A uniform quantitative method for determining ventilation requirements for commercial food preparation processes.

By Tom Johnson, 1/7/2006, all rights reserved

This paper reviews a new quantitative method to evaluate hazards associated with commercial food operation processes traditionally protected by requirements found in the model mechanical codes for localized kitchen exhaust ventilation; Type I or Type II hoods.

By universally applying this investigation methodology to various food preparation processes proposed for specific enclosed (indoor) spaces, public health and safety can be protected whilst not restraining trade.

Commercial food preparation processes done inside of a building present two common hazards that the model codes attempt to eliminate by imposing specific criteria for safety.

1. The first is a **fire** hazard due to smoke and grease vapor emissions.
2. The second is a **health** hazard due to excessive indoor humidity.

Combustible particulate matter generated from aggressive thermal processing of animal proteins and released into the indoor space mixes with the general room air. As these particles cool they condense, merge and grow. Eventually these big, sticky particles contact a surface in the space. How much goes where depends upon air currents, proximity to the process and contact surface characteristics. When the deposition is on an electrical junction, a switch or near a high heat source, a fire danger looms. Animal fat has a flash point of 650F and vegetable oils will spontaneously combust to flame at 681F.

Some surfaces, such as the metal grid in some suspended ceilings systems take on magnetic differential especially where the air currents are strongest and turbulence greatest such as near an air inlet to the space. That's why discoloration due to grease depositions is first noticed on the grid work nearest the make up or inlet air diffusers

Quantifying the fire hazard

We use the best method of test known to us to quantify acceptable particulate emissions and that is **UL710B, *Standard for Safety for Recirculating Systems***.

There are two product categories in this Standard; KNKG is for "Commercial Cooking Appliances with Integral Recirculating Ventilation Systems". For sake of clarity in this discussion, allow me to rename this section and call it "Commercial Cooking Appliances with Integral systems for reducing combustible particulate emissions".

Since this is the test method used to certify equipment, we use its reference test standard for quantifying acceptable combustible (condensable) grease emissions. The logic of this is supported by the attached reprint of a **NFPA 96** tentative interim amendment TIA 04-01.

The new section 4.1.1.2 identifies the reference standard results requirement, and it is leads to the answer, it's the 5MG/m3 is of condensable (combustible?) particulate, but it is expressed as a concentration. In order to convert it to a total allowed emission without a separate containment system (a hood of one type or another) we need to multiply that value by the test rate of exhaust, a nominal 500 CFM.

GREASE VAPOR SAFETY FORMULA
First we need to convert cubic feet into cubic meters.

1ft3 = 0.028316847m3 (reciprocal, 1m3 = 35.3146 ft3)

500 x 0.028316847 = 14.1584235
14.1584535 x 5 = 70.79225
70.79225 x 60 = 4247.535

Thus, 5mg/m3 condensable particulate amounts to a total production rate of roughly 71mg of particulate emissions per minute, which equals 4.25g/hr (4247mg/h).

Accordingly,
if our space emissions are at a mean (SD) rate greater than this value, then a fire hazard exists.
If a fire hazard exists, then listed fire extinguishment equipment is required (eg UL300).
If listed fire extinguishment equipment is required, then a complete Type I hood and fan control system is required.

But,
if our rate of effluent emissions are tested by a third party and determined to be below the 71mg/min of particulate emissions, then the potential fire hazard is not enough as to require approved fire suppression.

When is a Type II hood system required?

For all commercial mechanical ware washing processes except those that are designed for light applications, such as machines designed for undercounter applications. Some new innovations have built in latent heat reduction systems that quench the steam and reduce latent heat emissions into the space. Their acceptability must be performance based meaning it must be considered after determining the mechanical systems ability to reduce the processes specified (latent) emissions. Emissions are measured by testing using approved instruments and methods for worst case applications for stated frames of intended use.

The FDA Food Code states that no area in the food space is to be subject to RH of 65% or more as these environmental conditions are favorable mold and other microbiological growth.

Thus,
if the latent heat emissions (into the breathable space) from our processing of food or wares presents an environment whereby the mean RH for the space cannot be kept below 65%, then a health hazard exists and a mechanical intervention is required.

The most common option is the Type II hood system which exhausts the moisture saturated air through a duct system to the outdoors. But the professional engineer has other mechanical system alternatives from which to choose, such as desiccant dehumidification in tandem with air conditioning or other methods of dilution to assure RH stays in control.

