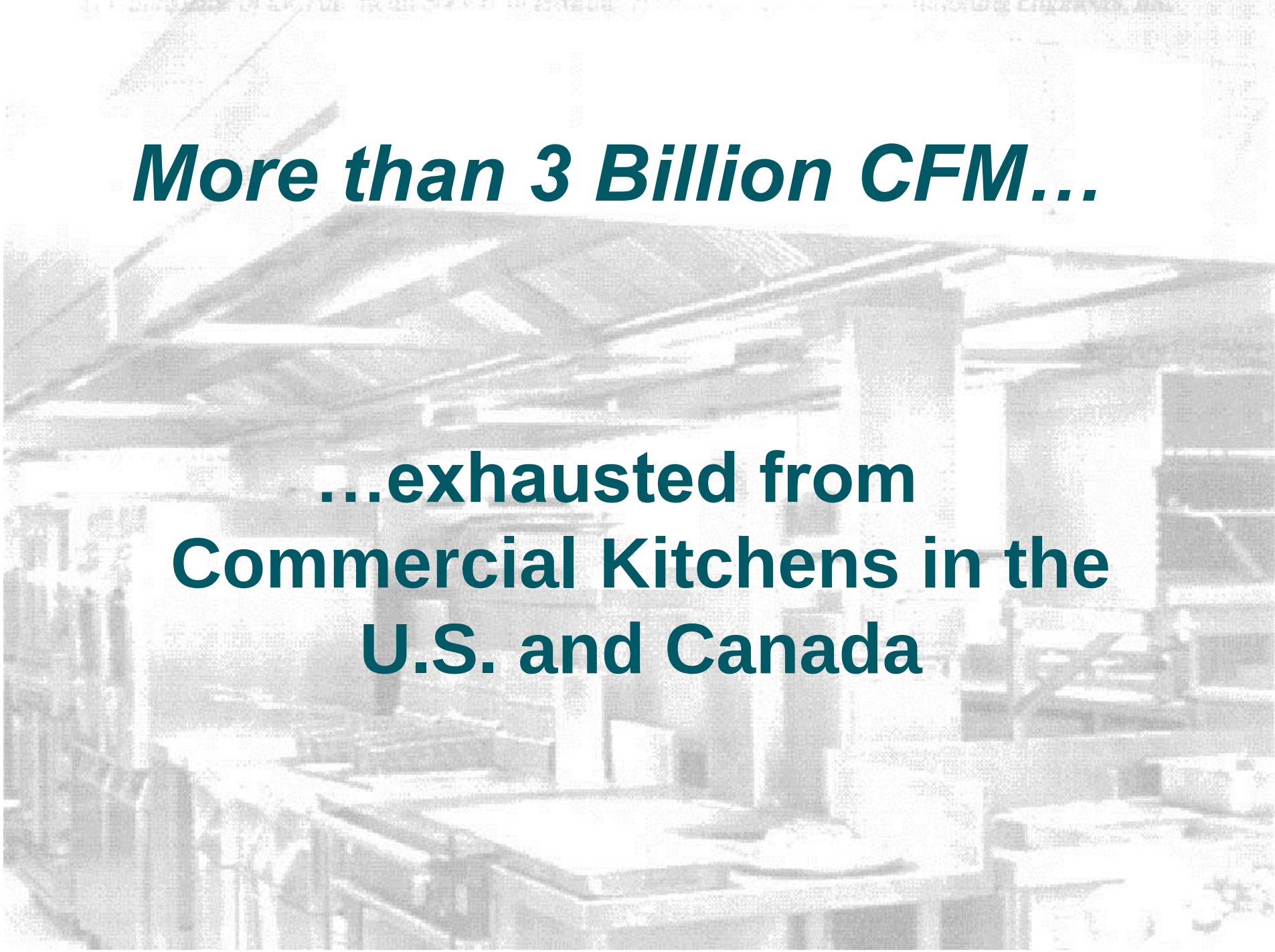
Fundamentals of Kitchen Ventilation System Design

Hood Selection & Sizing


The “Heart” of Restaurant HVAC
…rooftop equipment!

…let's drop on a few exhaust fans!

…it doesn't get easier!



More than 3 Billion CFM…

…exhausted from Commercial Kitchens in the U.S. and Canada

…dominated by single-speed systems!

Why care?

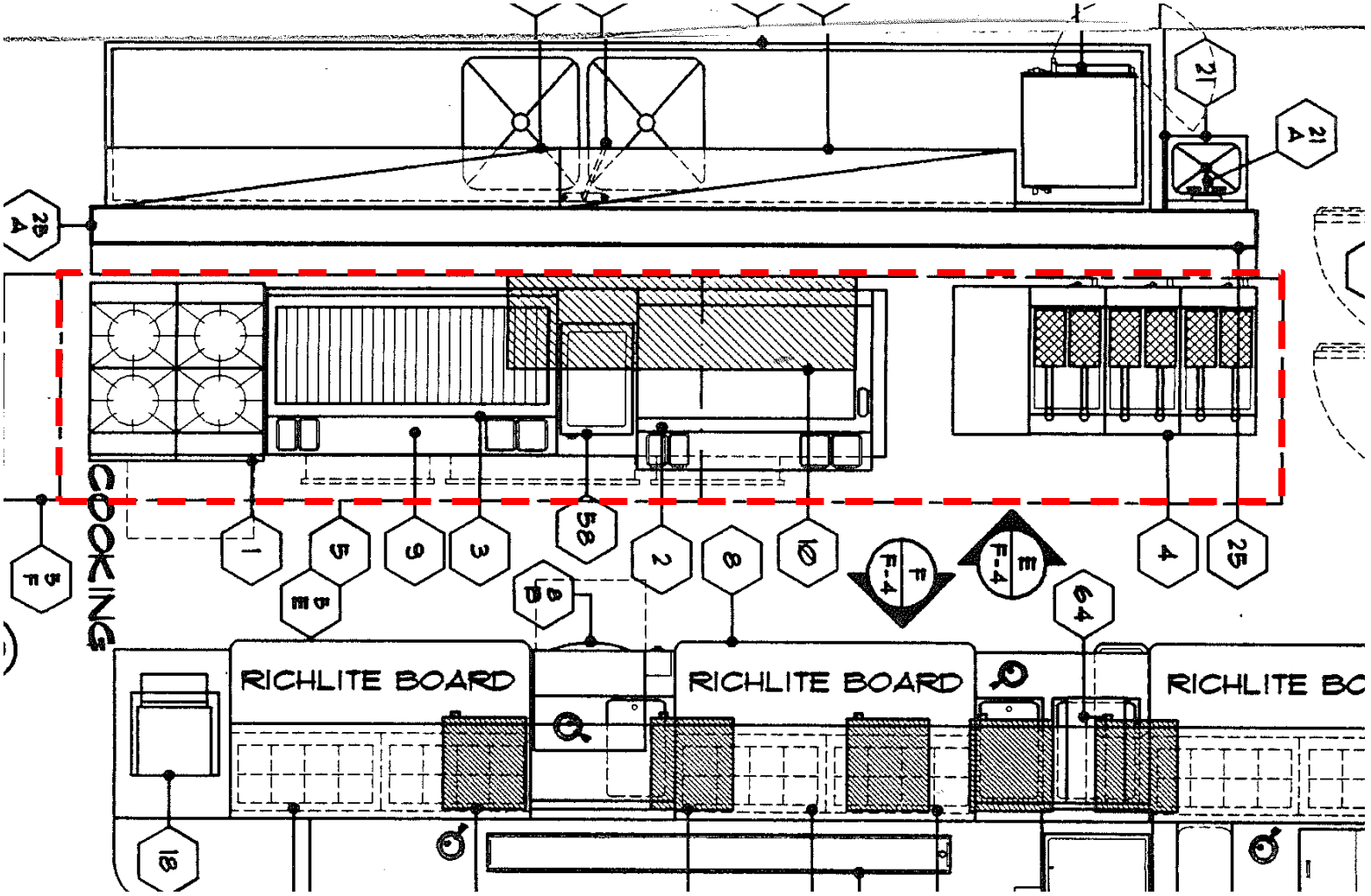
Makeup Air Heating & Cooling

Fan Energy

CKV Design: Just not that easy!

There is no piece of equipment in the commercial kitchen that generates more controversy that the exhaust hood!

