

# DEGREASING THE MODERN KITCHEN

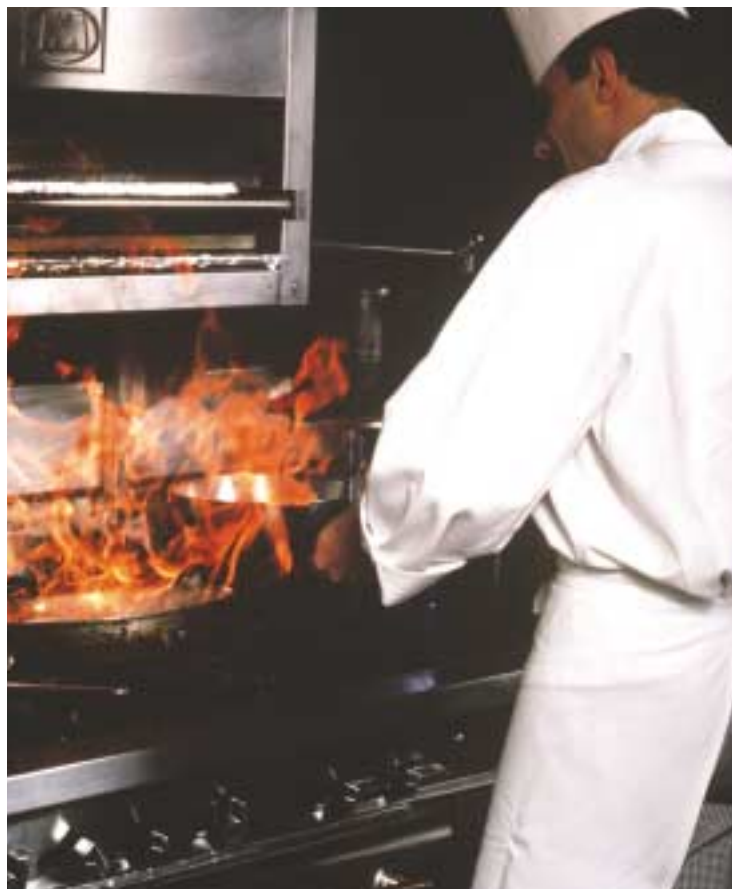
The unique challenges posed by stand-alone, urban,  
and food-court restaurants

By **ANTHONY MCGUIRE, PE**  
*McGuire Engineers*  
Chicago, Ill.

**T**he design and installation of kitchen grease-exhaust systems has a dynamic history. It started out simply with the need to capture and remove smoke. Our cave-dwelling ancestors knew firsthand the complications and dangers of cooking in closed quarters. With man's acquired taste for cooked meat came a host of new problems to solve for the earliest design engineers. Archeologists have found caves with ceilings embedded with smoke effects over cooking areas. Grease fires may have been prehistoric man's second discovery after fire. The progression of exhaust-system design moved onto property loss protection, and then onto today's penultimate concern: life safety. That is not to say that all of the challenges have been met. Modern developments, such as the ubiquitous mall food court, present a host of new problems for designers. And there still is a lot that can be done to resolve the problems we have been dealing with for decades, such as nuisance odors, which are still a significant problem in urban settings where homes and offices are often located in buildings with dining facilities.

## TODAY'S CHALLENGES

Over the last 50 years, the commercial cooking field has experienced unparalleled growth and diversity. The National Restaurant Association estimates that there are more than 830,000 restaurants in the United States. These range from formal settings with white tablecloths to the corner hot dog stand offering takeout fare. There are estimates that this number will climb to over 1 million over the



next 10 years. New to the American scene over the last several decades have been:

- Fast-food restaurants and takeouts.
- Japanese steakhouses.
- Indoor barbeque establishments.
- Pizza parlors.

