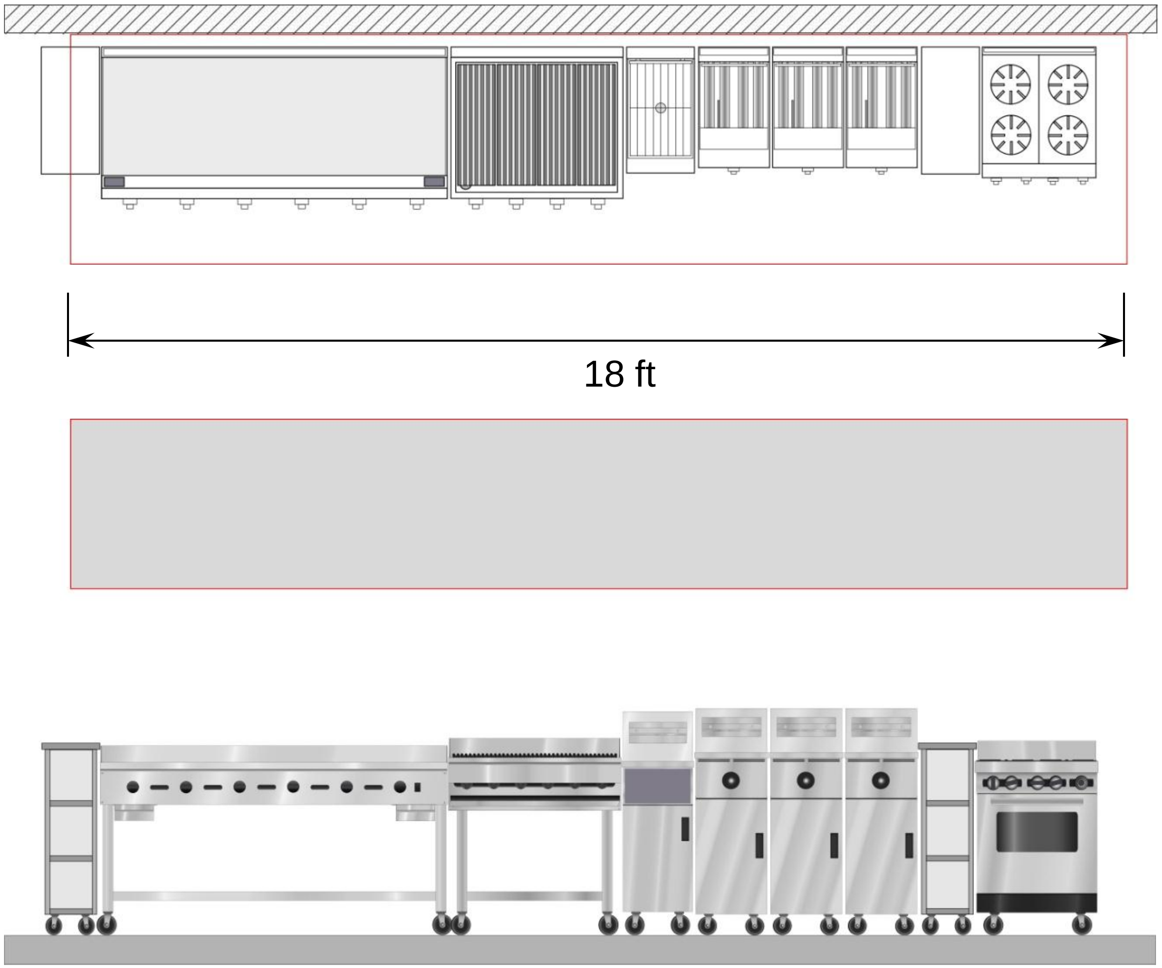
per IMC for Heavy Duty Equipment:

19 ft. x 400 cfm/ft. = 7600 cfm

per UMC for high temperature :