The plan view…



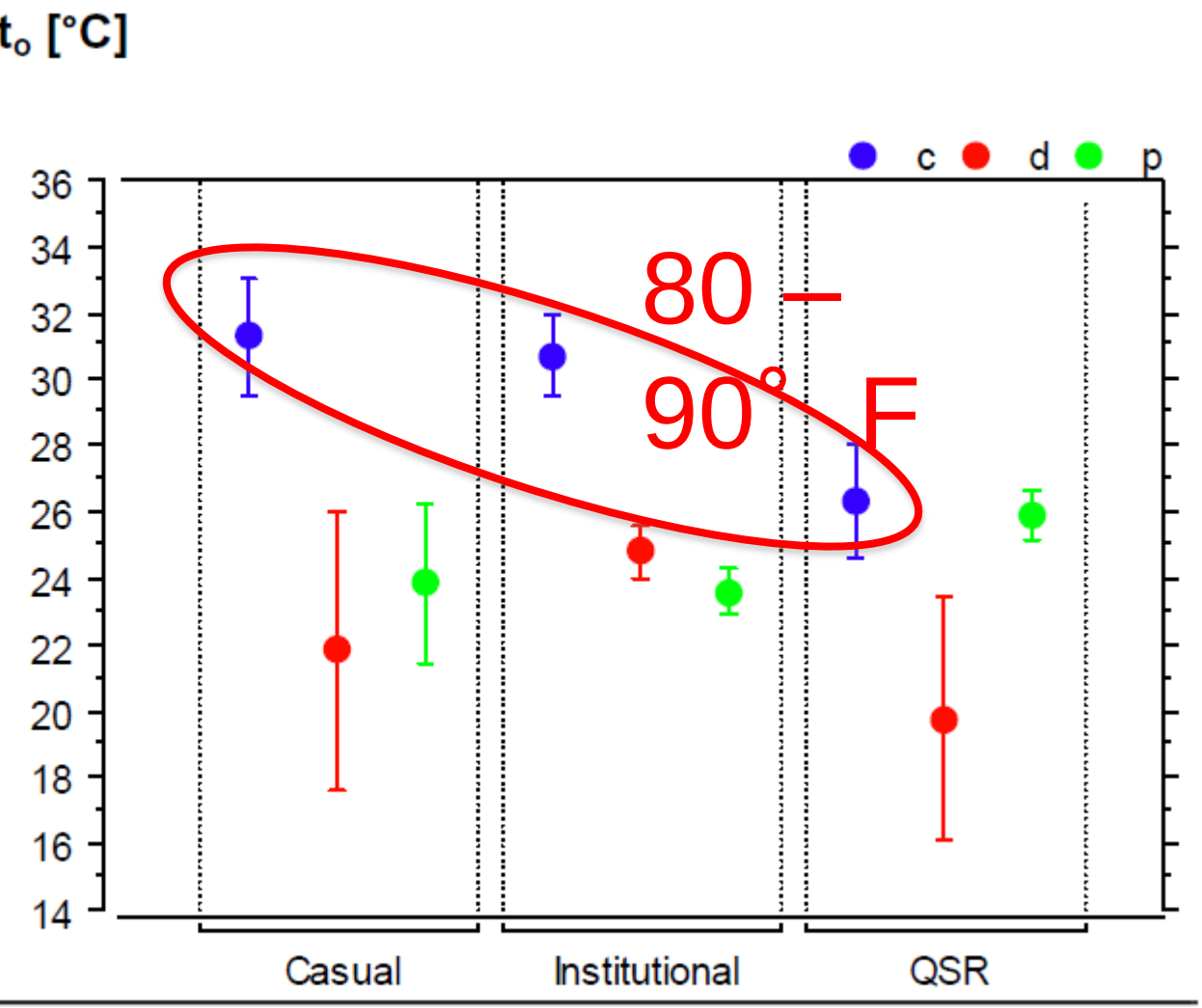
The elevation view…

ASHRAE RP-1469 – Thermal Comfort in Commercial Kitchens

Final Report 01.06.12

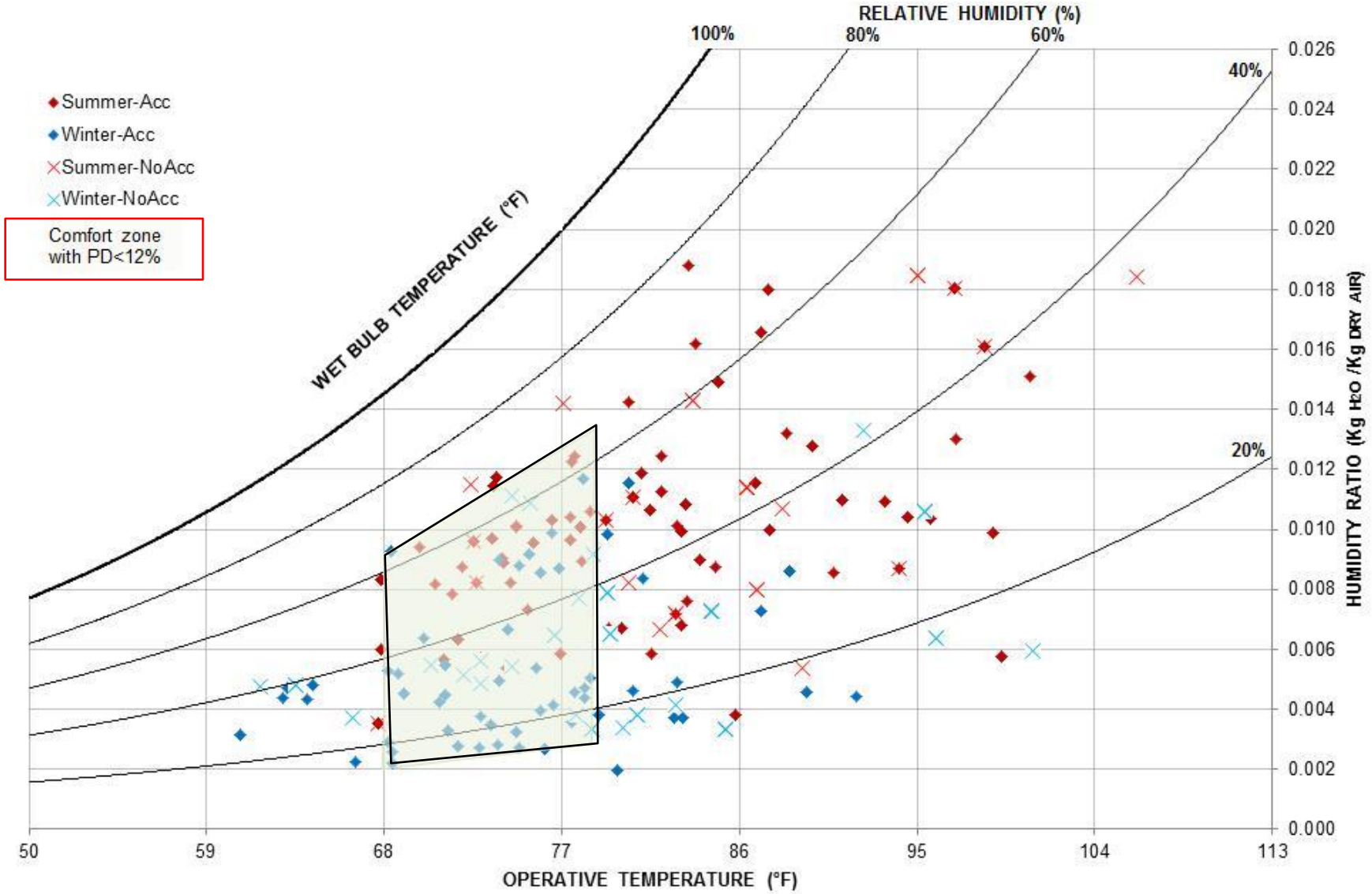
Average of Operative Temperature for Kitchen Type and Kitchen Zones with 95% confidence interval (100 kitchens)

t_o [°C]	t_o [°F]
36	97
34	93
32	90
30	86
28	82
26	79
24	75
22	72
20	68
18	64
16	61
14	57



Note: “c” is Cooking, “p” is Preparation, and “d” is Dishwashing zone.

Suggested Thermal Comfort Zone for Commercial Kitchens

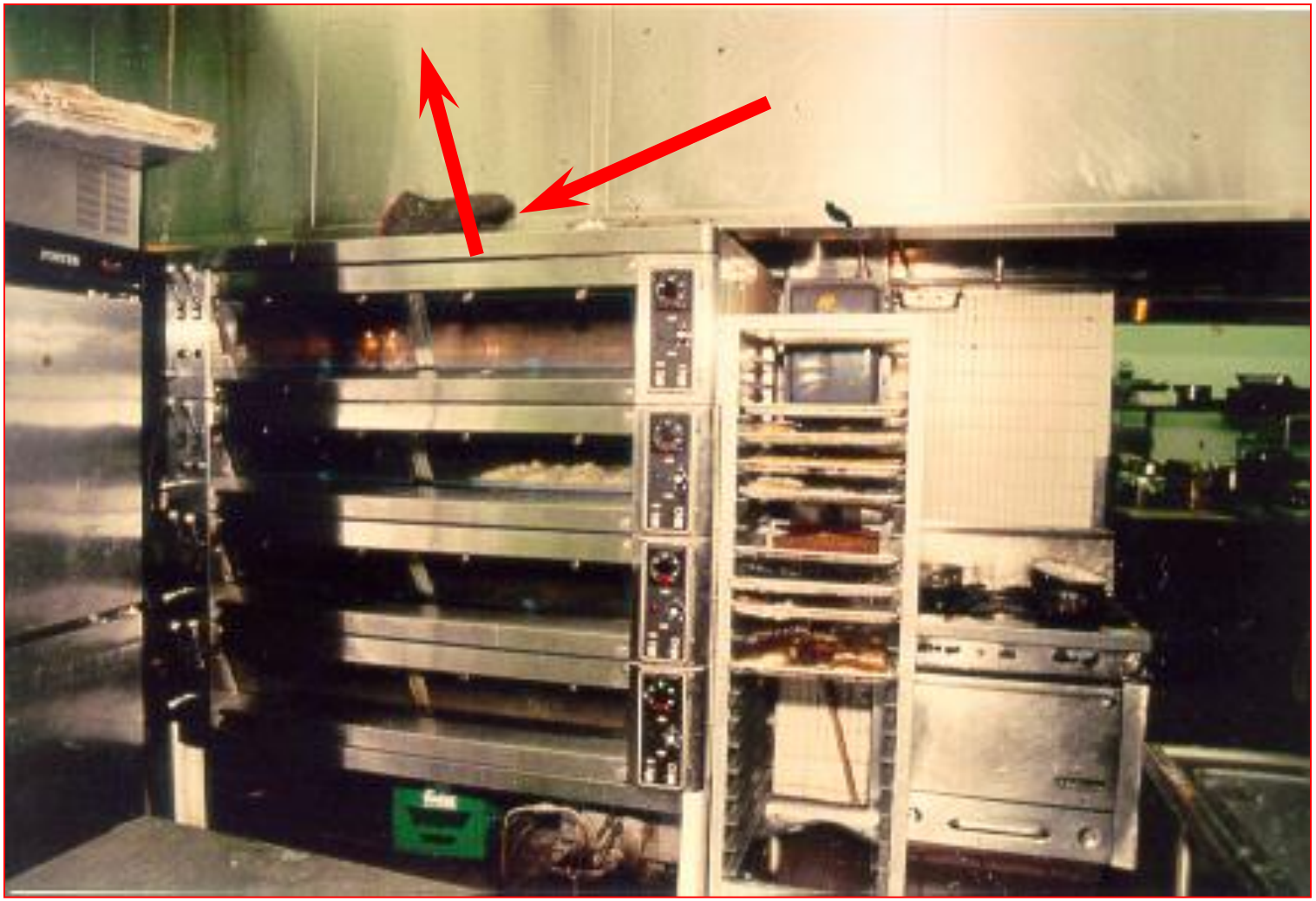


Appliance diversity!