---

*Anthony McGuire is the president of McGuire Engineers in Chicago and is an ASHRAE Fellow. His firm is involved in commercial office, medical, museum, library, industrial, and educational facilities. One of his first articles in HPAC Engineering was "Commercial and Industrial Kitchen Exhaust Systems," which appeared in May of 1993.*

- Food courts.
- New “ethnicity” foods.

We will get back to examine these, individually, but let us suffice to say that commercial kitchens in the new millennium are significantly more diverse (also more sophisticated) than they were in the 1950s when much of our current design criteria were established.

Let us look at what we, as ventilation

## Pros and Cons of Mall Food Courts

Let’s look at some of the benefits to a mall food court with a central grease exhaust.

- One exhaust fan versus many.
- One roof penetration.
- Single source of smoke and odors outside of the building.
- Fan is sized using a level of diversity.
- Quality of grease exhaust systems is controlled by building owner.
- Leasing becomes more attractive since tenants can avoid some fan equipment/installation costs.
- Ceiling space, possibly building height, and aesthetic treatment may be minimized due to a single exhaust duct versus multiple ducts.

With the good comes a little bad, at times. The central system has some details that can be viewed as negatives, including:

- Balancing is difficult and can be impossible at times.
- Tenant exhaust needs will differ from those initially projected.
- Duct main should be cleaned more frequently for safety reasons. That is, multiple kitchens expose each other to the spread of fire.
- Larger areas may become part of the same fire zone.
- Energy costs may run high due to the manifold arrangement.
- Restaurant operator loses a level of control of the exhaust system.
- Odors may migrate from one operator to another resulting in country-fried cinnamon buns with essence of curried garlic.

professionals, want to achieve for our restaurant clients, their customers, and their neighbors. Neighborliness makes for good business. Grease exhaust/containment systems have major impacts on customers and neighbors. This may be a keystone for successful restaurant operations. Kitchen systems, as a whole, need to attain:

**Cleanliness.** My immigrant grandmother would say, “Cleanliness is next to godliness”— Not a bad motto to apply to commercial kitchens. People will consume the products that receive the highest quality of attention from all parties involved.

**Efficiency.** Restaurants are one of the most fickle and competitive businesses we can find. Volume can shoot to the moon or fall off a cliff at the publication of a critic’s review. Competition comes in all facets of the business. Facility operations need to be cost effective.

**Comfort.** There was a time when human comfort in the kitchen was not in the recipe. Only the elite chefs’ most successful operators made major strides in upgrading conditions for their kitchen staff. A tight labor market, better products and more highly trained chefs have contributed to advancements. Today, it is hard to find the T-shirted, sweaty cooks that have been portrayed by Hollywood.

**Safety.** Concerns for safety can be divided into three groupings: kitchen workers, customers, and neighbors. The work environment of a commercial kitchen has many hazards that require proper training of food-service workers. Back injuries, cuts, bruises, burns from hot liquids, slips, trips, and falls are some of the many risks these workers face, in addition to the big one: fire.

Customers deserve the preparation and delivery of clean food in an adequately protected facility.

Neighbors are all those who occupy adjacencies, which may be in the same

building, next door, down the street, or in the community.

## DESIGN CONCERNS

Enough of the more global aspects of restaurants. Let’s get back to the grease-exhaust systems. For this article, we will discuss three types of buildings that can contain a restaurant: stand-alone, one-story; multi-story, urban; and food courts within malls.

**Stand-alone, one story.** Each of us will have our own depiction of a stand alone restaurant. It may be one of the popular fast-food-chain hamburger restaurants. Maybe fried chicken? Is it the greasy spoon diner depicted on television? Or is

it that five-star haute cuisine spot that is frequented only on special occasions? Their common denominator is isolation from others. This, in general, makes our treatment of exhaust easier. We have a single building which can be designed to locate our exhaust fan pretty close to the grease hood. The fan can be selected

**My immigrant grandmother would say, “Cleanliness is next to godliness”— Not a bad motto to apply to commercial kitchens.**

with discharge direction and velocity that disburse smoke and odors away from people and neighboring buildings.