19 ft x 4 ft x 100 cfm/ft^2 = 7600 cfm

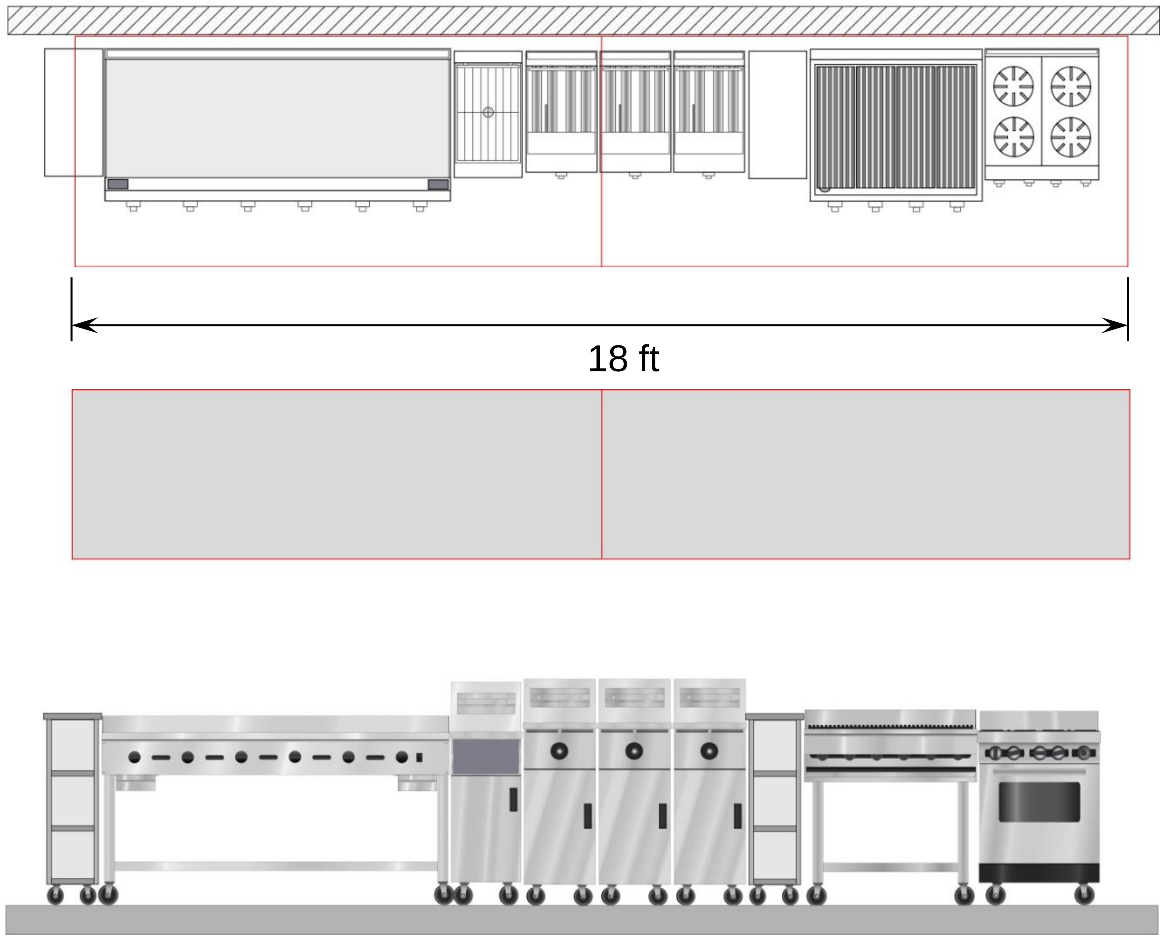
Smaller Unlisted Wall Canopy Hood



per IMC for Heavy Duty Equipment:
18 ft. x 400 cfm/ft. = 7200 cfm

per UMC for high temperature :
18 ft x 4 ft x 100 cfm/ft^2 = 7200 cfm

2 Unlisted Hoods with Rearranged Line

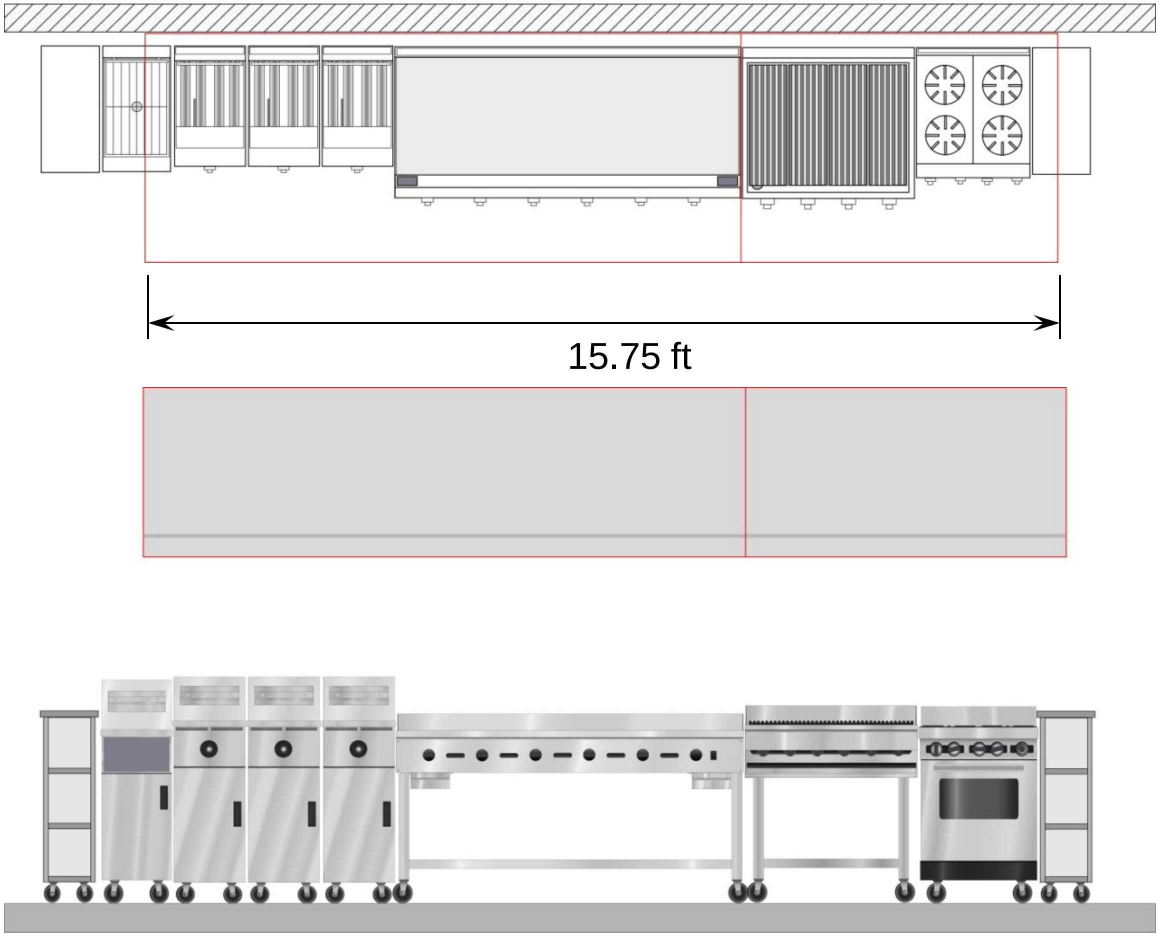


Hood over broiler & range:
9 ft. x 400 cfm/ft. = 3600 cfm

Hood over griddle & fryer:
9 ft. x 300 cfm/ft = <u>2700 cfm</u>

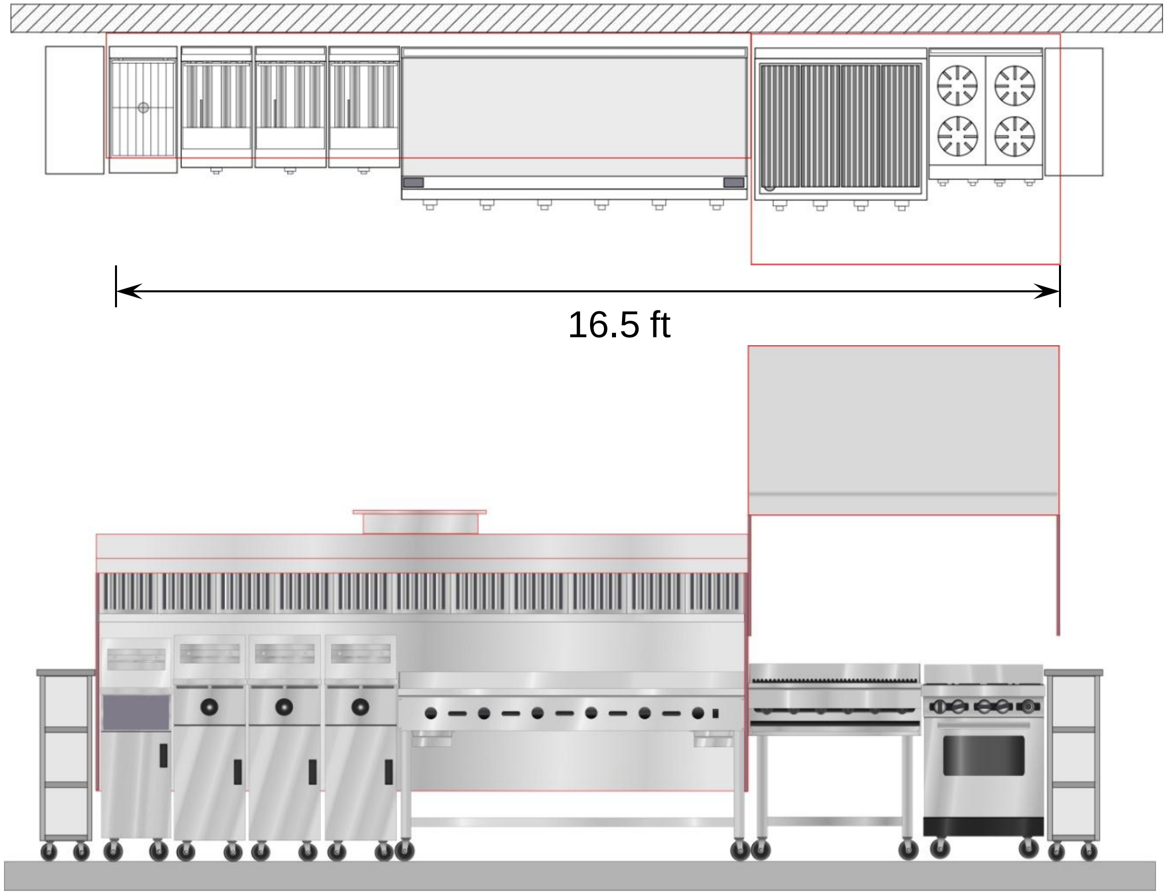
Total = 6300 cfm

2 Unequal Length Listed Hoods



Hood over griddle & fryers: 10.25 ft. x 250 cfm/ft.	=	2560 cfm
Hood over broiler & range: 5.5 ft x 400 cfm/ft	=	2200 cfm
Total	=	4760 cfm

Custom Combo Backshelf/Canopy



Proximity hood over griddle & fryers:

11 ft. x 150 cfm/ft.	=	1650 cfm

Canopy hood w/side panels over broiler & range:

5.5 ft x 300 cfm/ft	=	1650 cfm
Total	=	3300 cfm

Design Strategy Comparison:

19 ft. unlisted hood	=	7600 cfm
18 ft. unlisted hood	=	7200 cfm
2 unlisted hood sections (with rearranged line)	=	6300 cfm
2 Listed Hood Sections (with rearranged line)	=	4760 cfm
Custom Backshelf/Canopy	=	3300 cfm

Another path to exhaust hood performance...

Lab-Based Hood Design

Food Service Technology Center affiliated with the Commercial Kitchen Ventilation Lab Wood Dale, IL

Manager:
Rich Swierczyna
Architectural Energy Corp.
Ph: 630-860-1439

Lab Originally Designed by McDonald's for Optimizing Hood Performance

… recently used to develop test method for Exhaust Hoods

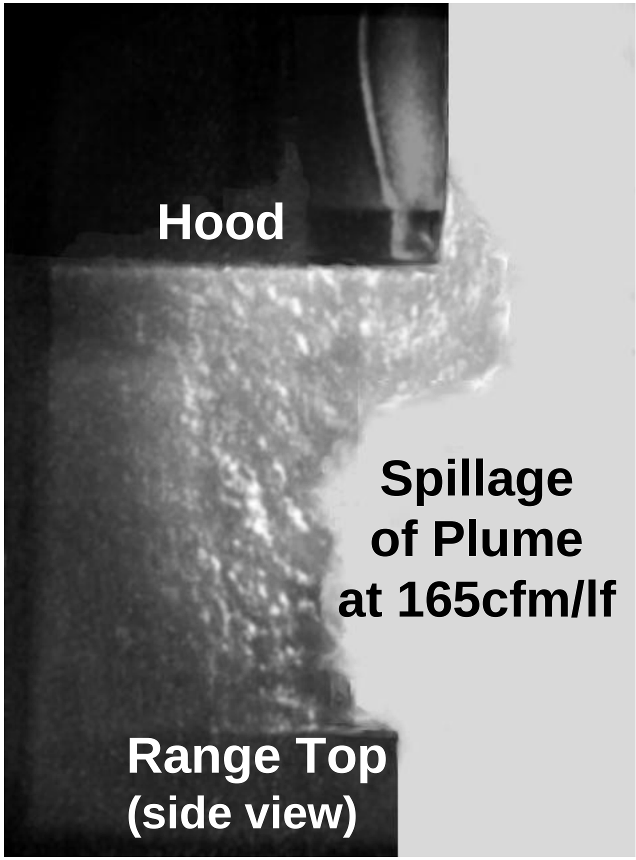
Scope of ASTM F1704-99:

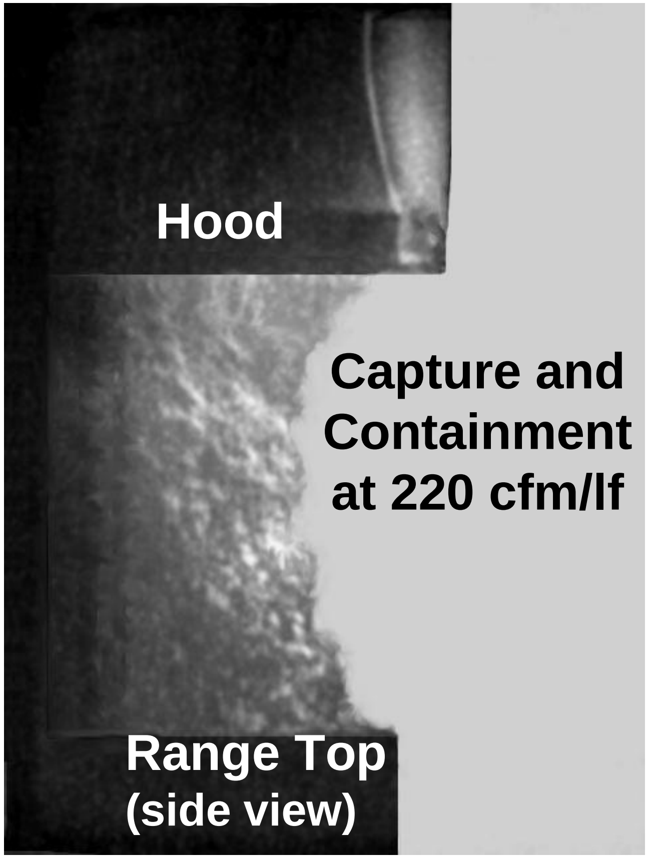
The performance evaluation of exhaust hoods with commercial cooking appliances and associated replacement air configuration

– Capture & Containment (C&C)

– Heat Gain to Space (Energy Balance Protocol)