Big hoods!

Small hoods!

… or not enough hood!



…or not enough overhang!

…or more hood than unnecessary!

…or no hood!

…or a fake hood!

…or it's not big enough!

…and sometimes there's just too much equipment!

or… why bother with the fan?

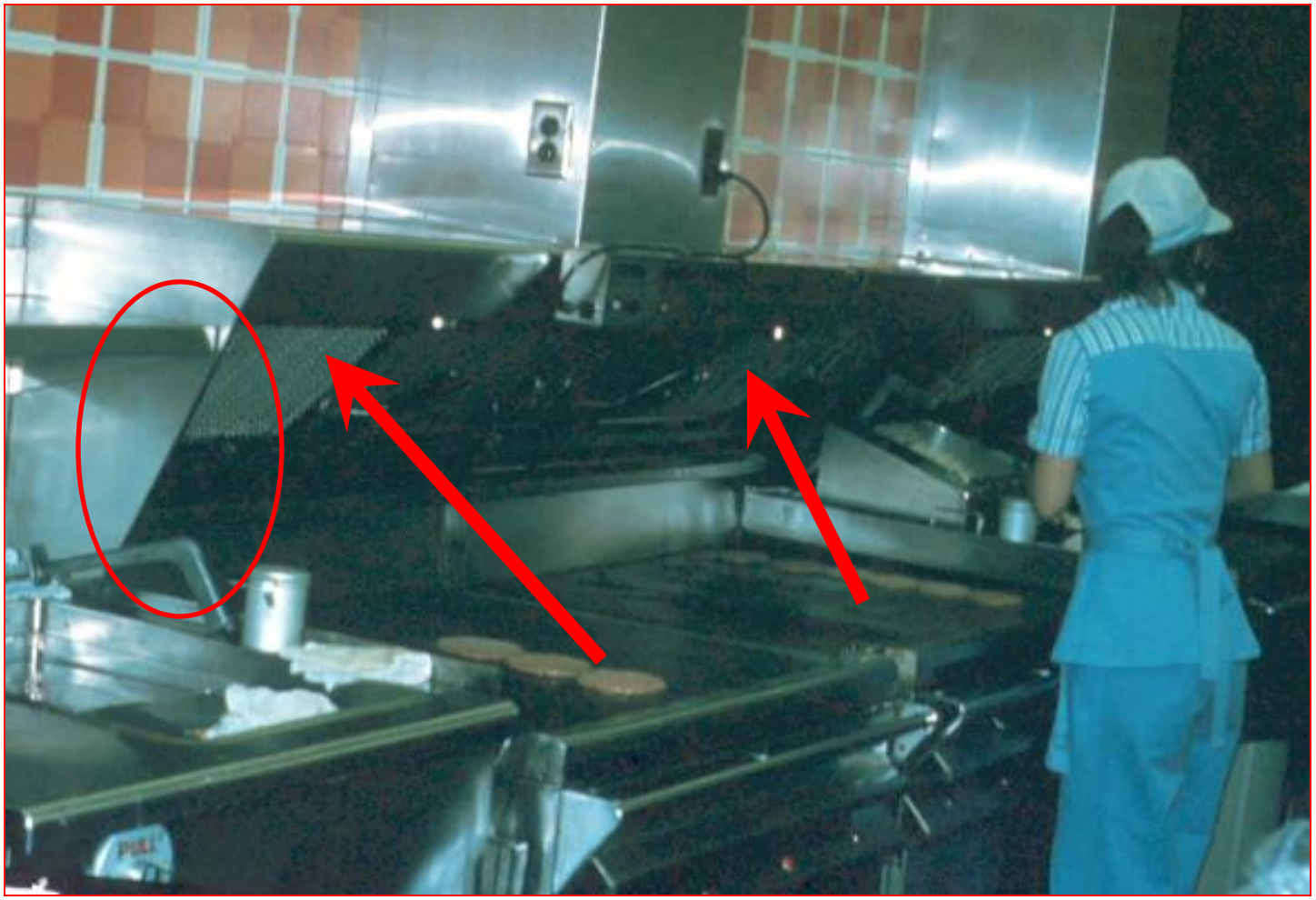
... or makeup air!

…just use the back door!

But no
4-way
diffusers
in kitchen!

Good intentions!

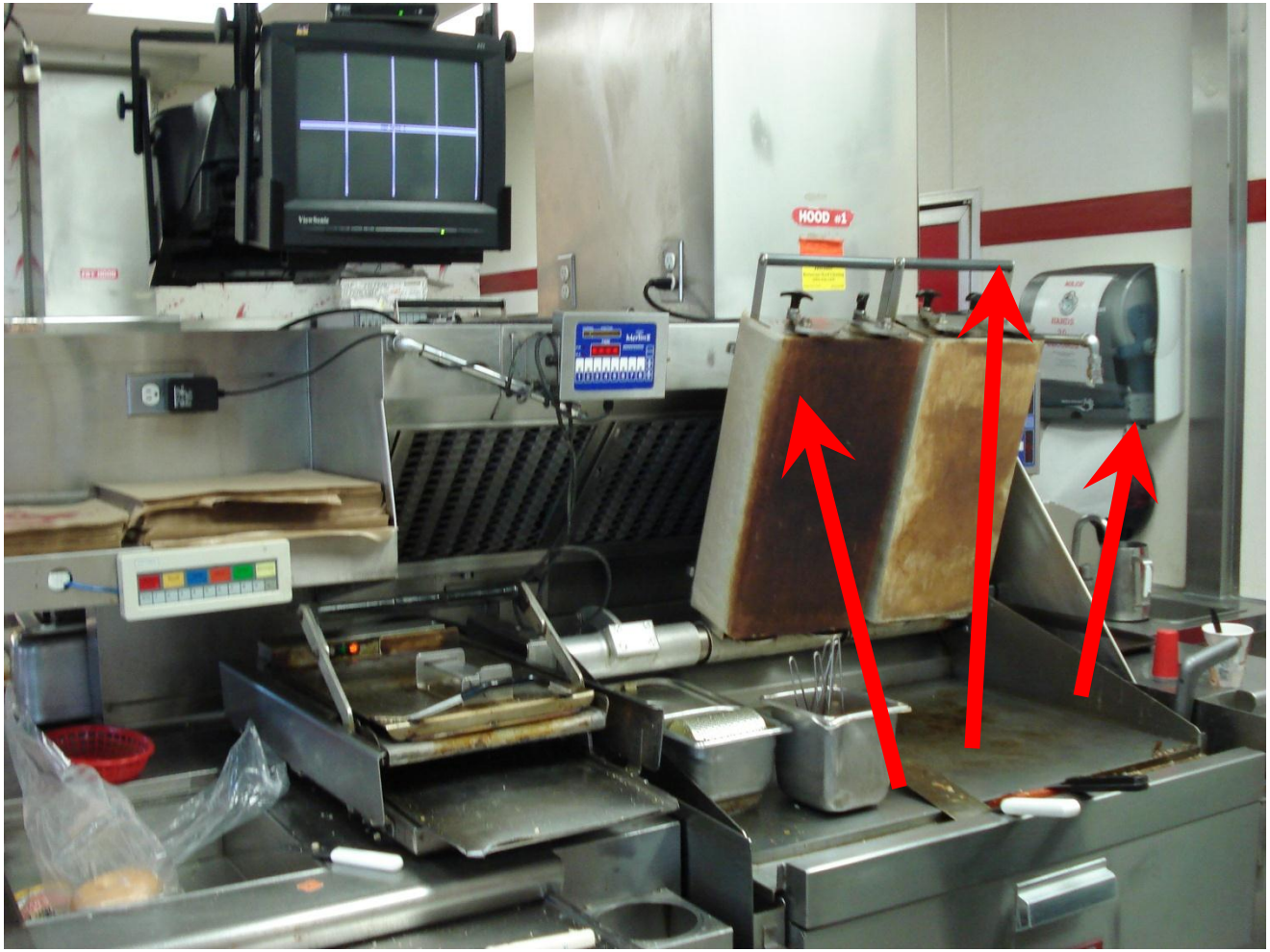
Good design!