Unless we overlook a significant factor, the installation, using manufacturers’ recommendations, will produce effective results. But as all engineers eventually learn, the devil is in the details. Here is a list of factors that can easily be overlooked in all three designs (stand-alone, multi-story, and food courts):

- **Ductwork.** The short run of grease-exhaust ductwork may carry too much grease out of the building, resulting in buildup on the roof. Filtration or other grease removal may be overlooked. Location of the grease exhaust must also be away from parking or drive-through areas.

- **What’s on the menu?** Different foods bring with them divergent challenges. Barbeque, mesquite grille, and other solid fuel cooking methods bring another concern. Luckily, NFPA 96, *Ventilation*

## Codes and Standards

The dynamics of our subject can best be expressed by the attention and evolution that has taken place in building code treatment of the topic. Table 1 compares various codes for kitchen grease systems.

Perhaps the most significant mechanical code aspect over the last ten years is the creation of the International Mechanical Code. It is designed for compatibility with the BOCA National Codes published by Building Officials and Code Administrators International Inc. (BOCA), the Standard Codes published by the Southern Building Code Congress International (SBCCI) and the Uniform Codes published by the International Conference of Building Officials (ICBO). The first edition of the International Mechanical Code was published in 1996. The second edition was published in 1998.

Technically, the 1998 International Mechanical Code supersedes the other codes. However, all jurisdictions have not adopted it "as is." There are many jurisdictions which still utilize older codes and earlier editions. Communities with limited construction activity may not have a priority in updating their building code. Other communities will incorporate amendments to address specific items. These are often the result of experiences of the community or its leadership.

In May 1992, *HPAC* published an article titled "Commercial and Institutional Kitchen Exhaust Systems," which discussed the wide variety of differences and inconsistencies in how grease exhaust systems are addressed by four different codes. This is a problem with no single solution, and one that is compounded in complexity when one considers that local jurisdictions tend to add their own

amendments to each.

As codes differ, the jurisdictional agents can also differ. Many cities welcome the activity represented by new restaurant construction. The officials can be most helpful in working with special situations. Some examples are:

Seattle publishes Director's Rule 14-98 on the Web ([http://www.cityofseattle.net/dclu/Codes/dr/dr14\\_98.htm](http://www.cityofseattle.net/dclu/Codes/dr/dr14_98.htm)). The rule gives very clear direction on the conditions under which a Type I exhaust system may terminate at a side wall. Otherwise, commercial kitchen exhausts must terminate above the roof.

Chicago Building Dept. has a standing committee, the Standards and Tests Committee, which hears requests for equivalencies to the city's code. When applicants have innovative methods or specific existing conditions that require non-traditional approaches, they are referred by building department officials to the committee for hearing and action.

building official, fire official, and operator.

**Multi-story, urban.** If neglected, the items above can wreak tremendous havoc, especially in older buildings. The solution is to break down the system components for analysis.

The toughest part of the equation in an existing, multi-story, urban building is egress: How do you get smoke out of the building quickly and safely? This is where cost becomes a huge factor. Finding a way for smoke to get up and out has generated

	Air velocity grease exhaust duct	Termination above roof	Termination at wall
BOCA National Mechanical Code (1984)	1,500 fpm (min.) 2,200 fpm (max.)	40 in. above roof, no nuisance.	Wall must be noncombustible, no other openings within three ft.
SBCCI Standard Mechanical Code (1988)	1,500 fpm (min.) no maximum set	40 in. above roof, 10 ft from adjacencies, vertical direction of air.	10 ft from adjacencies, grade and windows or openings vertical direction of air permits air-recovery for recirculation.
ICBO Uniform Mechanical Code (1997)	1,500 fpm (min.) 2,500 fpm (max.)	Two ft above roof, 10 ft from adjacencies.	"Through roof unless approved by building official."
International Mechanical Code (1996)	1,500 fpm (min.) 2,500 fpm (max.)	Two ft above roof, 10 ft from adjacencies or five ft if directed away, permits air-recovery.	"Through the roof unless otherwise approved by the code official."
International Mechanical Code (1998)	1,500 fpm (min.) 2,500 fpm (max.) <sup>a</sup>	Two ft above roof, 10 ft from adjacencies or five ft if directed away, fan min. two ft from parapet <sup>b</sup>	"Where approved by code official." "Shall not be located where protected openings are required."
NFPA No. 96, Ventilation Control and Fire Protection of Commercial Cooking Operations (1994)	1,500 fpm (min.) no maximum set <sup>a</sup>	40 in. above roof, 10 ft from adjacencies, upward direction of air, grease drain at traps or low points.	Noncombustible wall, 10 ft from adjacencies, flow perpendicular to wall or upwards.