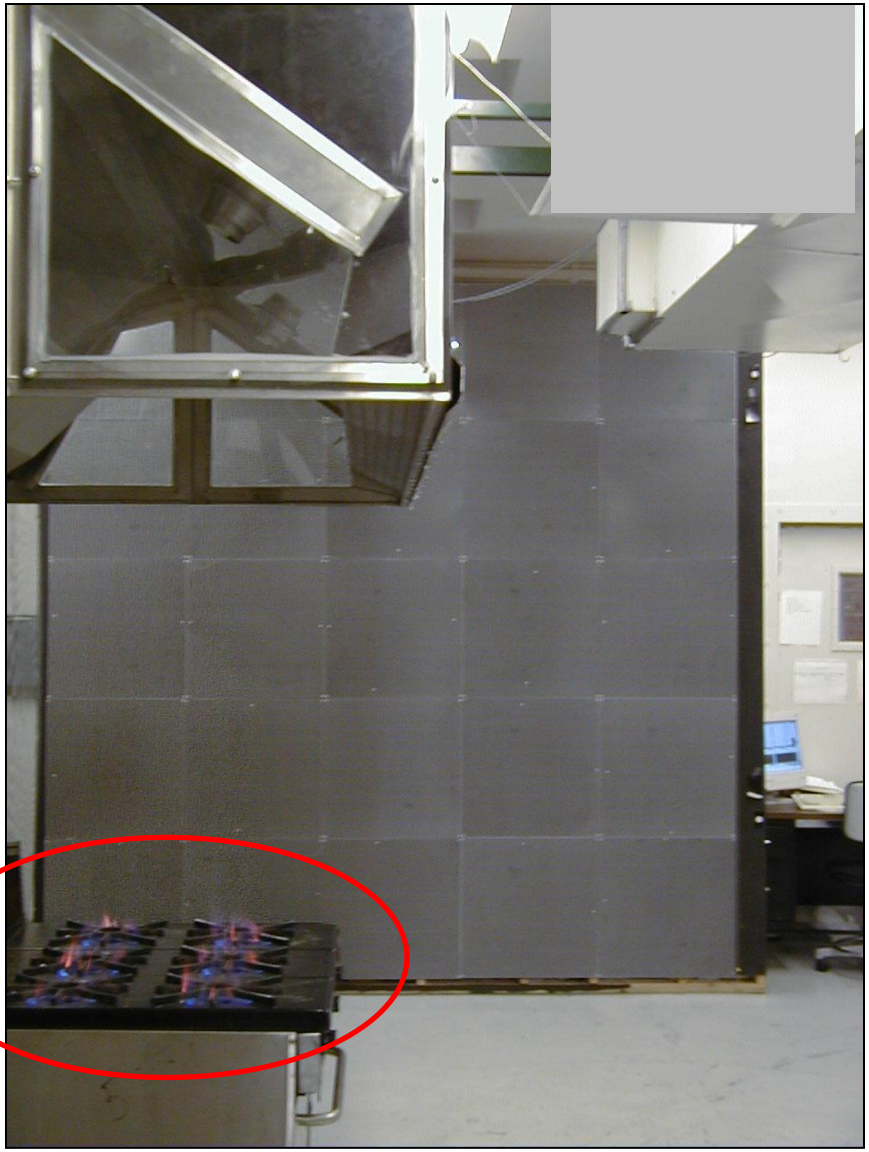
Schlieren Flow Visualization



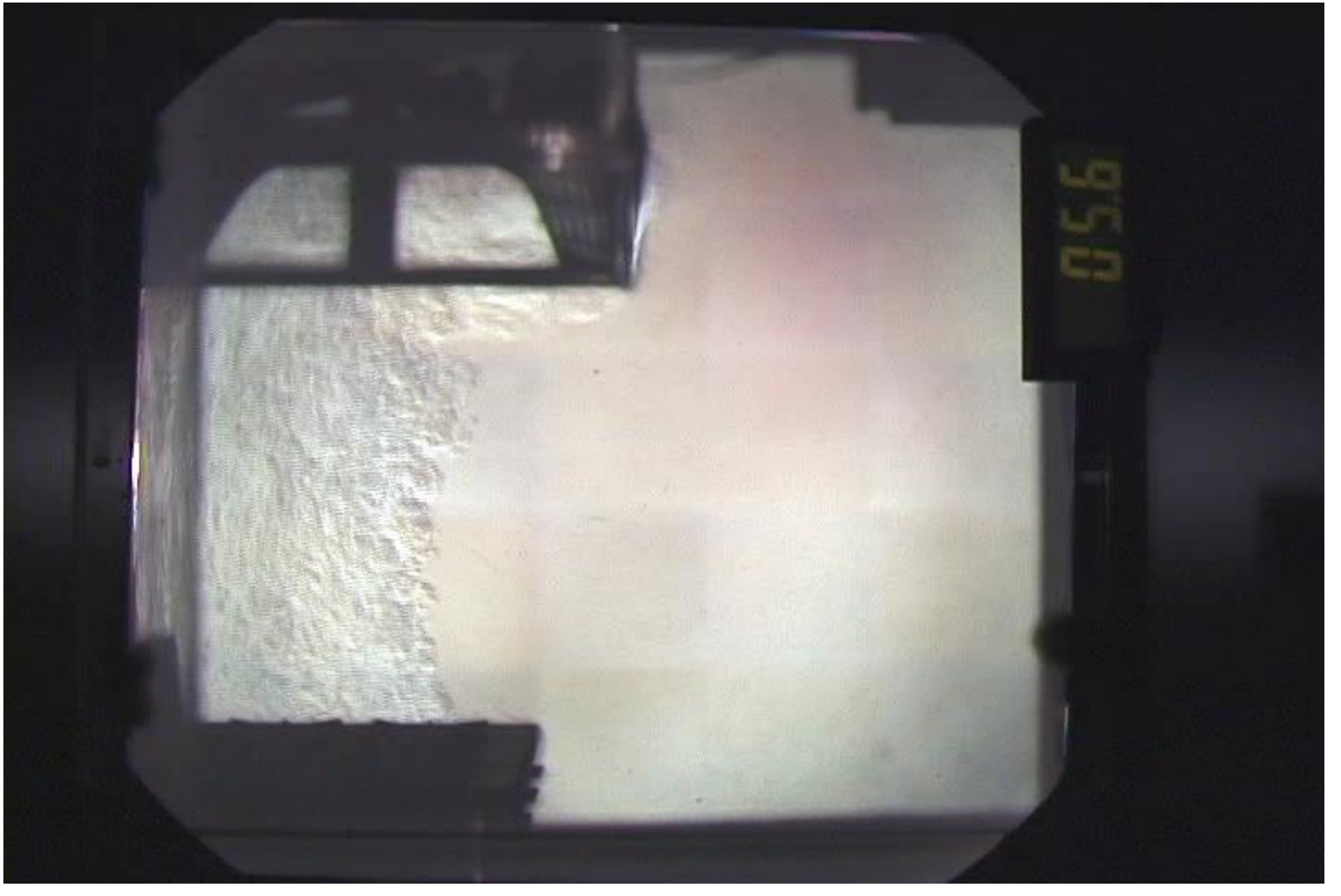


What the Eye Sees!

8-Ft Wall Mounted Canopy Hood

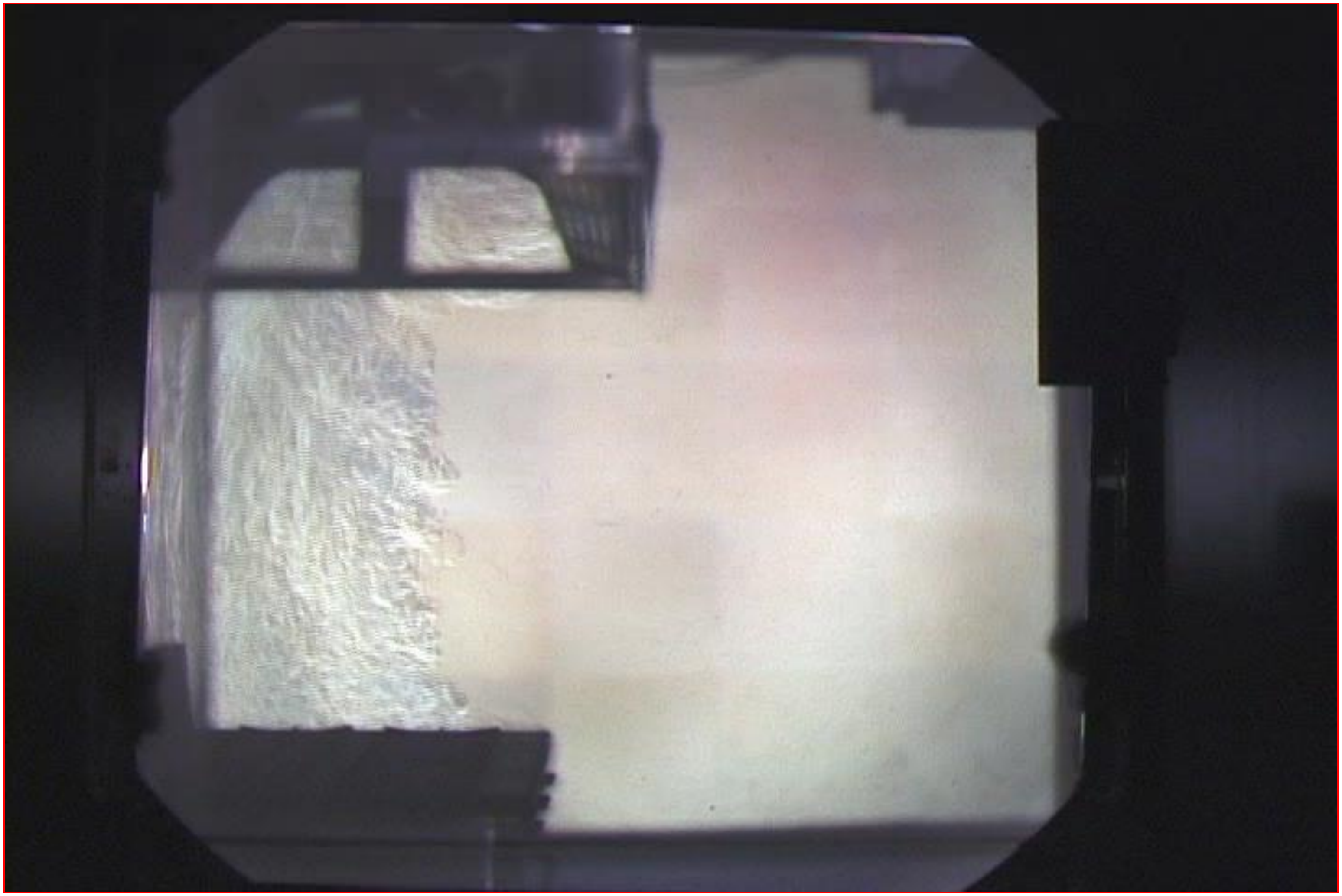


What the Camera Sees!



Hood Does Not Capture & Contain

Makeup Air Introduced at Low Velocity



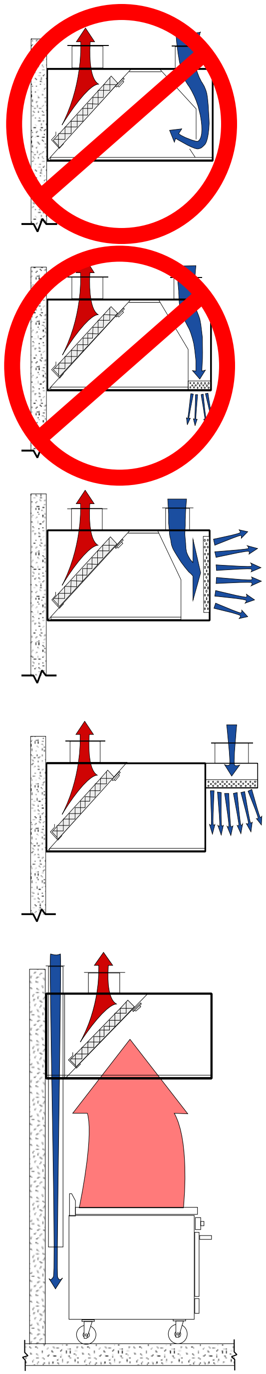
Capture & Containment (C&C) @ 1400 CFM

The Mechanical Design Disconnect!