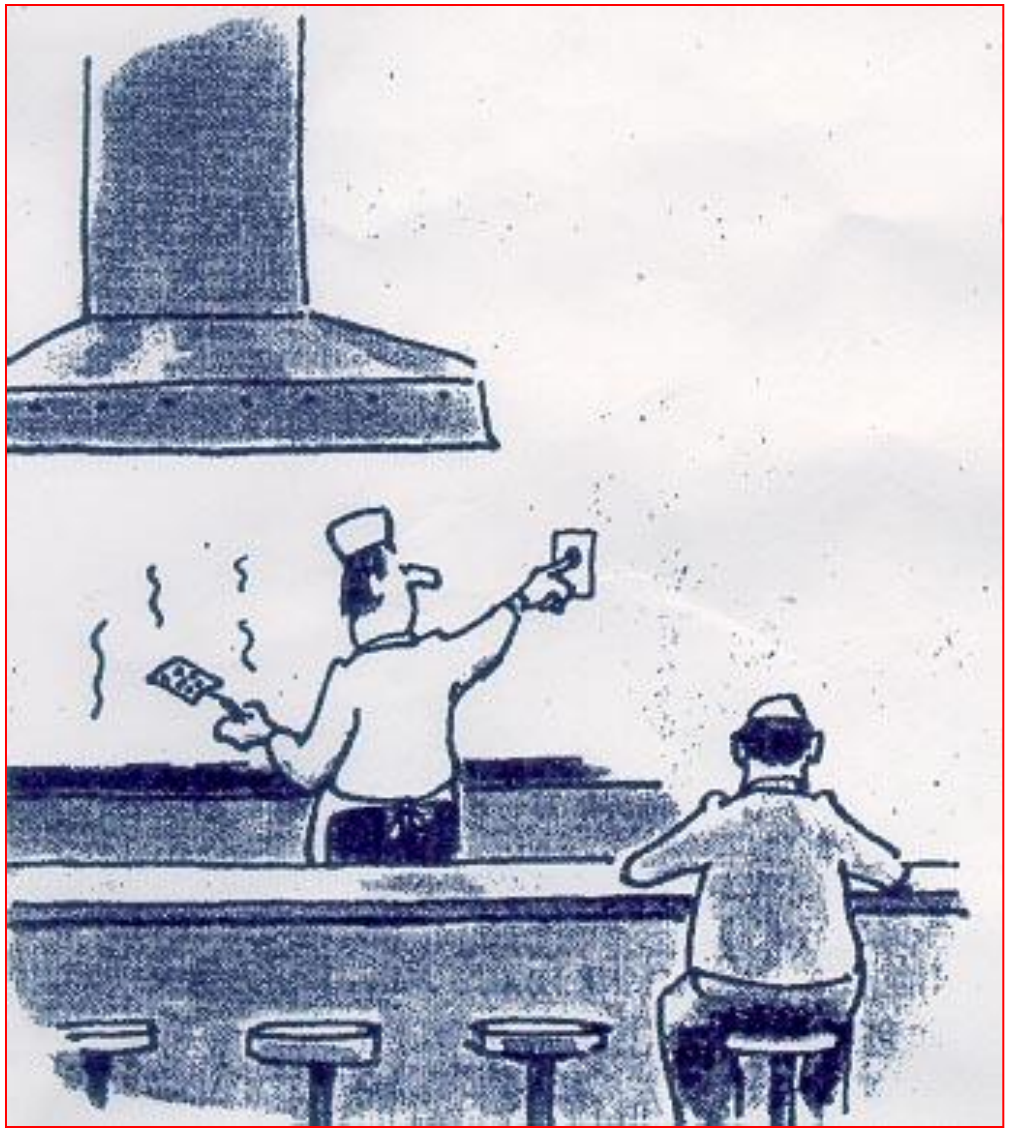
McDonald's set an industry standard …

Redesigned for Clamshell Grill

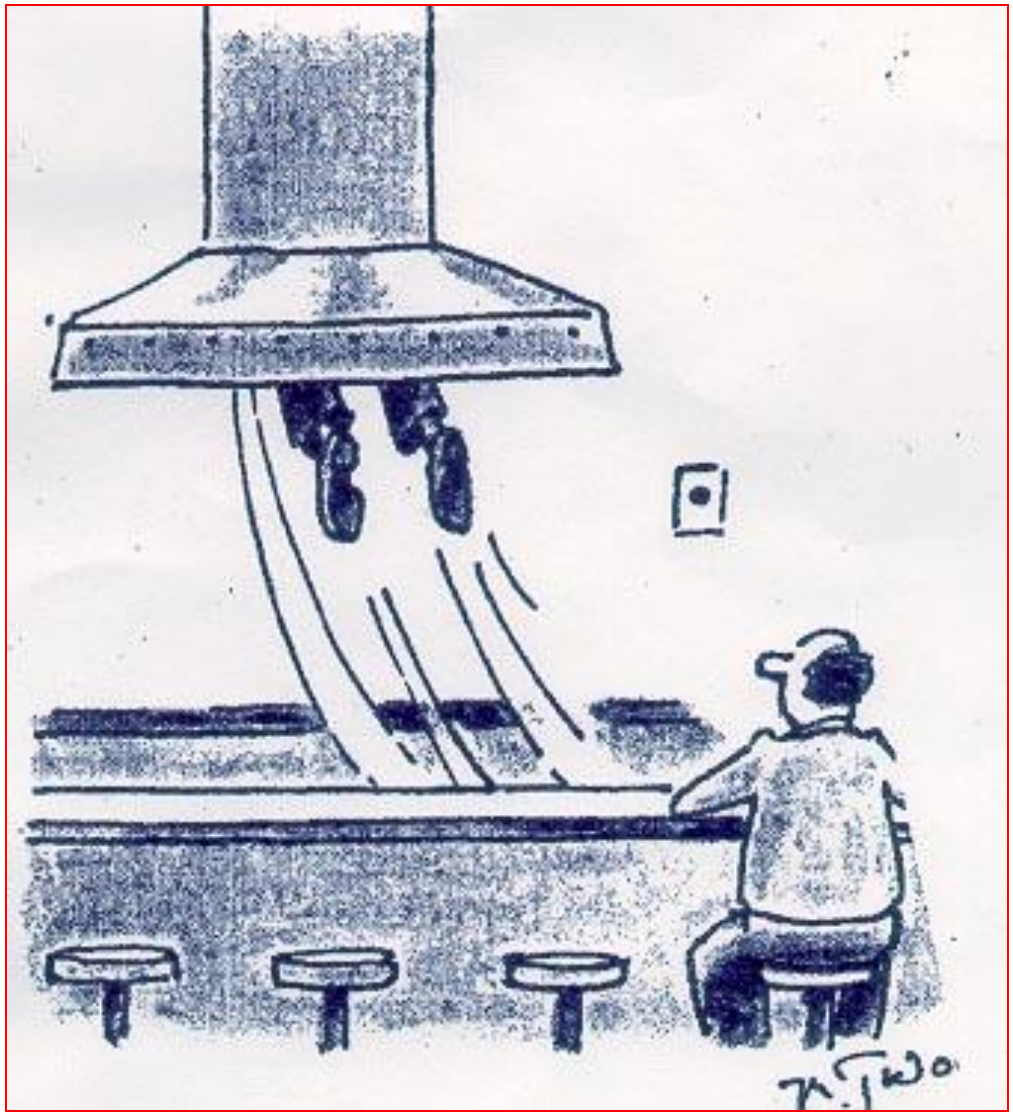
Somebody tried to copy…



So how much…….



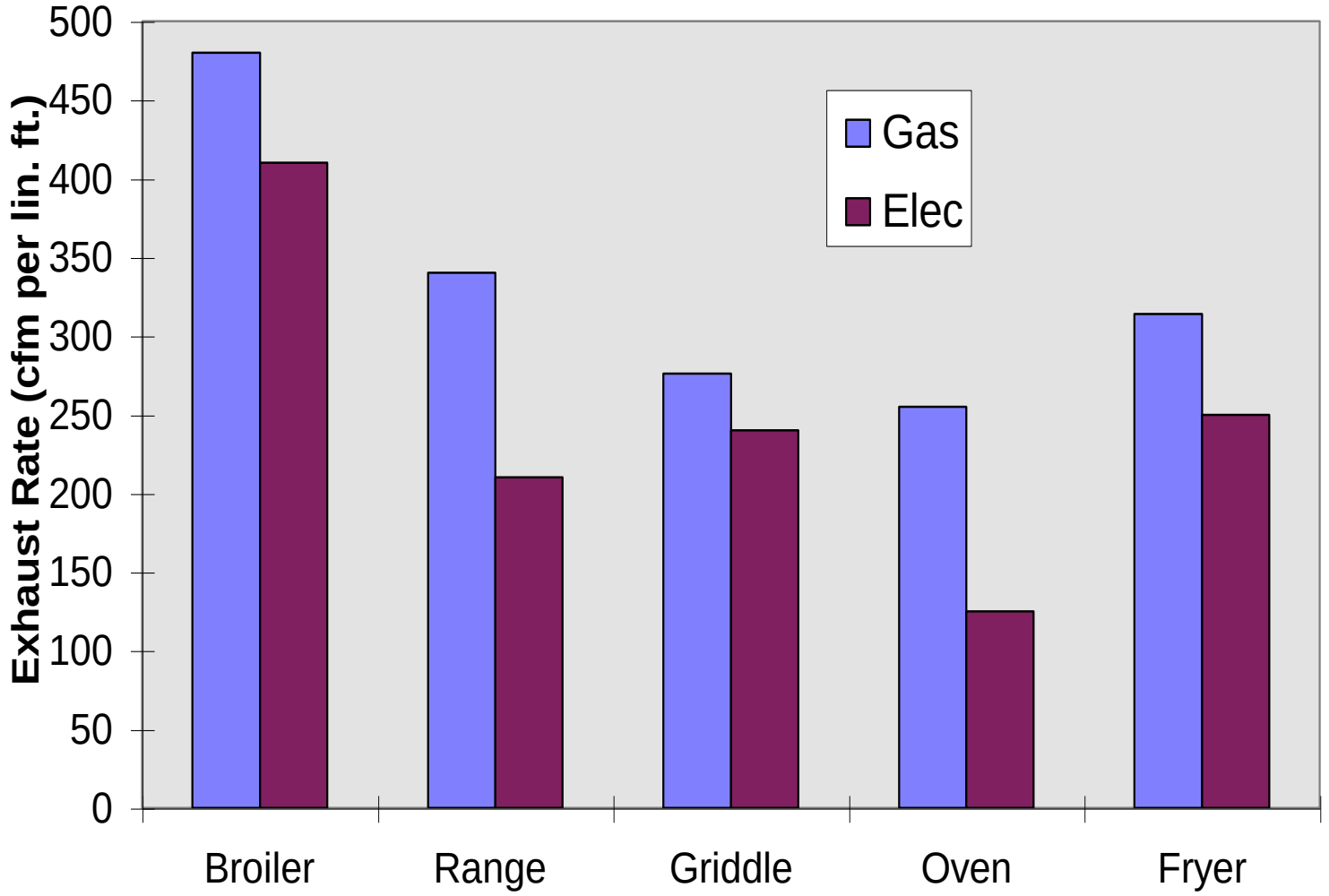
…….is too much?



…depends on Appliance Category and Usage

vs.

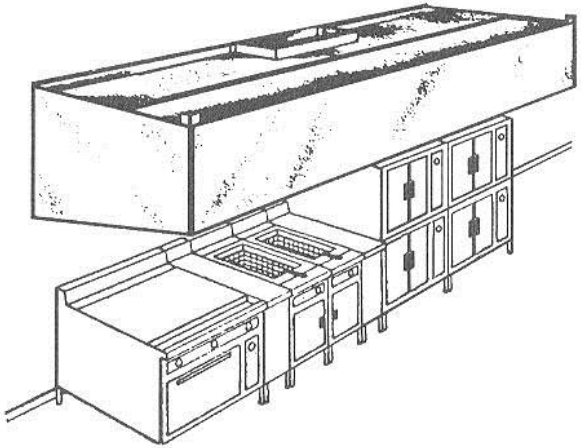
Wall-Canopy Hood: Capture & Containment



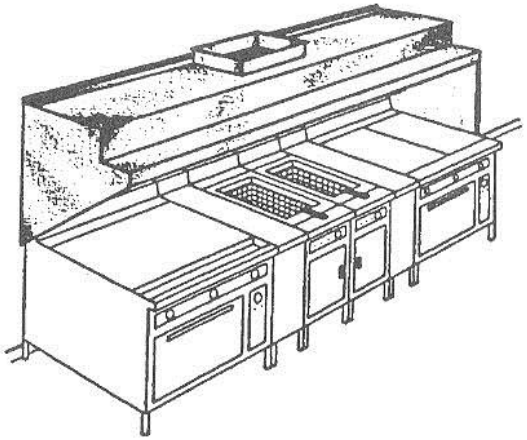
Source: EPRI

Note: CFM data is for 5 ft. wall canopy hood with minimum 6 inch overhang.