**Table 1 Comparison of various codes for kitchen exhaust systems. Notes: a. Exceptions to velocity limitations permitted for hood and fan connections up to three ft in length. b. The 1998 edition has removed reference to engineered air-recovery systems. However, their use is growing.**

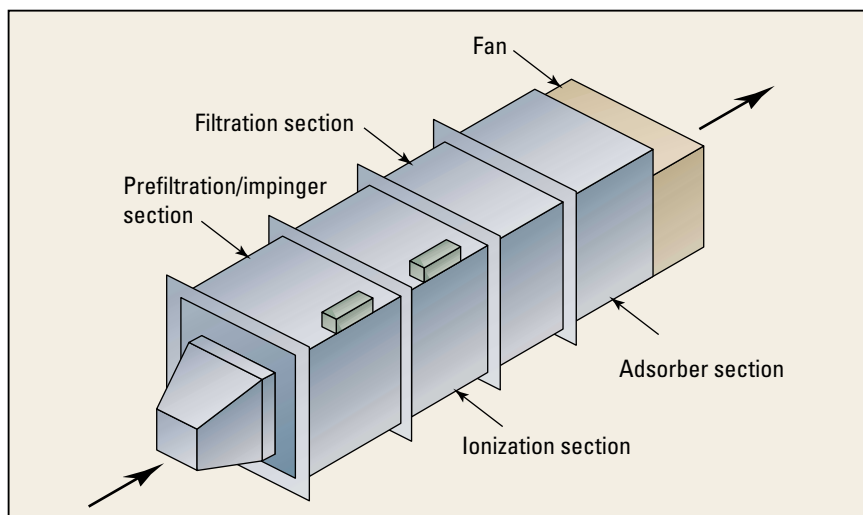
*control and fire protection of commercial cooking operations*, covers solid-fuel cooking very well.

- *Smells.* Restaurant patrons anticipate strong and exotic smells when they enter their favorite restaurant as part of the dining experience, but what about the neighbors? Manufacturers are continually developing odor removal systems and tools that are billed as effective and cost effective. Charcoal filtration (adsorption) is the most favored. However, ionization with high efficiency collection

cells can capture smoke and grease particles that are odor transporters (see "Latest Approaches" later in this article).

- *Noise.* Every HVAC engineer's experience includes noise problems from fans. Grease exhaust systems can require high pressure drops due to filter/grease extractors and the need for higher velocities. These factors need to be accommodated.

A key aspect of these design issues is good communication among the entire team—the owner, architect/designer, engineer, kitchen designer, contractors,



**FIGURE 1. Multi-phase kitchen exhaust pollution control with pre-filter, ionization, and wash-down cycle.**

accumulate, an access door is necessary immediately upstream. In addition, many manufacturers recommend more frequent duct cleaning as well as notifying the duct-cleaning firm to assure, the desired extra attention is paid.

Since our prime concerns of having grease-exhaust systems are cleanliness, efficiency, comfort, and safety, it seems to be very prudent to find this orifice/flat plate approach an acceptable means of achieving all of these goals.

**Energy costs** Something has to give somewhere. When we balance by putting devices in ducts, we add pressure drop and, in turn, incur higher energy usage for the system. Even a manifold system with branches sized for balancing accomplishes the same energy demand.