Hoods do not like high velocity…

Replacement (Makeup) Air Options

- Transfer air (e.g., from dining room)
- Displacement diffusers (floor or wall)
- Ceiling diffusers (2-way, 3-way, 4-way)
- Slot diffusers (ceiling)
- Ceiling diffusers with perforated face
- Integrated hood plenum including…



- Short circuit (internal supply)
- Air curtain supply
- Front face supply
- Perforated perimeter supply
- Backwall supply (rear discharge)
- Combinations of the above

PUBLIC INTEREST ENERGY RESEARCH

"Research Powers the Future"

Focused on minimizing the effect that makeup air supply can have on the performance of exhaust hoods

www.fishnick.com

Design Guide 2
Commercial Kitchen Ventilation
Optimizing Makeup Air

This design guide provides information that will help achieve optimum performance and energy efficiency in commercial kitchen ventilation systems. The information presented is applicable to new construction and, in many instances, retrofit construction. The audience for this guideline is kitchen designers, mechanical engineers, food service operators, property managers, and maintenance people. This guide is intended to augment comprehensive design information published in the Kitchen Ventilation Chapter in the ASHRAE Handbook on HVAC Applications as well as Design Guide No. 1: *Commercial Kitchen Ventilation – Exhaust Hood Selection & Sizing.*

Introduction

An effective commercial kitchen ventilation (CKV) system requires balance—air balance that is. And as the designer, installer or operator of the kitchen ventilation system, you may be the first person called upon to perform your own "balancing act" when the exhaust hood doesn't work. Unlike a cooking appliance, which can be isolated for troubleshooting, the exhaust hood is only one component of the kitchen ventilation system. To further complicate things, the CKV system is a subsystem of the overall building heating, ventilating and air-conditioning (HVAC) system. Fortunately, there is no "magic" to the relationship between an exhaust hood and its requirement for replacement or makeup air (MUA). The physics are simple: air that exits the building (through exhaust hoods and fans) must be replaced with outside air that enters the building (intentionally or otherwise). The essence of *air balance:* "air in" = "air out!"

Background

If the replacement air doesn't come in, that means it doesn't go out the exhaust hood and problems begin. Not only will the building pressure become too "negative," the hood may not capture and contain (C&C) cooking effluents due to reduced exhaust flow. We have all experienced the "can't-open-the-door" syndrome because the exhaust fan is sucking too hard on the inside of the restaurant. The mechanical design may call for 8000 cubic feet per minute (cfm) of air to be exhausted through the hood. But if only 6000 cfm of outdoor air is able to squeeze in through closed dampers on rooftop units and undesirable pathways in the building envelope, then only 6000 cfm is available to be exhausted through the hood. The exhaust fan creates more suction (negative pressure) in an unsuccessful attempt to pull more air through the hood.

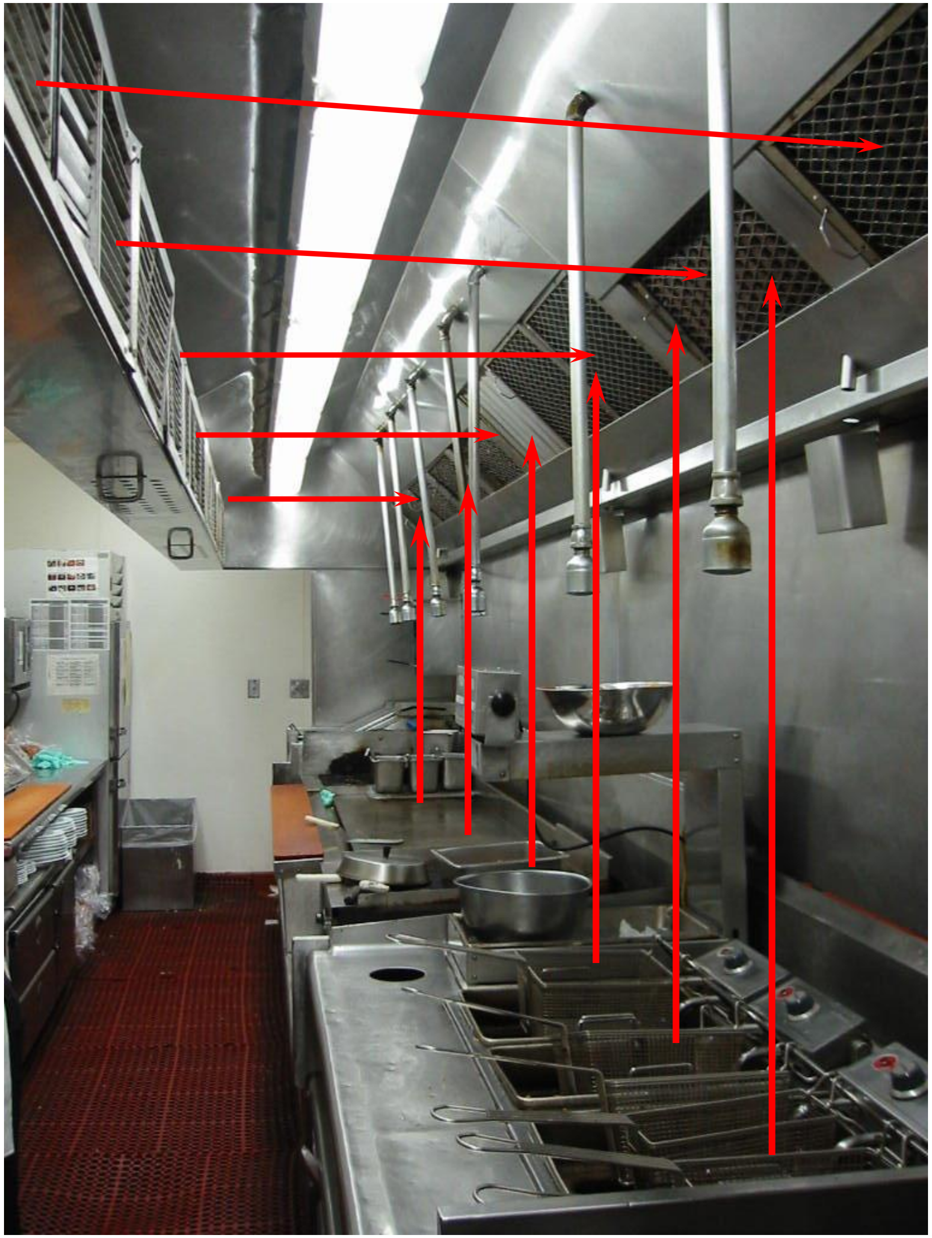
There is no piece of equipment that generates more controversy within the food service equipment supply and design community than the exhaust hood in all its styles and makeup air combinations. The idea that by not installing a dedicated

Hypothesis:

IF the local makeup air strategy were to have no effect on hood performance (i.e., equivalent to the displacement base-case condition),

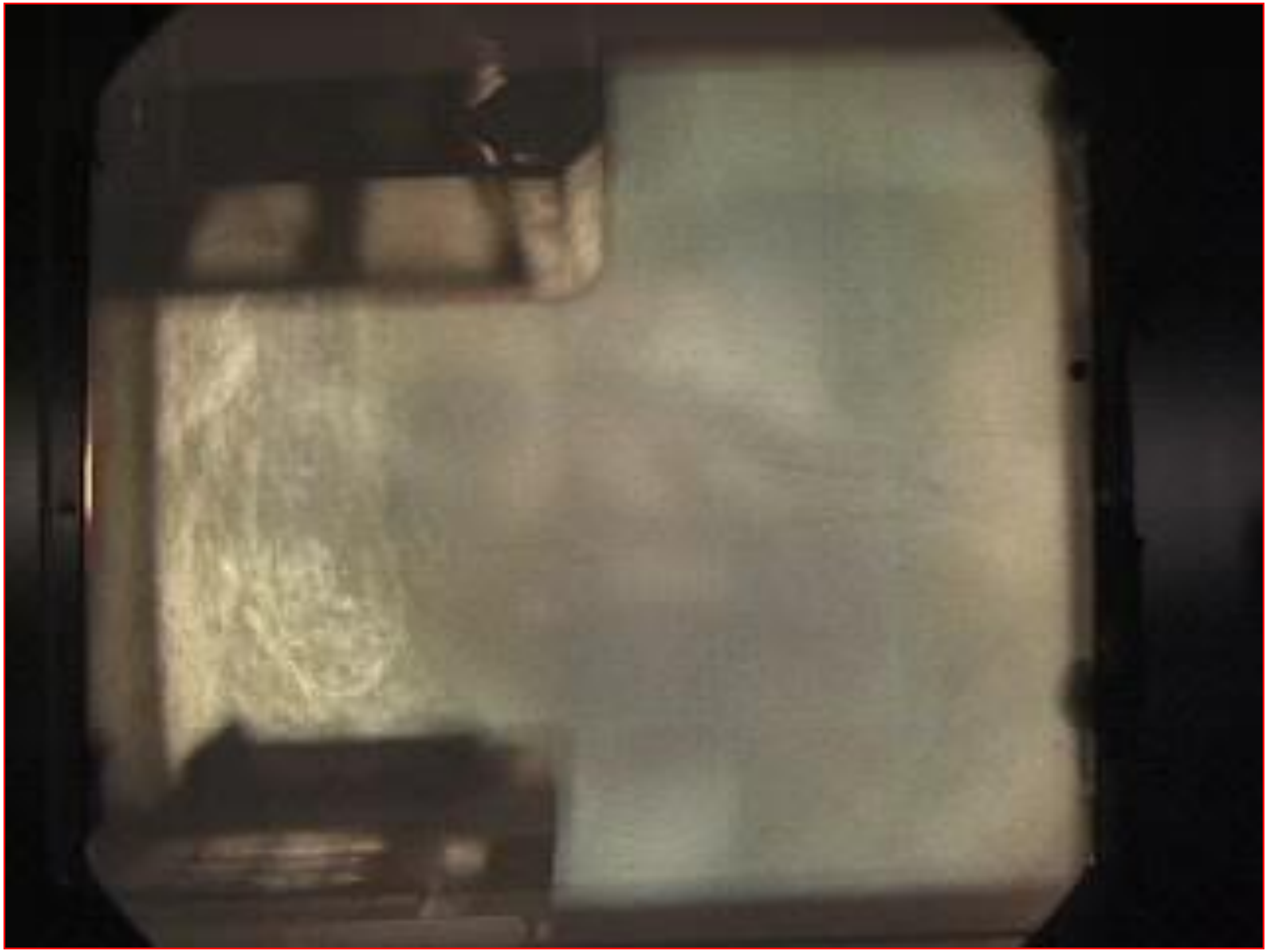
THEN it would be possible to replace 100% of the air exhausted through the makeup air configuration being investigated.

Short-Circuit Challenges Capture & Containment!