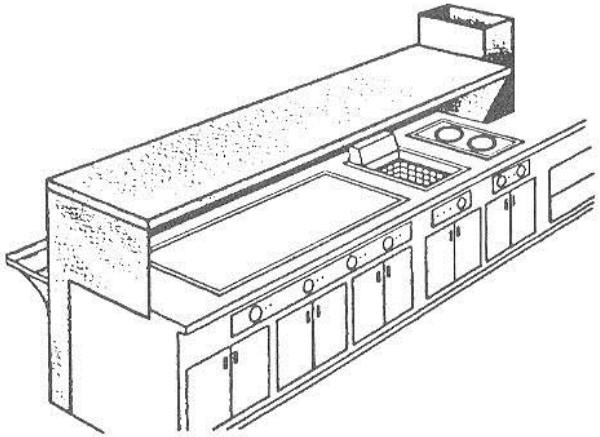
Depends on Hood Style & Design



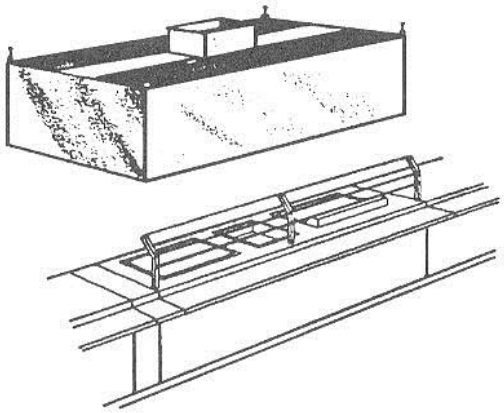
WALL-MOUNTED CANOPY



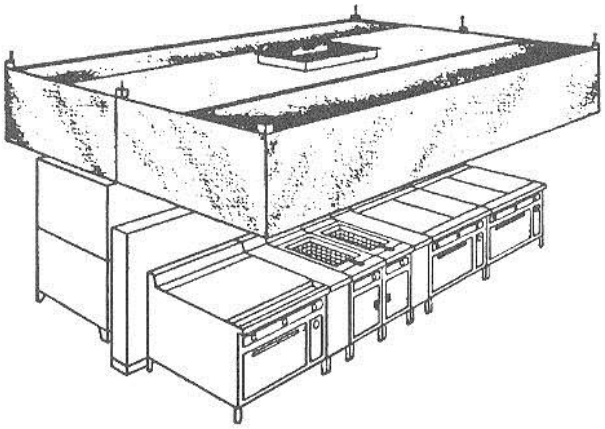
BACK SHELF



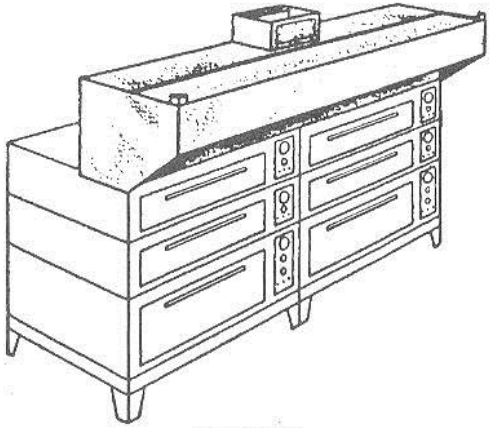
PASS-OVER



SINGLE-ISLAND CANOPY

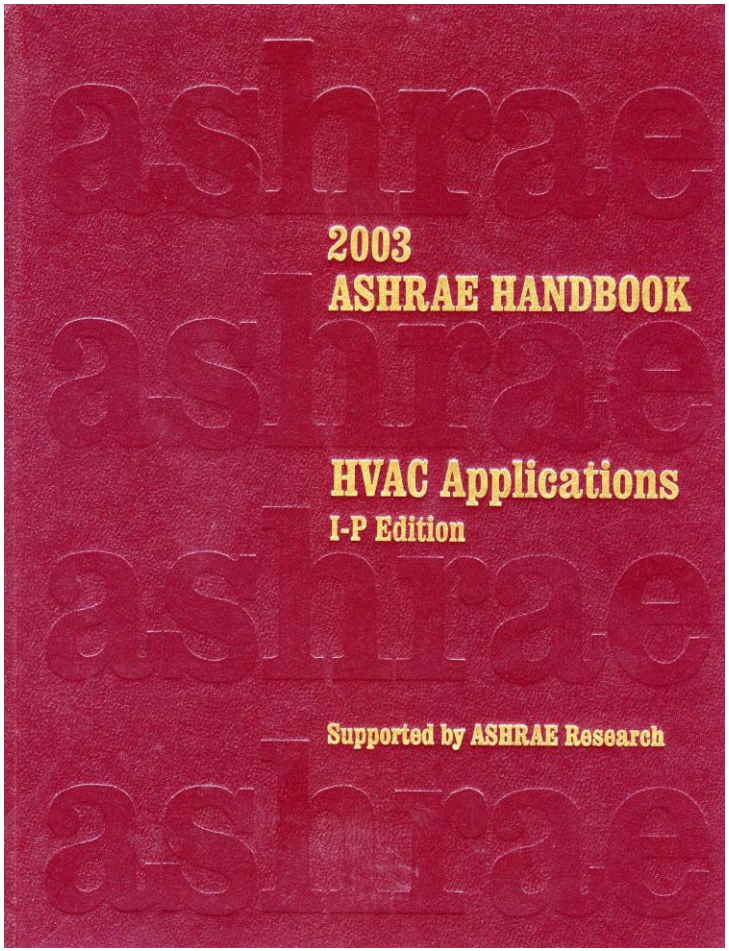


DOUBLE-ISLAND CANOPY



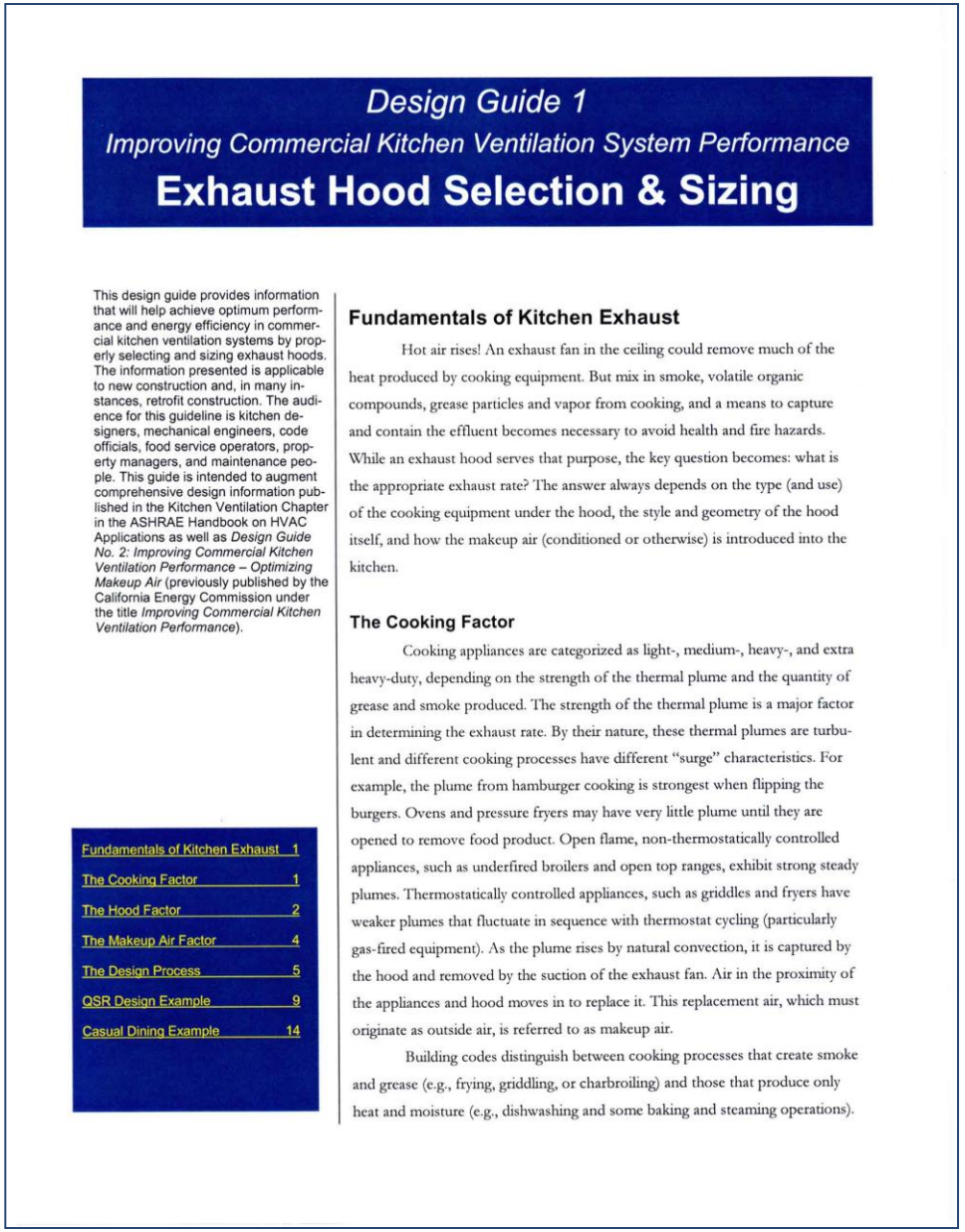
EYEBROW

ASHRAE HVAC Applications Handbook Chapter 31 on Kitchen Ventilation



- Cooking effluent
- Exhaust hoods
- Exhaust systems
- Replacement (makeup) air systems
- Systems integration and balancing
- Energy considerations
- Fire protection
- Operations & maintenance
- Residential kitchen ventilation

FSTC Guide: Focused on Hood Selection & Sizing



Design Guide 1

Improving Commercial Kitchen Ventilation System Performance

Exhaust Hood Selection & Sizing

This design guide provides information that will help achieve optimum performance and energy efficiency in commercial kitchen ventilation systems by properly selecting and sizing exhaust hoods. The information presented is applicable to new construction and, in many instances, retrofit construction. The audience for this guideline is kitchen designers, mechanical engineers, code officials, 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. 2: Improving Commercial Kitchen Ventilation Performance – Optimizing Makeup Air* (previously published by the California Energy Commission under the title *Improving Commercial Kitchen Ventilation Performance*).

