

2021 WSEC & 2021 IMC - Commercial Kitchen Air Systems



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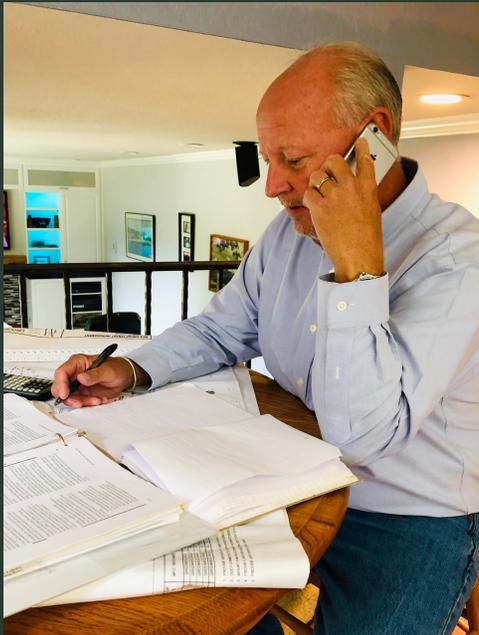
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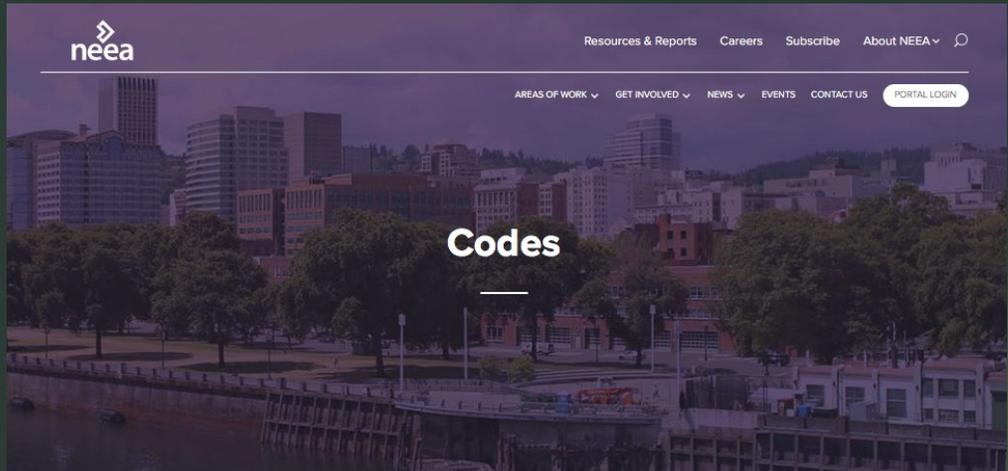
- On-call technical support thru 3 avenues
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 - Email inquiries – com.techsupport@waenergycodes.com
- Classroom and webinar training
- We administer the technical support and compliance documentation webtool



Duane Lewellen,
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Increasing progressive effectiveness of energy codes

The NEEA Codes and Standards program supports regional stakeholders in the development and adoption, training and implementation of energy codes. States engage in the code development process along different cycles and code versions, but all states now use the International Energy Conservation Code (IECC) as a baseline for their commercial energy codes. All states except Oregon now use the IECC as the basis of their residential code. The adoption of codes is the responsibility of state code boards or agencies. Official state-by-state energy code information can be found on state building code websites:

Idaho - <http://dbs.idaho.gov/boards/index.html>

Oregon - <http://www.cbs.state.or.us/external/bcd/>

Washington - <https://sbcc.wa.gov/>

Montana - <http://svc.mt.gov/gov/boards/>



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WSEC technical support services are made possible thanks to the generous support of the Northwest Energy Efficiency Alliance

www.neea.org

Today's Presentation

- This presentation represents ETC's *unofficial* interpretation of WA State Energy Code intent.
- Our technical support team is not an affiliate, nor do we speak for the Washington State Building Code Council (SBCC).
- The WSEC commercial technical support we provide is advisory only and non-binding.