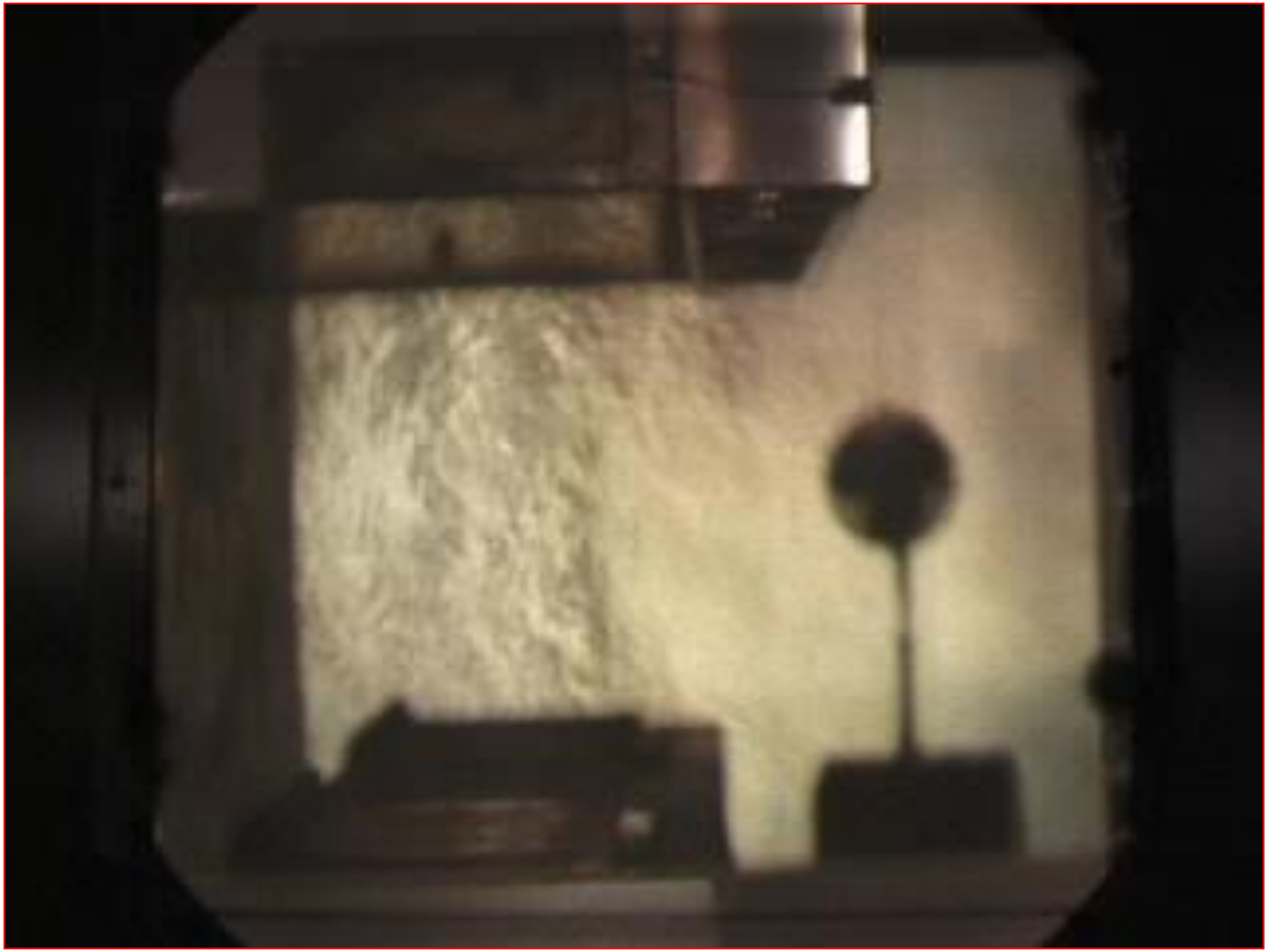
Wall Mounted Short Circuit Canopy Hood

Two Charbroilers Idling -- 3375 cfm Exhaust
2100 cfm (62%) Internal Makeup Air



Air Curtain (Perimeter) Discharge

Two Broilers Simulated Cooking -- Spillage at 4100 cfm Exhaust 1200 cfm (29%) Air Curtain Supply



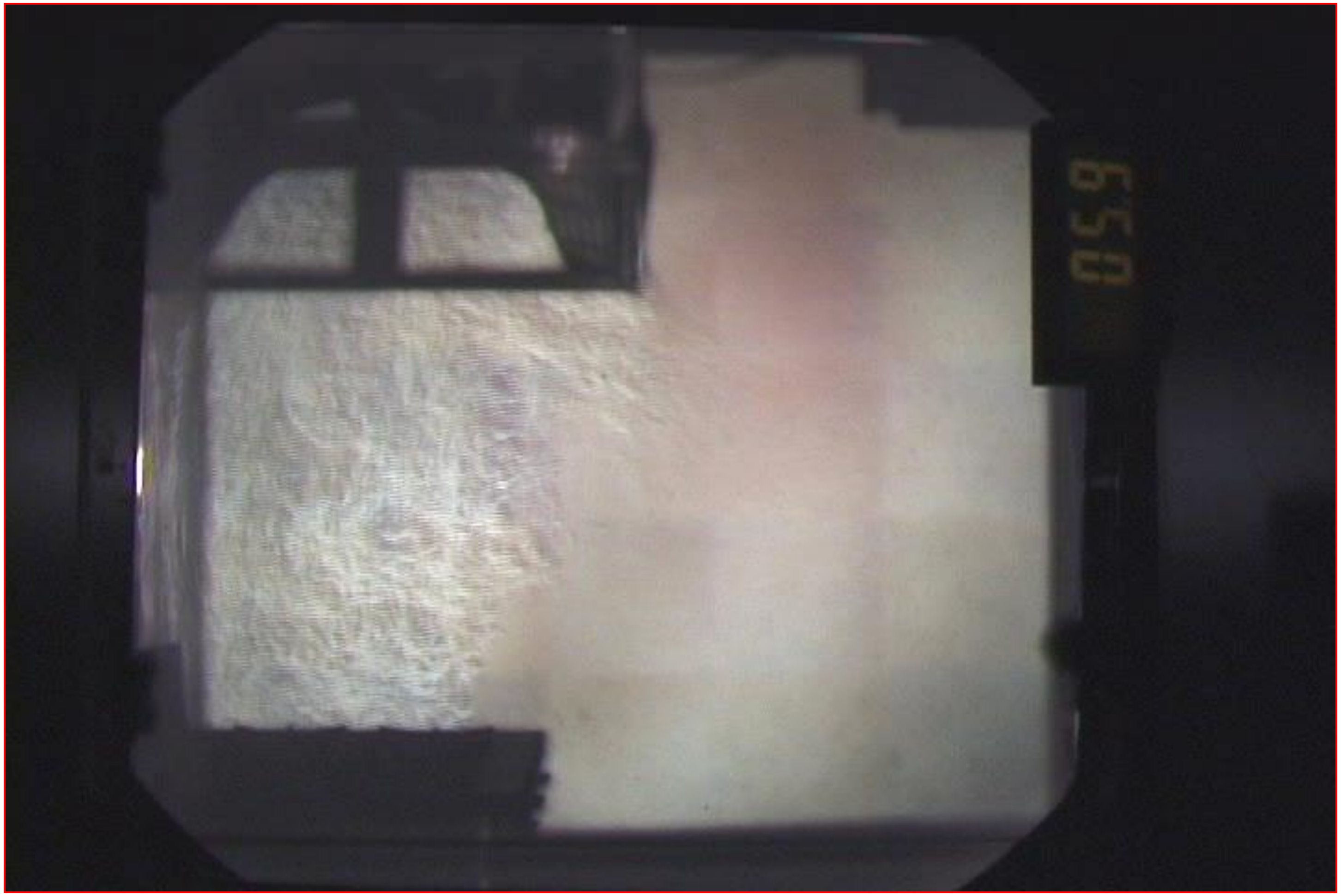
Air Curtain, Real World

Don’t go there!