Fundamentals of Kitchen Exhaust

Hot air rises! An exhaust fan in the ceiling could remove much of the heat produced by cooking equipment. But mix in smoke, volatile organic compounds, grease particles and vapor from cooking, and a means to capture and contain the effluent becomes necessary to avoid health and fire hazards. While an exhaust hood serves that purpose, the key question becomes: what is the appropriate exhaust rate? The answer always depends on the type (and use) of the cooking equipment under the hood, the style and geometry of the hood itself, and how the makeup air (conditioned or otherwise) is introduced into the kitchen.

The Cooking Factor

Cooking appliances are categorized as light-, medium-, heavy-, and extra heavy-duty, depending on the strength of the thermal plume and the quantity of grease and smoke produced. The strength of the thermal plume is a major factor in determining the exhaust rate. By their nature, these thermal plumes are turbulent and different cooking processes have different "surge" characteristics. For example, the plume from hamburger cooking is strongest when flipping the burgers. Ovens and pressure fryers may have very little plume until they are opened to remove food product. Open flame, non-thermostatically controlled appliances, such as underfired broilers and open top ranges, exhibit strong steady plumes. Thermostatically controlled appliances, such as griddles and fryers have weaker plumes that fluctuate in sequence with thermostat cycling (particularly gas-fired equipment). As the plume rises by natural convection, it is captured by the hood and removed by the suction of the exhaust fan. Air in the proximity of the appliances and hood moves in to replace it. This replacement air, which must originate as outside air, is referred to as makeup air.

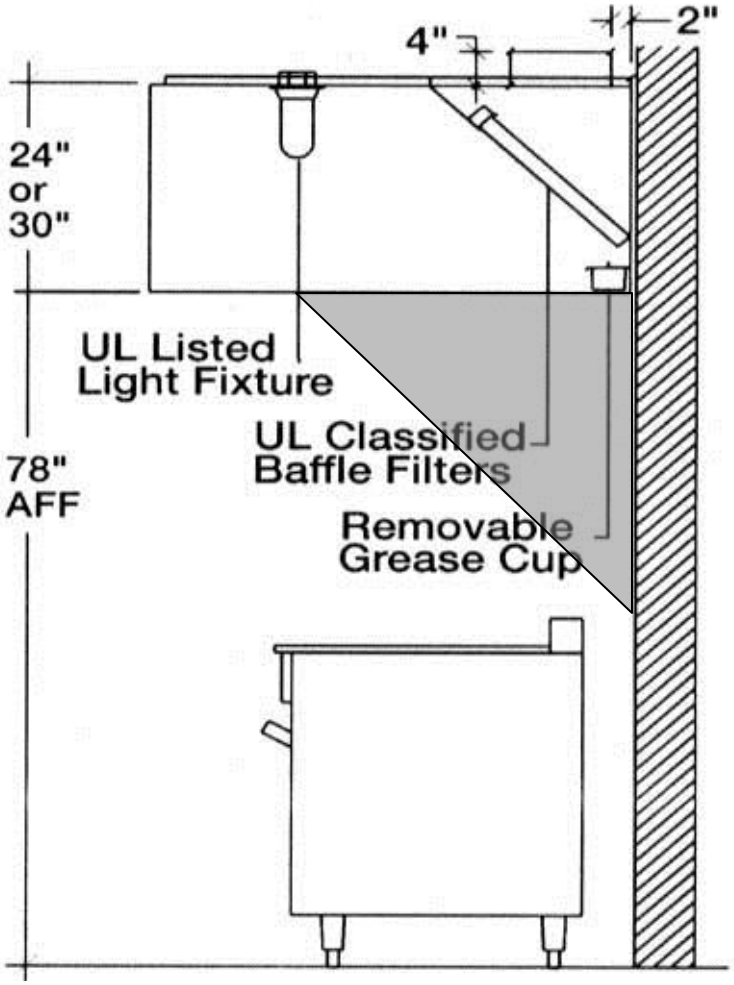
Building codes distinguish between cooking processes that create smoke and grease (e.g., frying, griddling, or charbroiling) and those that produce only heat and moisture (e.g., dishwashing and some baking and steaming operations).

Download at:
http://fishnick.com/ventilation/designguides/

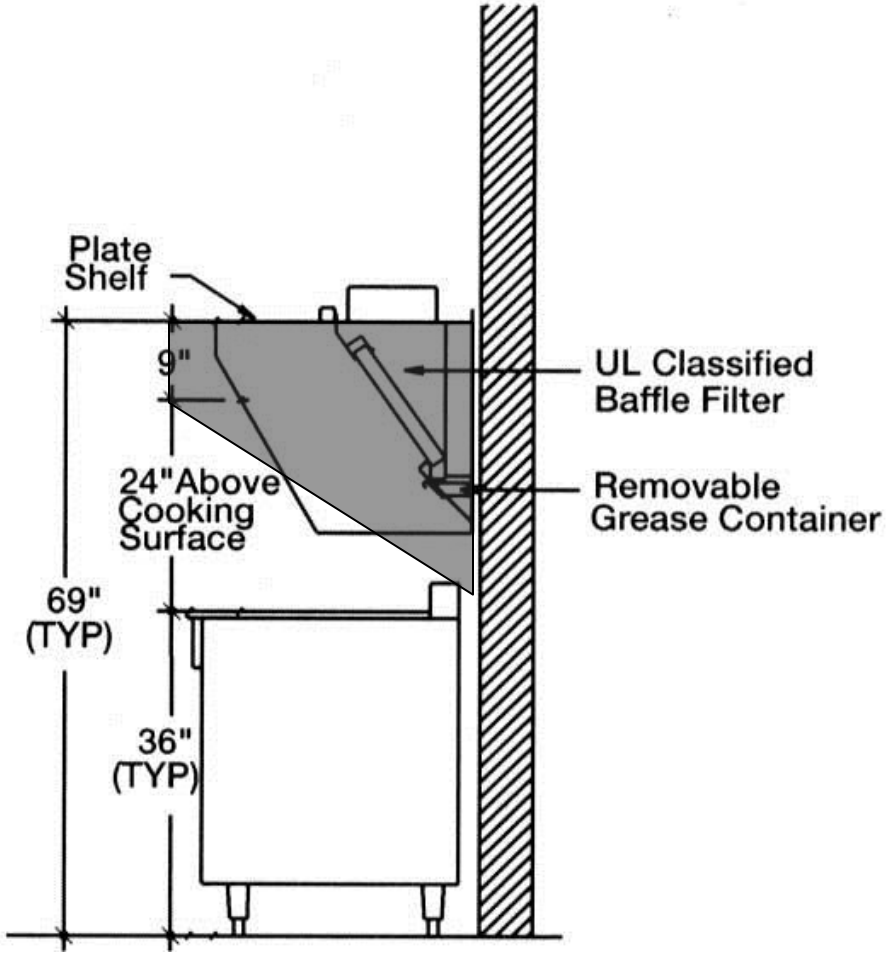
CKV 101:
Focus on Hood Selection & Sizing

1. Establish position and “duty” classifications of appliances.
2. Select hood type and style.
3. Specify exhaust airflow rate (and select fan per system pressure drop).
4. Select and size makeup air system(s).
5. Commission and field test.