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Topics we'll discuss today ~

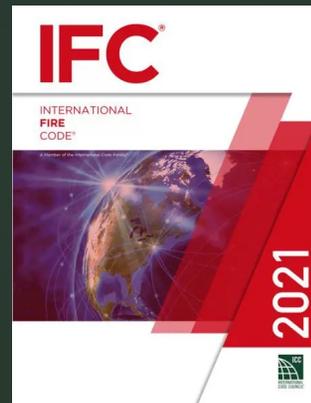
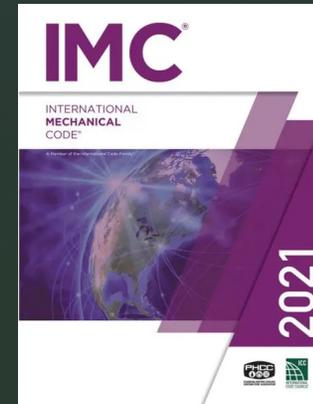
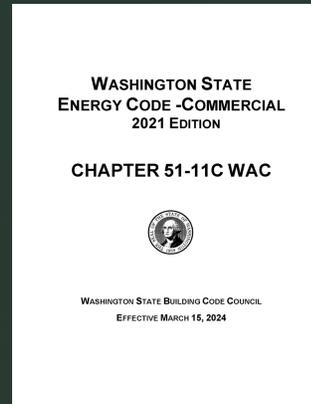
1. Applicable codes governing kitchen exhaust & make-up air systems
2. Kitchen exhaust hood types
3. Requirements for exhaust hood construction and operation
4. Kitchen supply, exhaust and make-up air systems
5. Kitchen systems interlock controls including DCKV
6. Replacement air balance calculations
7. Options for energy recovery
8. Question & answer session

Commercial Kitchen Systems



Applicable Codes

- 2021 WSEC Commercial
- 2021 IMC with WA State Amendments
- 2021 IFC with WA State Amendments
- 2021 IFGC (Fuel Gas)
- NFPA 96 Ventilation Control & Fire Protection of Commercial Cooking Operations
- Underwriters Laboratory UL197 (Appliances) & UL710 (Exhaust Hoods)



2021 WSEC-C Requirements

WSEC C403.7.7.1 (Commercial) Kitchen Exhaust Systems

- C403.7.7.1.1 Replacement air (introduced directly at hood)
- C403.7.7.1.2 Kitchen exhaust hood certification & maximum airflow
- C403.7.7.1.3 Kitchen exhaust hood system (controls)