4-Way Diffuser Set-up

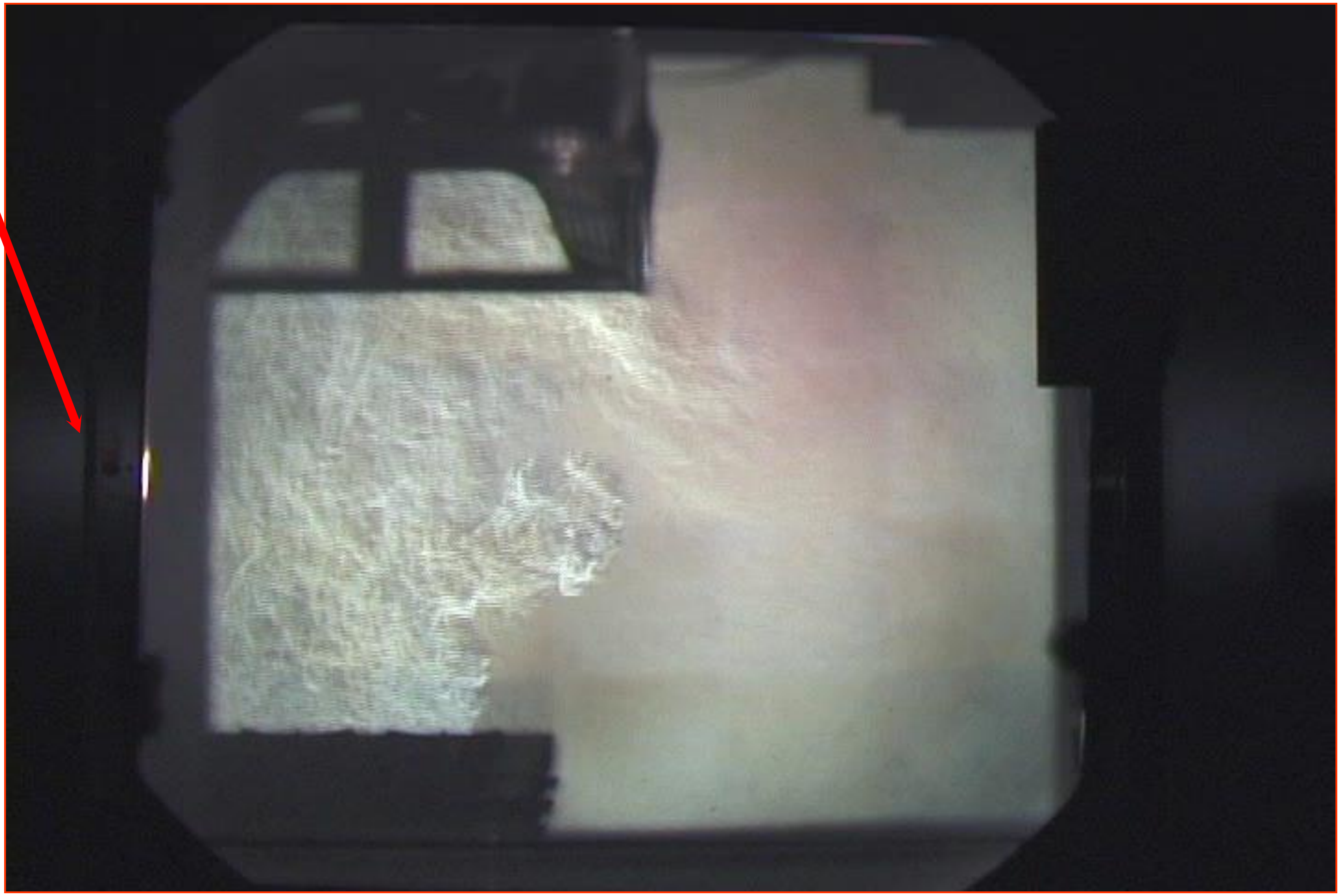
8-Ft Wall Mounted Canopy Hood

1400 SCFM to 4 Way



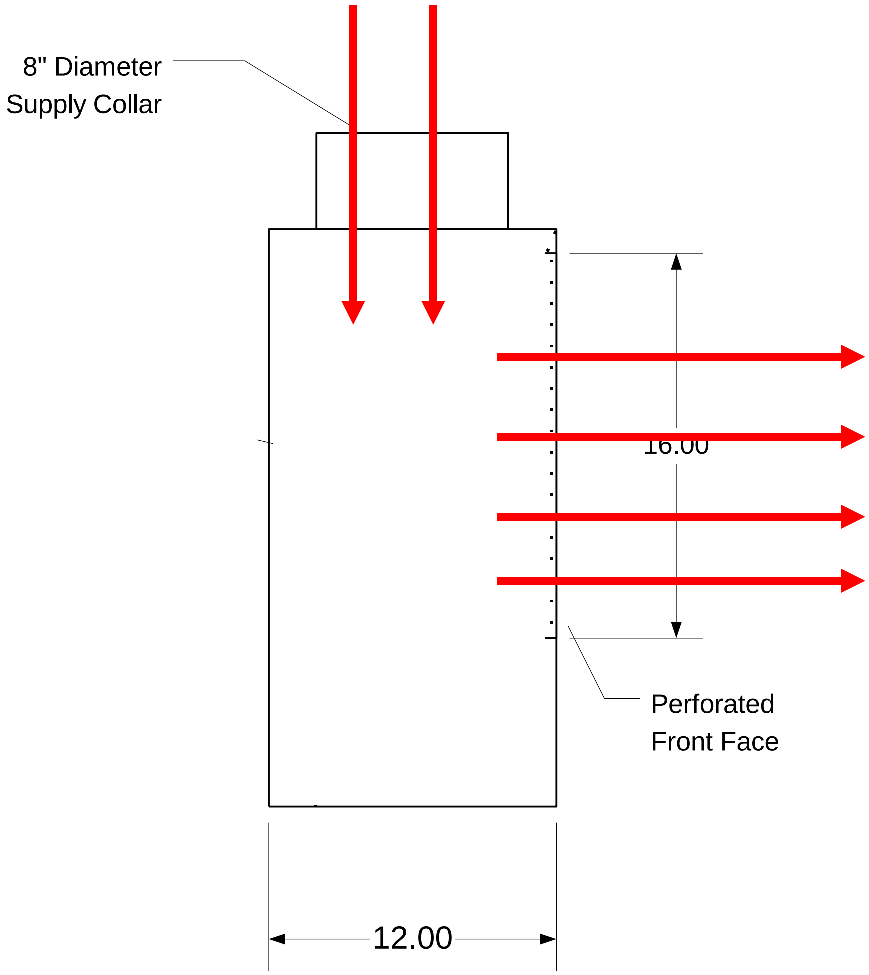
Even Worse with Island Canopy Hood

No Back Wall



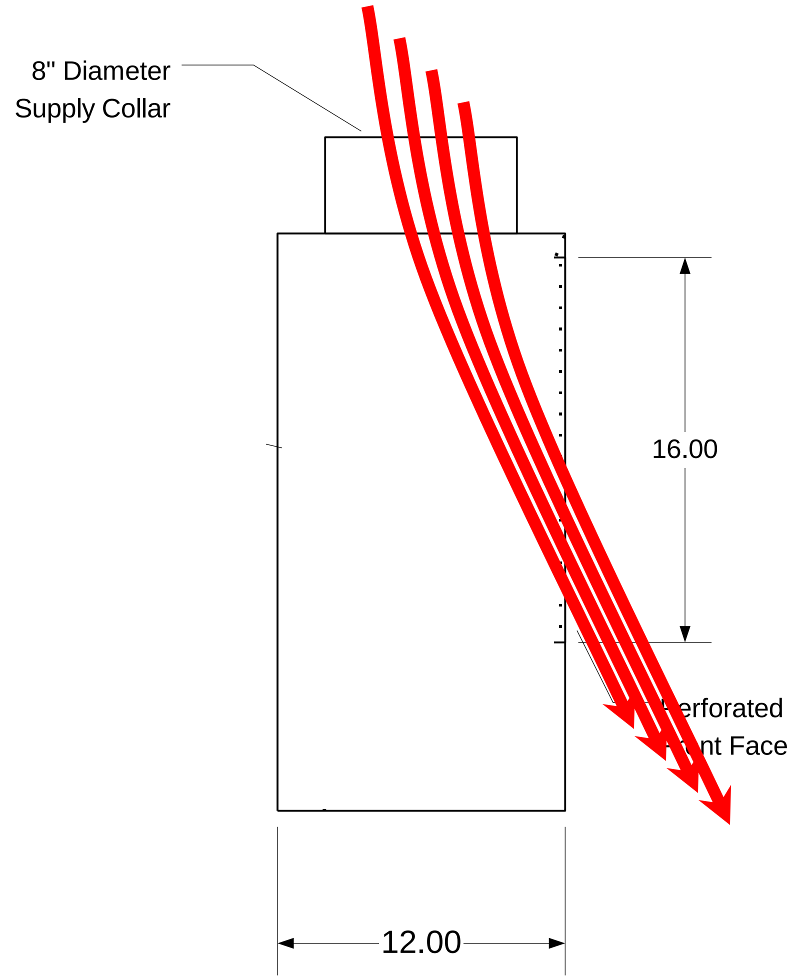
Front Face Discharge

Front Face #1:
Plenum with no Baffling



Two Charbroilers Idling -- Spillage at 3600 cfm Exhaust
1200 cfm (33%) MUA through Front Face Diffusers

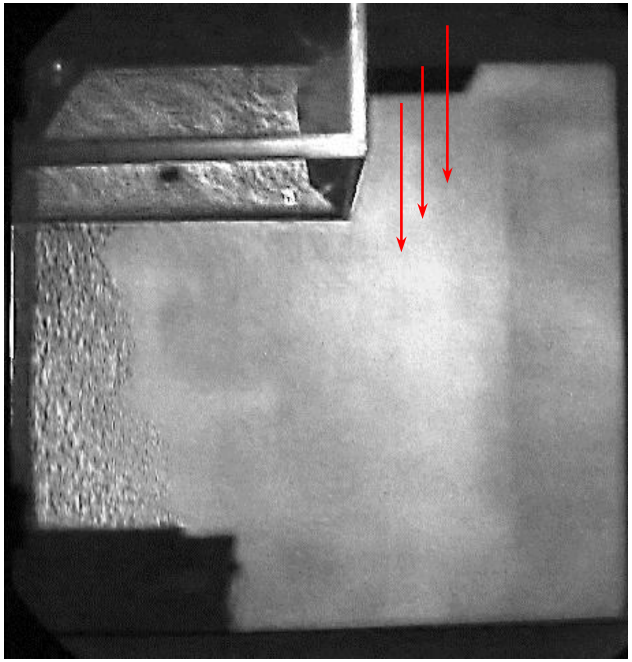
Front Face #1:
Plenum with no Baffling



Rear Plenum Discharge

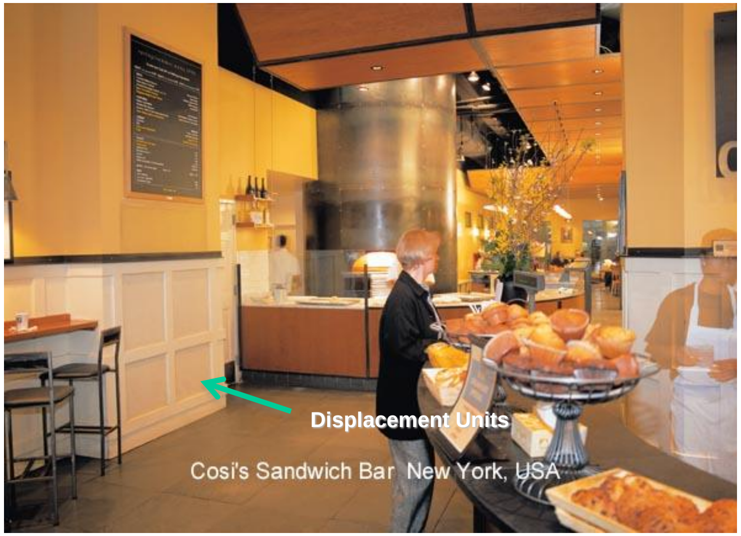
Two Charbroilers, Simulated Cooking -- C&C 3500 cfm Exhaust 2000 cfm MUA (57%) through Rear Discharge

Perforated Perimeter Supply

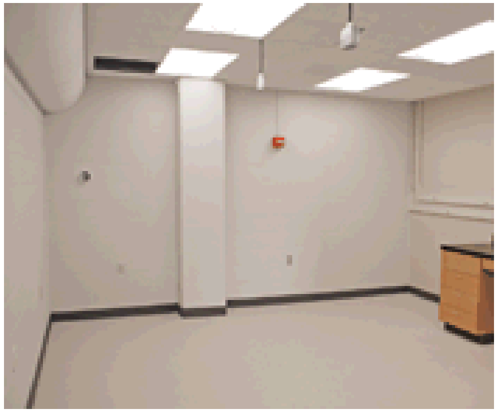


Performance similar to the back supply when velocities are minimized by maximizing perforated area