Additional energy premiums are paid because the manifold system needs to maintain a minimum air velocity in the master exhaust duct whenever any one hood is in operation. This means full air flow at the exhaust fan. Of course, if the exhaust fan is running at full airflow, makeup air must be provided. In most instances, this requires supply-fan energy and heating/cooling as necessitated by outdoor-air conditions.

#### LATEST APPROACHES

In recent years, several manufacturers have developed equipment that addresses purification of grease-exhaust air. The potential benefits are great. Smoke may be reduced to the point of elimination. Odors may be significantly reduced and, in some cases, completely removed. While the manufacturers we reviewed have not marketed the concept of recirculation of grease exhaust air, the cleaning/filtration methods that they use appear to be moving in a direction with the potential of greatly reducing make up air requirements. This could prove to be a major energy-saving approach for the industry. As you will note, this approach does not have a clear approval in the codes analyzed above. Local code officials have been approving such installations after “case-by-case” analysis. We are unaware of any outright approval, but have observed individual approvals in multi-

new thinking and products. The many improvements in grease filtration and extraction can result in ductwork that is not the “grease collector” of the past. Seattle’s Director’s Rule 14-98 has eight requirements to meet for low rise buildings and eleven for buildings of five stories or 60 vertical ft to the roof when you plan to use a side-wall discharge (see sidebar). These items provide for the cleanliness, efficiency, comfort and safety desired.

**Mall food courts.** During the 1980s, this trend revolutionized the food-service industry. In what is, in reality, a merger of the fast-food restaurant and the cafeteria, a family or group of friends can come, meet, and feast to their personal preference. Of course, food courts are not limited to malls. In fact, they appear in all kinds of buildings—from gas stations to the most magnificent skyscrapers. Design concerns that we will discuss will be around mall arrangements and the food court itself. When we think of the food court as a unit, we can project its systems into the multitude of building types and add the nuances for each particular case. For example, the fire-safety approaches used at a gas station/truck stop food court will take into account the location of storage tanks, exhaust location/direction, fuel pumps, as well as all the other details of good design.

How do we handle grease exhausts in the food court? Some basic designs keep it very simple. Each grease hood is served by its own dedicated exhaust system, which is designed with a control interface with the supply air system(s) that assures sufficient makeup air when the hood is in operation.