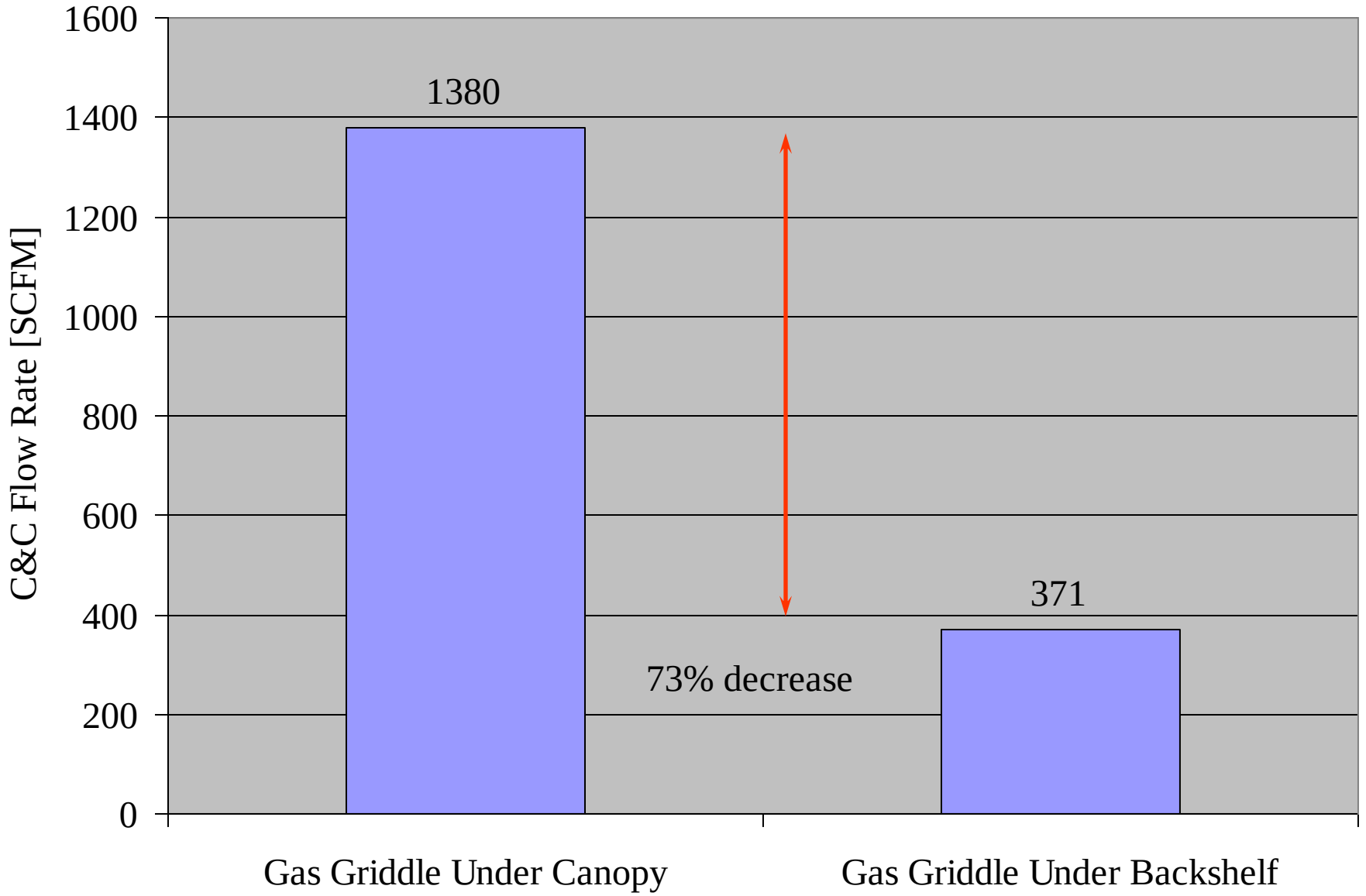
Wall-Mounted Canopy



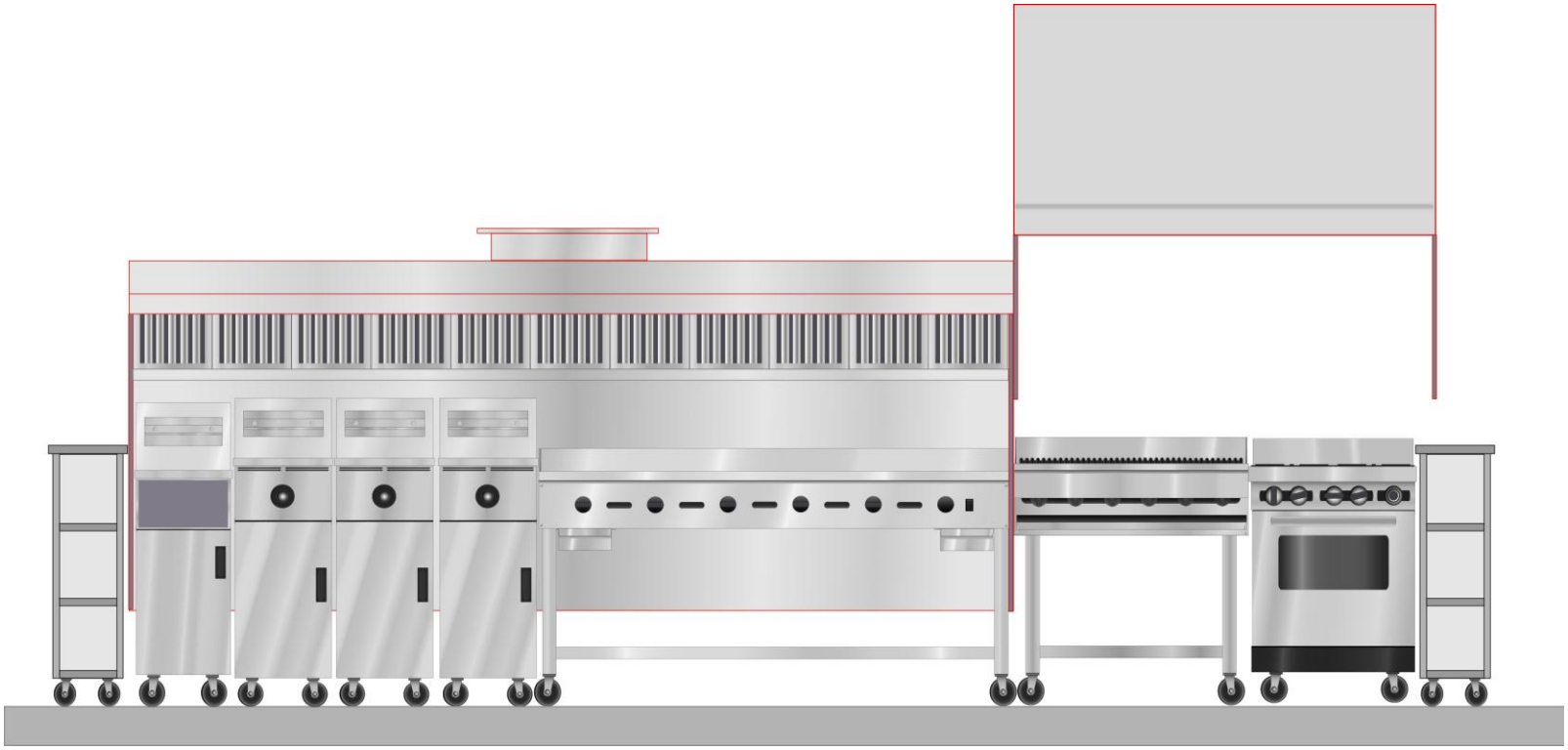
Proximity (Backshelf) Hood



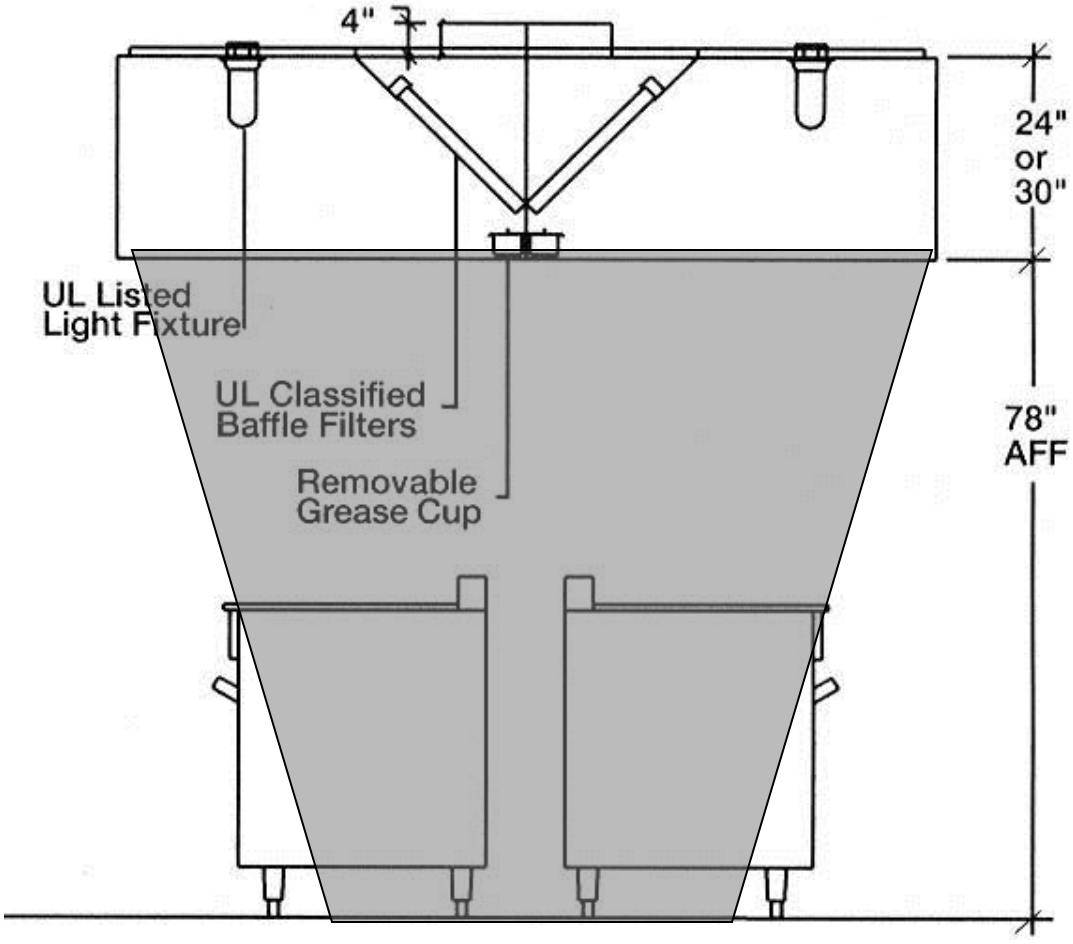
Example: Canopy vs. Custom Backshelf



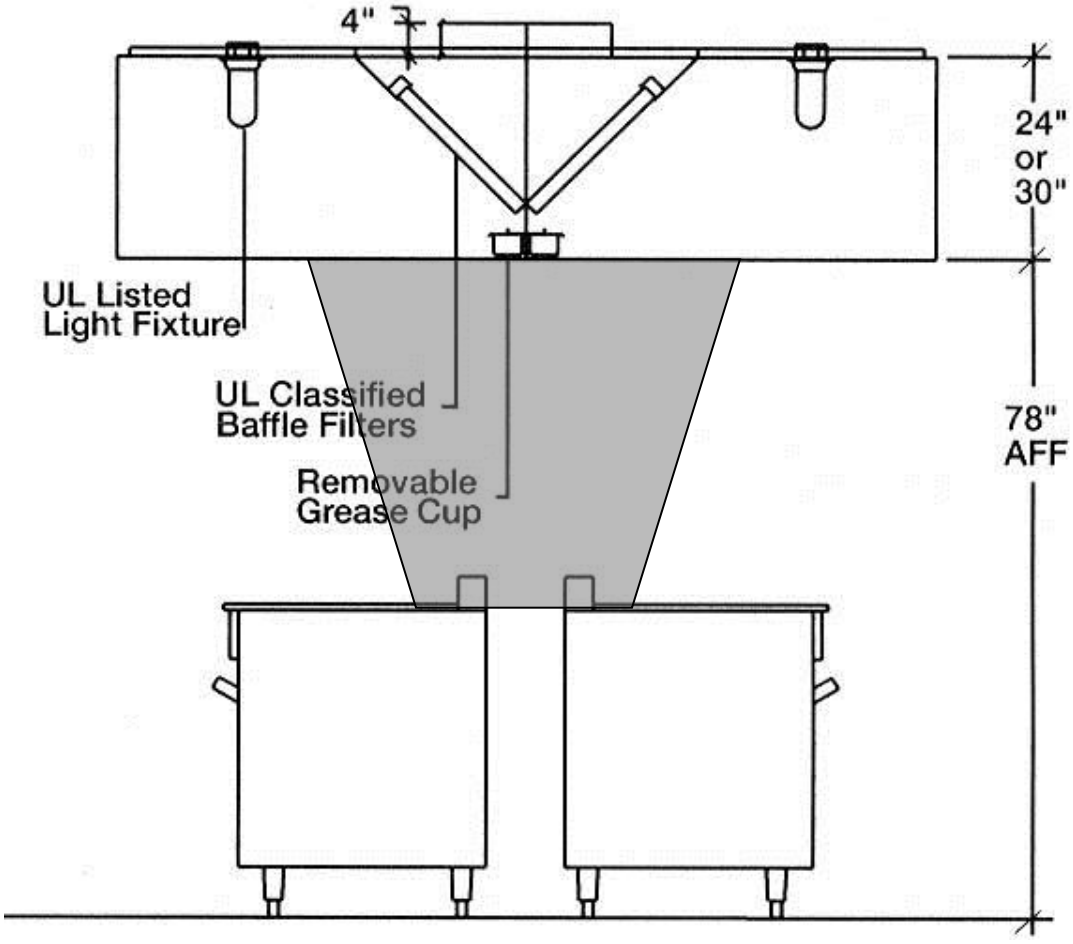
Mix-and-Match?



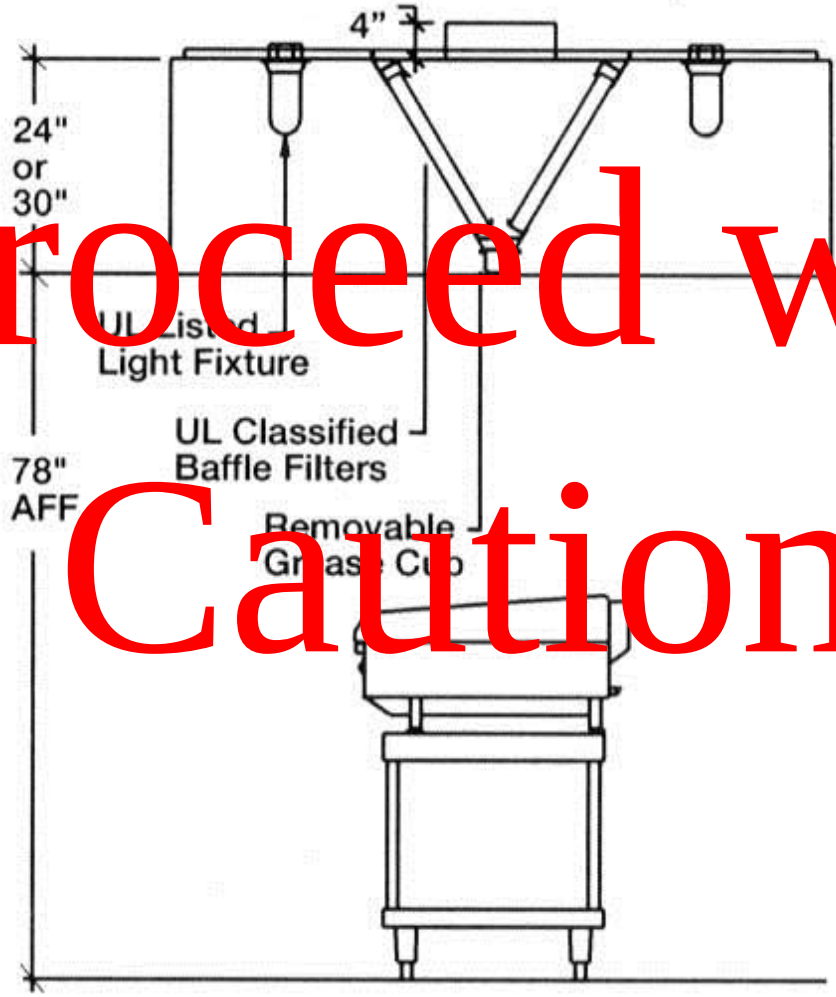
Double-Island Canopy



Double-Island Canopy



Single-Island Canopy



Proceed with Caution!

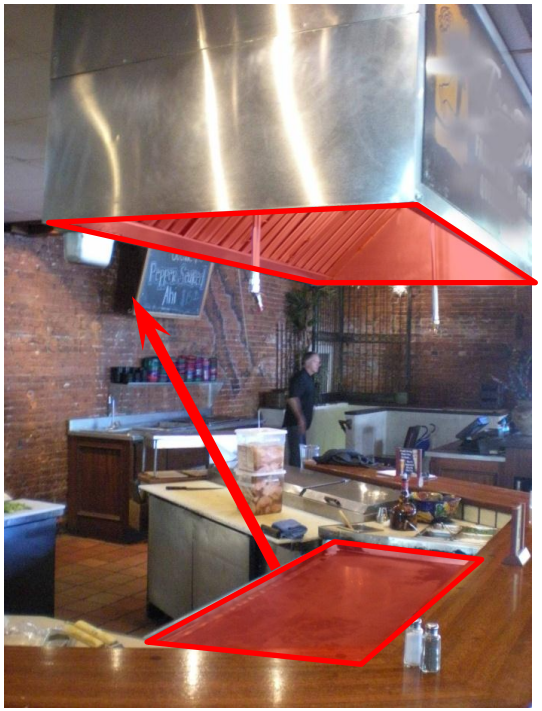
Display Cooking!

Difference today?

Display cooking with heavy duty equipment!

Problem 1:

Hood footprint typically is minimized to reduce cost, compromising hood overhang.



Just not big enough!

Problem 2:

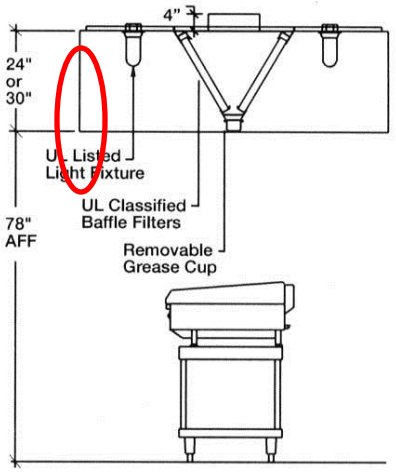
Single-island canopy hoods exposed on four sides are extremely vulnerable to cross drafts and/or unbalanced makeup air supply within the kitchen.

In need of a back wall…

Problem 3:

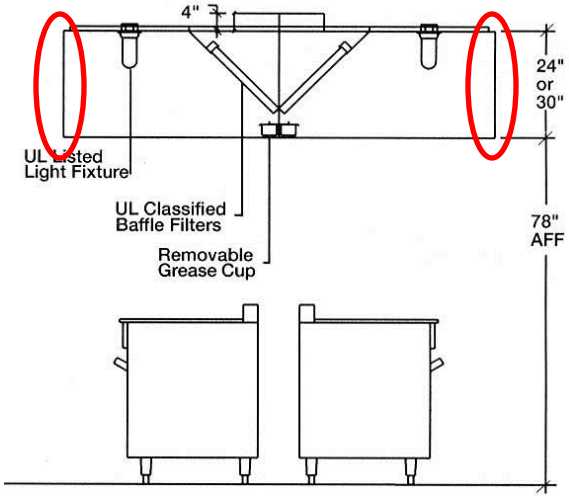