Displacement Ventilation



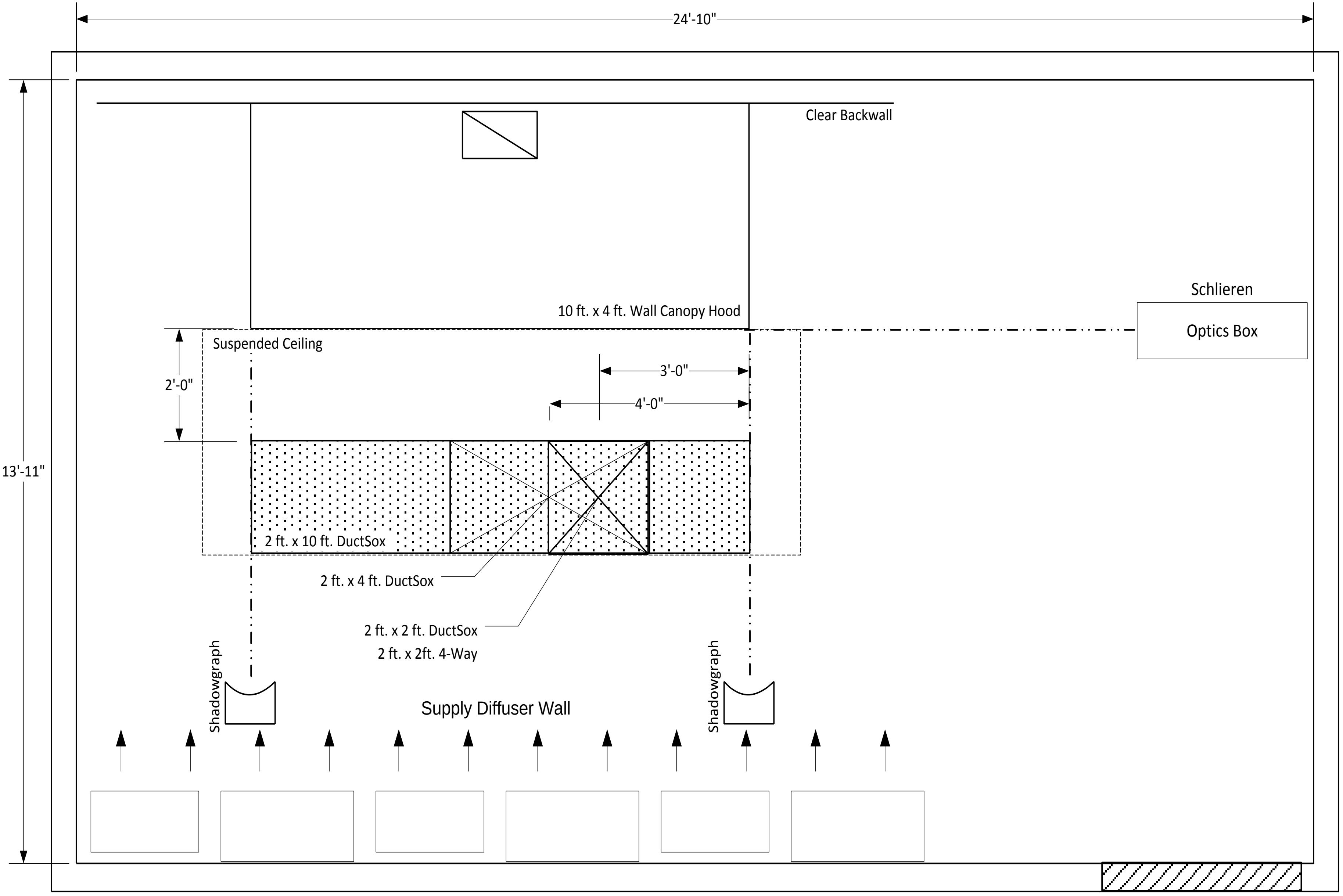
KitchenSOX™



DUCTSOX®

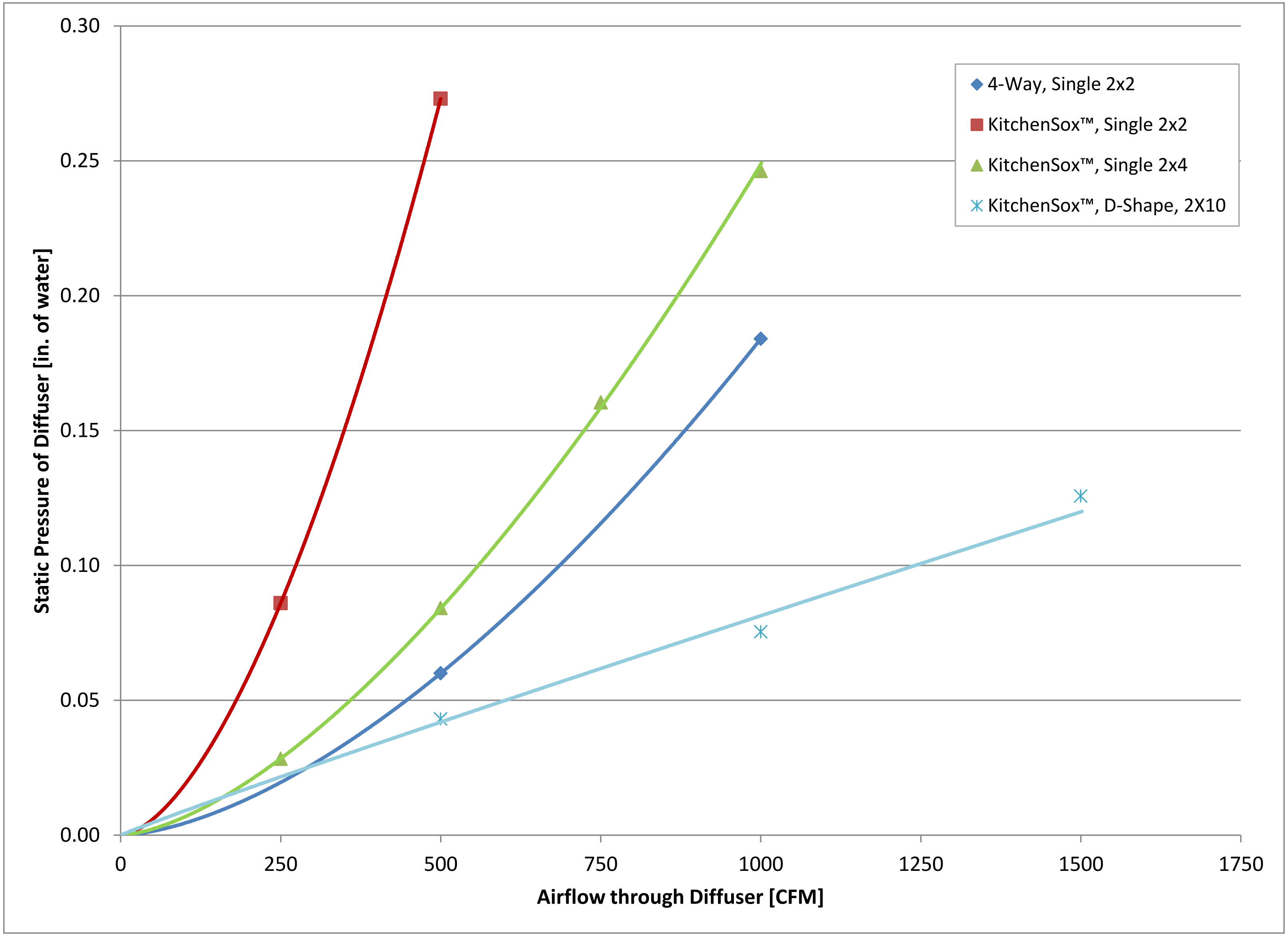
DuctSox Testing

DuctSox Set-Up

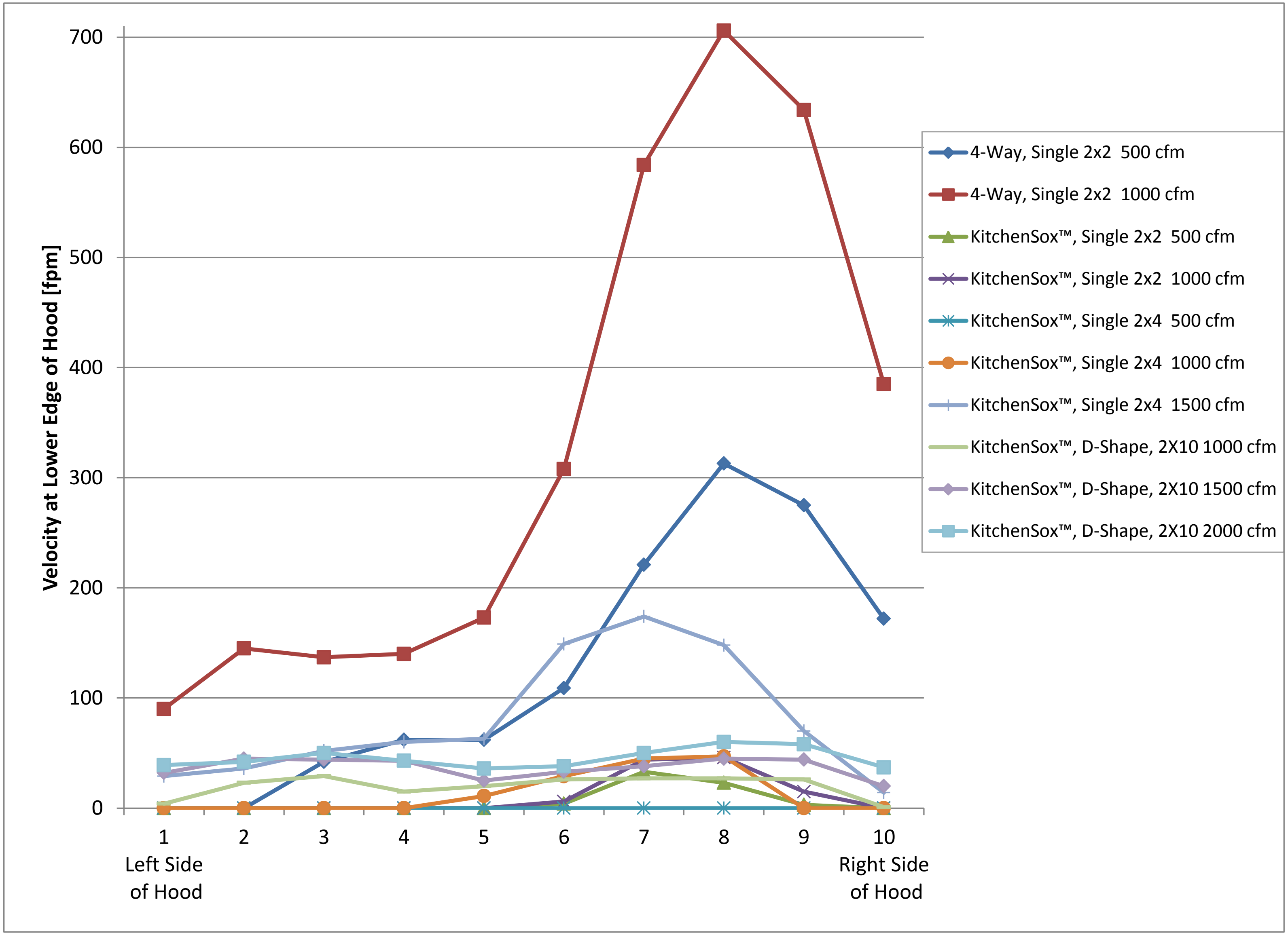


4-Way & DuctSox Diffusers

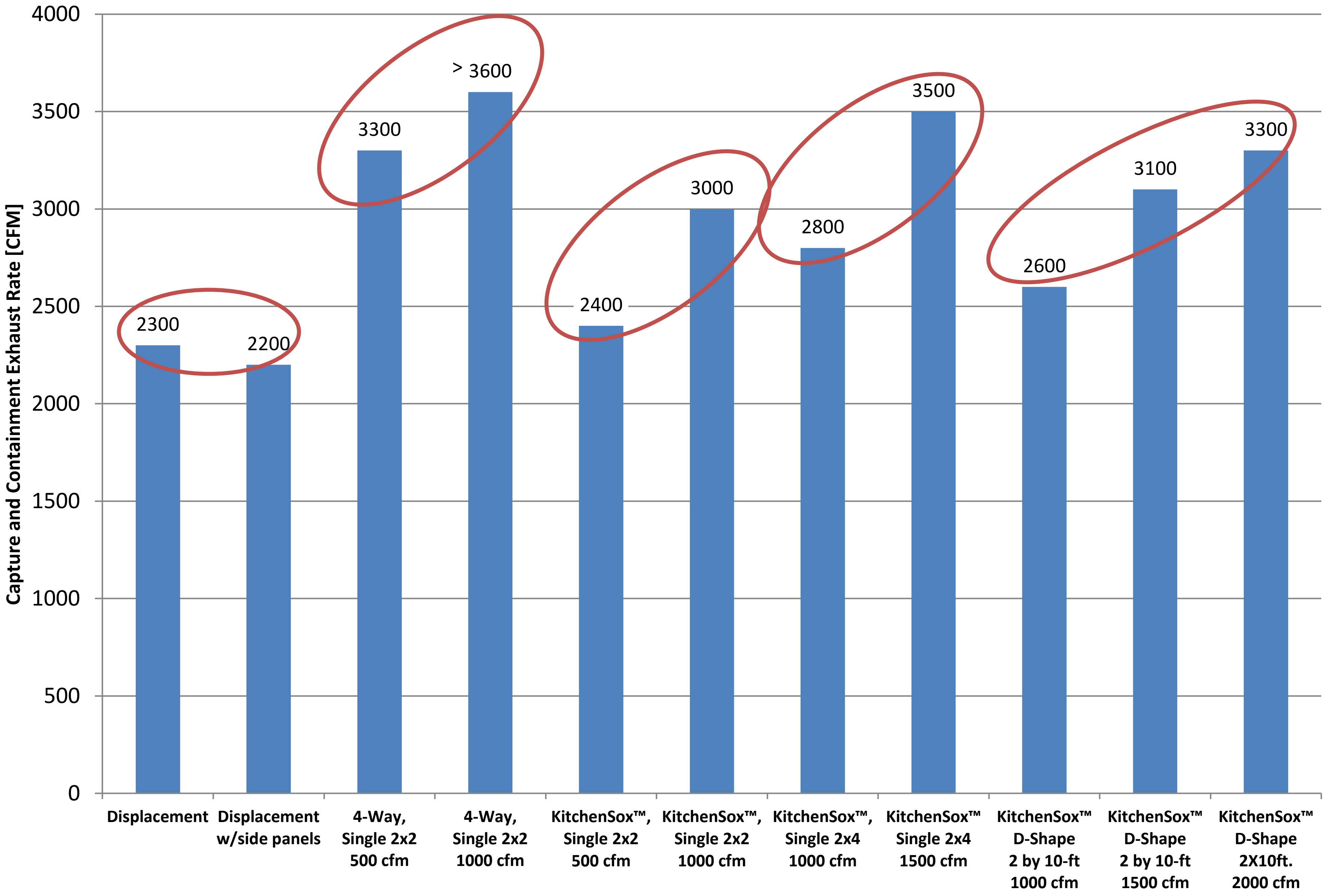
Pressure versus Airflow



Velocity versus Airflow



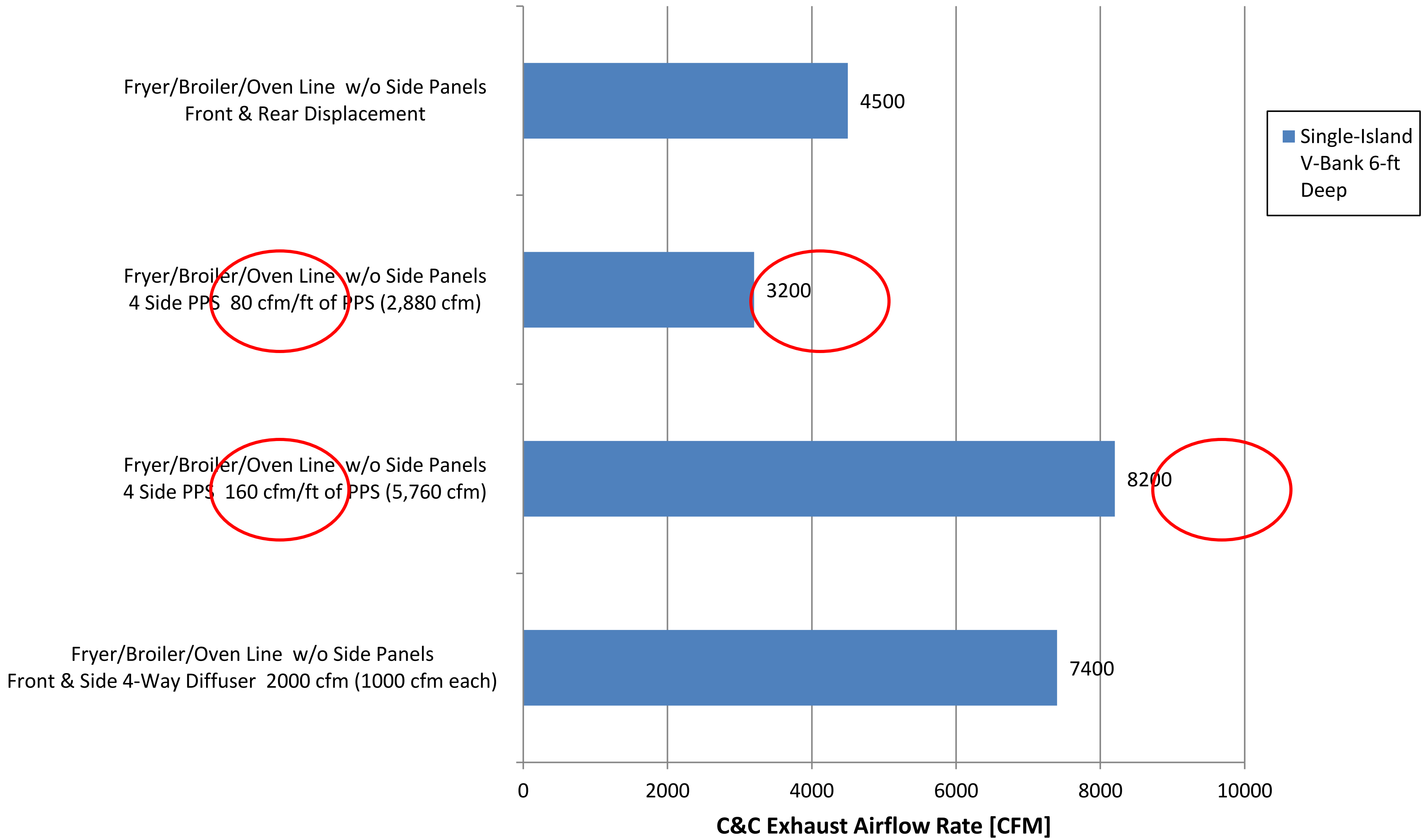
Capture and Containment Results



Perforated Supply Plenum (PSP)

Perforated Supply Plenum (PSP) & Island Hood Testing