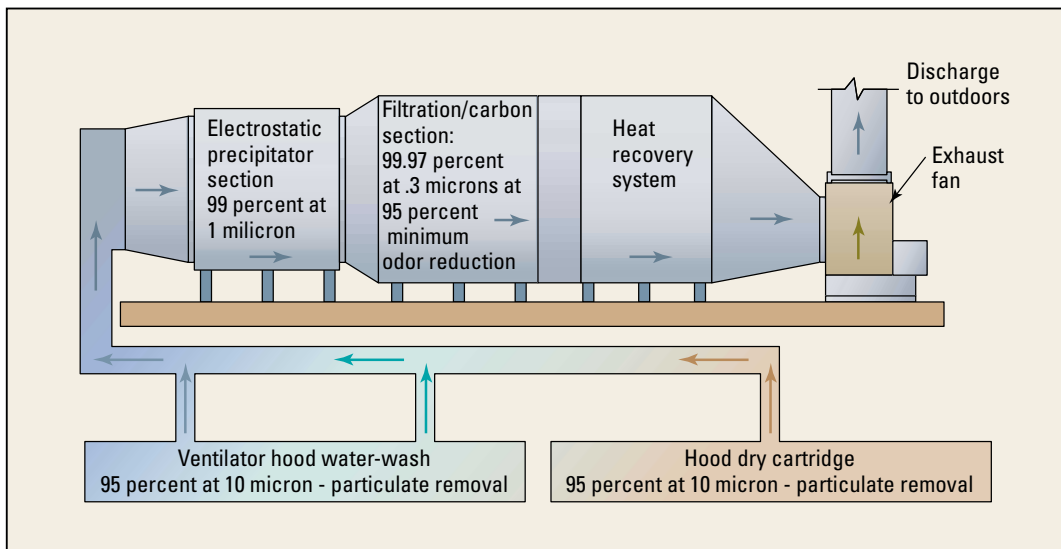
The larger, more sophisticated food

courts have utilized a common grease-exhaust system using a duct header with taps available at each rental unit. This centralized system approach has some of the wonderful benefits that central systems can give but it also has drawbacks (see sidebar “The Pros and Cons of Mall Food Courts”). Two key aspects of the food court are deserving of more discussion: balancing and energy costs.

**Balancing** When we follow NFPA 96, paragraph 6-1 of the dampers section, we find that, “Dampers shall not be installed in exhaust ducts or exhaust-duct systems.” Without dampers, the test and balance technician is left without his prime tool. Systems with single hoods and fans are relatively easy to balance as long as we have belt- (out of the air stream) driven fans to adjust. Manifold systems don’t offer this luxury. To compound the problem, we find that each restaurant operator on the system may change/clean his grease filters on a different schedule. Hoods themselves operate at different hours, which may be overcome by using a bleed air source that both measures and adjusts air quantity.

However, food courts can become very variable with a regular change in tenants. Today’s french fry stand may be a cold sandwich operation next month. This necessitates a program of scheduled rebalancing in addition to duct cleaning.

Back to our basic balancing—it cannot be done well without devices in the duct system. While some balancing firms confess to installing “devices,” but not dampers, in ductwork, the primary choice is an orifice plate, with a second choice being a flat plate mounted on the top side of the duct. Since grease will ac-



**FIGURE 2. Flow diagram of kitchen exhaust pollution-control unit with multiple hoods for dry and wet wash, high efficiency filtration, a mechanical collection and adsorption section, and heat recovery.**

ple jurisdictions.

Figure 1 shows a basic piece of such equipment. The unit's air flow from the hood first passes through an impinger module that serves as a prefilter as well as a safety device. It knocks down heavy mists and kitchen grease. The ionization module ionizes the air and provides for high-efficiency, multi-staged collection. A wash-down cycle may be provided for either or both of these modules. Following is the filtration module, which may house any of a variety of filters depending on the application. These could be panels, bag or even HEPA filters. The prime benefit of this section is the protection and life extension that is given to the adsorber module that follows. Media in the adsorber may be activated carbon granules or activated alumina impregnated with potassium. Such media may control hydrogen sulfide or similar acidic or sulfur bearing gases. Finally, we have the fan module. Many options are available in the control sequencing, levels of filtration, wash/detergent systems, fire sensing and fire suppression.

Figure 2 shows a scheme with multiple

hoods, with one being dry and the other with a wet wash. The first section of the unit provides for electric precipitation of particles and gives 90-percent filtration of 1-micron particles. Next is the main mechanical collection/adsorption section with traditional and carbon filters. A heat recovery system module can be pro-

**Customers deserve the preparation and delivery of clean food in an adequately protected facility.**

vided with any of a number of recovery methods since the grease exhaust air has been well filtered. Heat wheels, run around coils, and air-to-air are all feasible in this approach. All grease exhaust air is discharged to the outdoors.

Both devices represent significant improvements in options for the design. However, caution must be used. Many advances are taking place without substantiation. Presently, ASHRAE Technical Committee 5.10, Kitchen Ventilation, is looking to develop a test method to determine the efficiencies of grease removal devices. Historically, grease filters were designed primarily as fire-protection devices. As their purposes have expanded, manufacturer's claims have come under scrutiny.

**CONCLUSION**

In summary, HVAC professionals have many wonderful opportunities and challenges in the realm of common kitchen exhaust work. Commercial kitchens are a growth area that is dynamic in its requirements. Professional organizations are addressing the problems and prospective solutions as they arise. Manufacturers continue to develop innovative approaches. With our ongoing learning, we will be capable of great improvements.