In the near term design professionals continue to spec Type II largely because the code official requires it. Unfortunately, none of the model codes have adequate criteria for Type II duct systems. They provide no criteria to enable inspection and cleaning of these systems.

There are in fact two separate Type II frames of use.
1. Venting excess moisture only, such as the dishwasher.
2. Venting food preparation processes that may have some effluent emission, but not enough to be required to have fire extinguishment equipment.

If the application is for one of the many very light, threshold food warming process commonly used to reheat ready to eat food items, then no hood may be needed. Examples include countertop electric: toasters, cookie ovens, pretzel, chip and cheese warmers, soup warmers, hot food wells and the like. If energy inputs in the electric equipment get to 3,7KWH or higher, its likely a mechanical will be required.

But if it's a more aggressive process and condensable particulate emissions are between 1-5mg/m3, it would be prudent to use a Type I system, with the understanding that a fire system is not required.

A critical element of this discussion is that the PROCESS <u>must be tested</u> by a third party to determine the effluent emission rate. The data is what you will need for evidentiary rules if someone claims injury and pursues you for negligence. Remember, if food is never placed into cooking equipment, you cannot get smoke or grease vapor. If moisture is never placed into the equipment, you cannot expect to find elevated humidity. It's the process emissions that create the hazard; not the equipment or the food by itself.

Recent revisions to some codes have introduced hermetic criteria to assure some liquid tight characteristics to kitchen duct systems. They require pressure tests or in some cases accept a light test to inspect for leaks. But much more is needed. Some duct systems are designed to be pressurized and other are designed to be in a vacuum. It's important that duct materials and methods or fabrication and installation be conducive to the specific intended use. Though SMACNA and other present some excellent material on duct fabrication and installation methods, it is not appropriate to use drive and sleeve galvanized ducts for Type II system. First because this type of duct system is design to be pressurized and Type II systems place their fans at the end of the duct run. Second, general conveyance air ducts are not expected to have moisture saturated air condensing on its walls. The resulting water must drain away to prevent any pooling where water can stagnate and microorganisms can grow.

More information on this topic can be found at http://www.jdpinc.com then click onto the knowledge button on the left. There is also a large powerpoint presentation on the site which was the basios for training for the MN State Fire Marshalls Annual Training program at the University of Minnesota in this January.

Bottom line is our interventions mandated by adopted rules must hit the target hazard. Any collateral overlap is a trade restraint without any offset advantage for public health and safety. Uniform enforcement of optimized rules is good for everyone, uniform enforcement of poorly written rules are bad for everyone. Its not a matter of jurisdiction…it's a matter of prevention, due diligence and your ability to prove you have been reasonable in your approach to mitigating hazards in your operation.

Tom Johnson.

Tentative Interim Amendment

NFPA 96

Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

2004 Edition

Reference: 4.1.1.1*, 4.1.1.2, Annex A and Annex B
TIA 04-1 (NFPA 96)
(SC-04-7-10/Log 791)

Pursuant to Section 5 of the NFPA Regulations Governing Committee Projects, the National Fire Protection Association has issued the following Tentative Interim Amendment to NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations,* 2004 edition. The TIA was processed by the Venting Systems for Cooking Appliances Committee, and was issued by the Standards Council on July 15, 2004, with an effective date of August 4, 2004.

Tentative Interim Amendment is tentative because it has not been processed through the entire standards-making procedures. It is interim because it is effective only between editions of the standard. A TIA automatically becomes a proposal of the proponent for the next edition of the standard; as such, it then is subject to all of the procedures of the standards-making process.

1. Add new section 4.1.1.1 as follows:

4.1.1.1* Cooking equipment that has been listed in accordance with UL197 or an equivalent standard for reduced emissions is not required to be provided with an exhaust system.

2. Add new section 4.1.1.2 as follows:

4.1.1.2 The listing evaluation of cooking equipment covered by 4.1.1.1 shall demonstrate that the grease discharge at the exhaust duct of a test hood placed over the appliance shall not exceed 5 mg/m^3 when operated with a total airflow of 0.236 cubic meters per second (500 cfm).

3. Add new section to Annex A
A.4.1.1.1 See UL 710B.

4. Add new section to Annex B
Add UL 710B, Outline of Investigation for Recirculation Exhaust Systems.