Capture and Containment Results



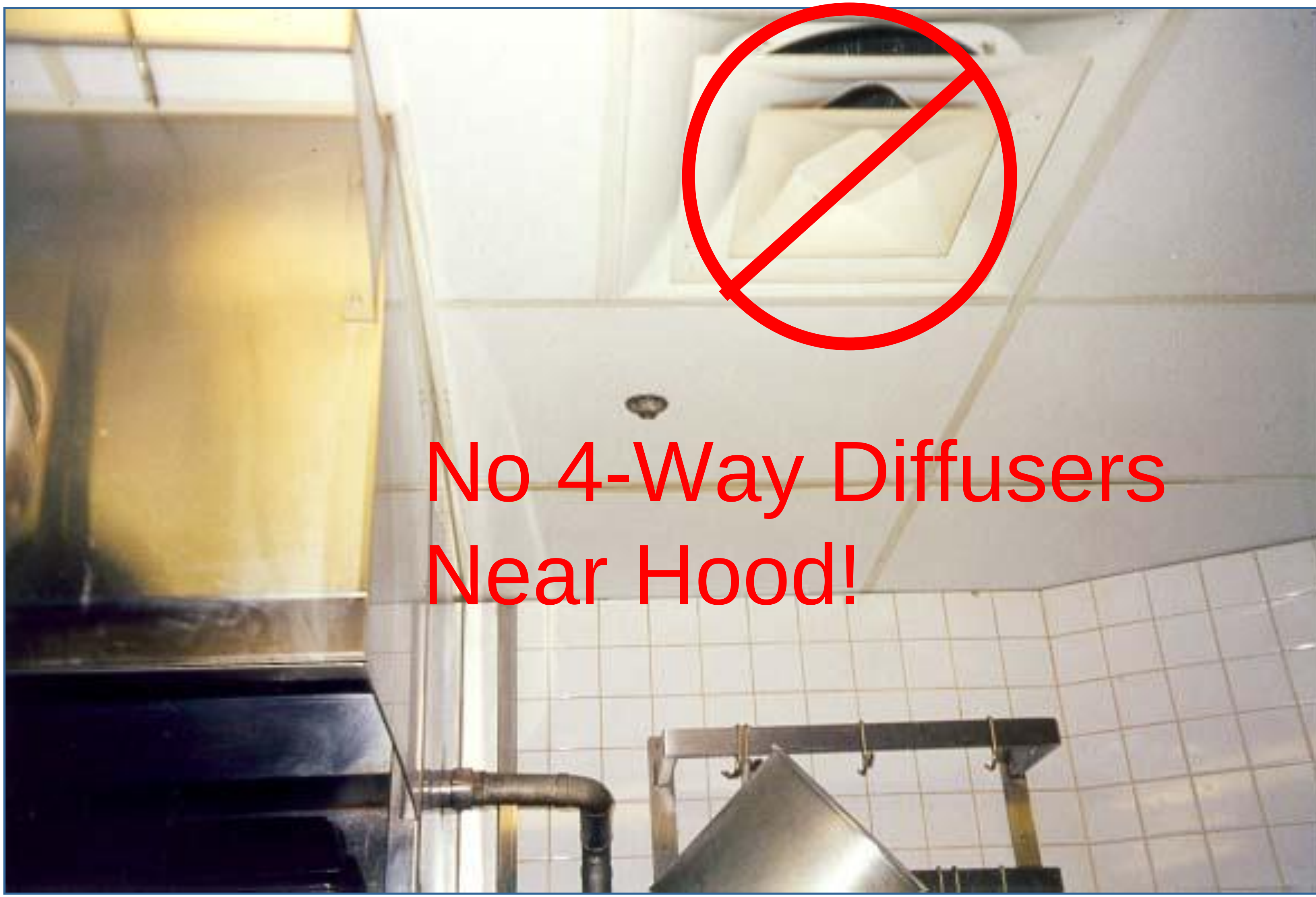
Recommendations

- Do not use short-circuit hoods
- Avoid air curtain strategies
- Do not spec 4-way diffusers near hoods
- Minimize MUA velocity near hood
- Maximize transfer air – minimize local MUA

Regardless of strategy…

Try to limit dedicated makeup air through any one pathway to 60% of the total exhaust rate, minimizing velocity of air around the hood perimeter.

[this is our experience; not standard practice]


No 4-Way Diffusers
Near Hood!