*Image per
2021 IECC
Commentary*

2021 IMC Requirements

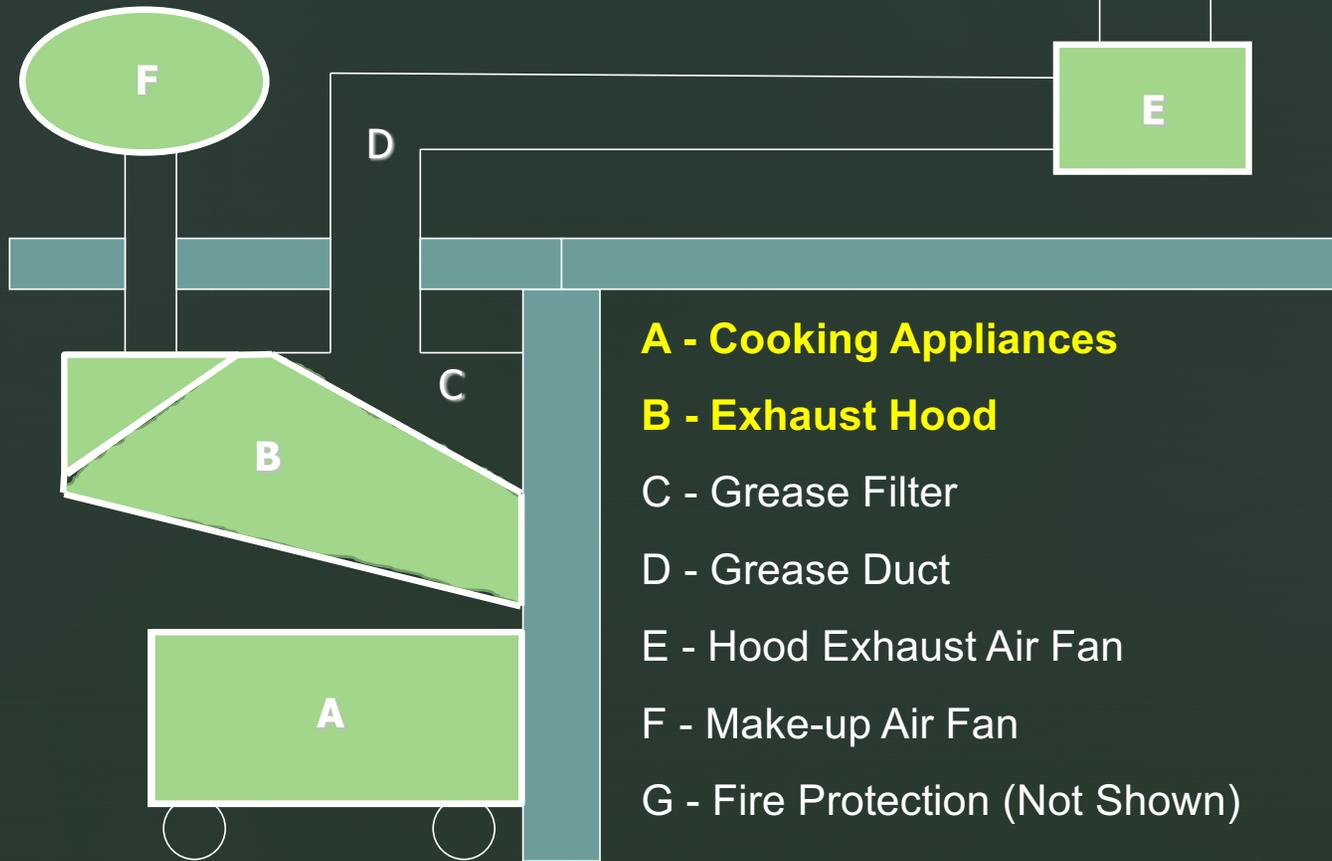
IMC 507 Commercial Kitchen Hoods

- 507.2 Type I hoods
- 507.3 Type II hoods
- 507.4 Hood size & location (overhang, setback & mounting height)
- 507.5 Capacity of hoods

IMC 508 Commercial Make-up Air

- 508.1 General requirements
 - 508.1.1 Make-up air temperature (differential w/ kitchen supply air)
 - 508.1.2 Air balance (kitchen/dining facility exhaust & replacement air)
- 508.2 Compensating hoods

Commercial Kitchen Systems



Cooking Appliances

- **COMMERCIAL COOKING APPLIANCES.** *Appliances* used in a commercial food service establishment for heating or cooking food.
- A commercial food service establishment is where food is prepared for sale or is prepared on a scale that is by volume and frequency not representative of domestic household cooking.



Cooking Appliance Duty

Type I Applications – Kitchen hood rated for collecting & removing grease-laden vapors and smoke from the cooking process. Shall be equipped with fire suppression system.

- Extra-Heavy Duty – Open flame combustion of solid fuel
- Heavy-Duty – Broilers, gas open-burner ranges, smokers
- Medium-Duty – Ranges, griddles, fryers, skillets, rotisseries, pizza ovens

Type II Applications – Kitchen hood rated for collecting & removing steam, vapor, heat, odors and products of combustion from the cooking process (other than smoke or grease).

- Light Duty Cooking - Ovens, steamers, kettles, pasta cookers
- Light Duty Moisture - Dishwashers and sterilizers

2021 WSEC-C – Additional Energy Efficiency Measure

C406.2.14 Enhanced commercial kitchen appliances

- Applies to buildings or spaces that are Group A-2 occupancy, and to facilities whose primary business involves the use of commercial kitchen equipment
- Requires Energy Star rated kitchen appliances
- Project shall have at least one gas or electric fryer
- Applies to fryers, steam cookers, ovens and dishwashers



Exhaust Hood Types

Factory Built

- Listed by a nationally recognized testing laboratory
- Ducted hoods listed and labeled per **UL 710**
- Recirculating (ductless) hoods listed and labeled per **UL 710B**
- Meets IMC requirements for hood materials and construction



Field Fabricated / Constructed

- Assumption is that hoods constructed in the field may not be as effective at capture and containment as those fabricated and tested in a factory environment.
- The IMC sets *minimum required exhaust airflow rates* to account for inconsistency in field construction.