Design air flow rates for single-island hoods are often based on "UL listed" cfm/ft criteria (that are too low to start with) applied only to one side of the hood!

(e.g., 10 ft x 400 cfm/ft = 4000 cfm).



Note: Airflow rates for double-sided canopy hoods are calculated based on a cfm/ft criteria applied to both sides (similar to back to back wall canopies)

(e.g., 10 ft. x 2 x 400 cfm/ft = 8000 cfm)



This island style looks ok…..

…until the broiler is turned on!

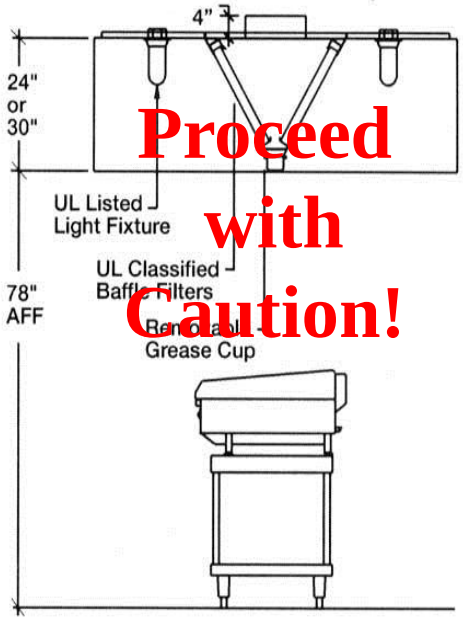
What is missing?

What needs to go?

Best Practice:

If possible, specify a wall-mounted canopy hood over a single-island hood!

If a single island canopy hood must be specified:



- Select a V-bank filter layout rather than a rear filter layout
- Maximize front, rear and side overhang
- Design replacement air to minimize turbulence near the hood with balanced supply to all sides of the hood.

Overhang with low velocity MUA is King!

10 ft x 6 ft

3200 cfm

VS.

10 ft x 4

7400 cfm

…exhaust rate also depends on Hood Classification

Listed

or

Unlisted