Exhaust Hood Types

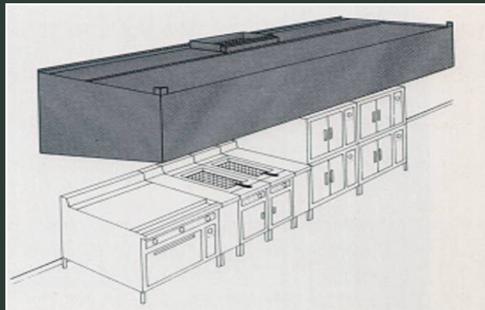
Types of exhaust hoods

- Wall-mount canopy
- Single island canopy
- Double island canopy
- Eyebrow hood
- Back-shelf hood
- Pass-over hood

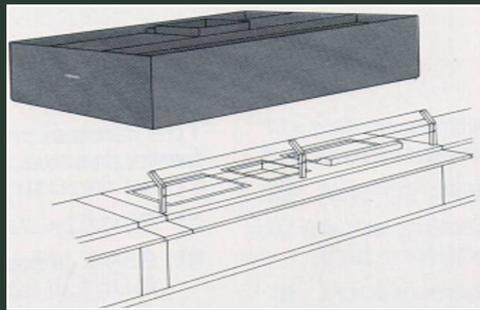
Other Types of Kitchen Exhaust Systems

- Pantleg dishwashing vent system
- Non-canopy hood per IMC 507.4.2 requirements.
- **Commercial cooking recirculating system** – Self-contained system consisting of the exhaust hood, cooking appliances, filters and fire suppression system... Removes contaminants from exhaust air and recirculates the air to the space from which it was withdrawn.

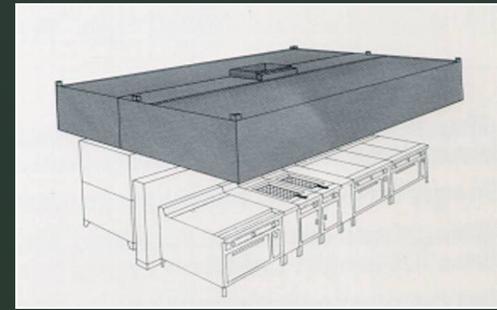
Exhaust Hood Types



Wall Canopy



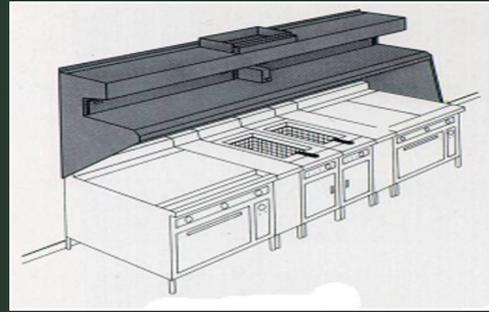
Single Island Canopy



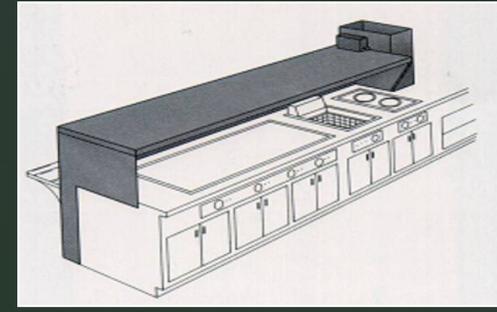
Double Island Canopy



Eyebrow



Back Shelf



Passover

Review total design airflow rates for all hoods in Kitchen Exhaust Hood Equipment Schedule

EXHAUST HOOD REQUIREMENTS



Is the total kitchen hood exhaust airflow rate $\geq 2,000$ CFM?

YES

Per **2021 WSEC Section C403.7.7.1.2**, each kitchen exhaust hood shall be listed per UL 710 for standard hoods or UL 710B for recirculating hoods.

UL 710 & UL 710B exhaust hoods are EXEMPT from the following requirements in the **2021 IMC**: hood materials and construction, and minimum required exhaust airflow rates.

All exhaust hoods shall comply with the MAXIMUM allowed exhaust airflow rates per **2021 WSEC Section C403.7.7.1.2** and DCKV controls requirements per **Section C403.7.7.1.3**.

NO

2021 WSEC-C maximum allowed hood exhaust airflow rates and DCKV controls requirements DO NOT APPLY.

All exhaust hoods shall comply with **2021 IMC MINIMUM** required exhaust airflow rates and all other applicable requirements.

Review total design airflow rates for all hoods in Kitchen Exhaust Hood Equipment Schedule

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EXHAUST HOOD REQUIREMENTS



Exhaust Hood Capacity – Additional 2021 IMC Requirements

- **IMC 507.5 Capacity of hoods** – Where any combination of heavy-duty, medium-duty and light-duty cooking appliances are located under a single hood, the required exhaust rate for the heaviest duty appliance shall be used for the entire hood.
- **IMC 507.5.5 Dishwashing appliances** – The minimum net airflow for Type II hoods used for dishwashing appliances shall be 100 cfm per linear foot.

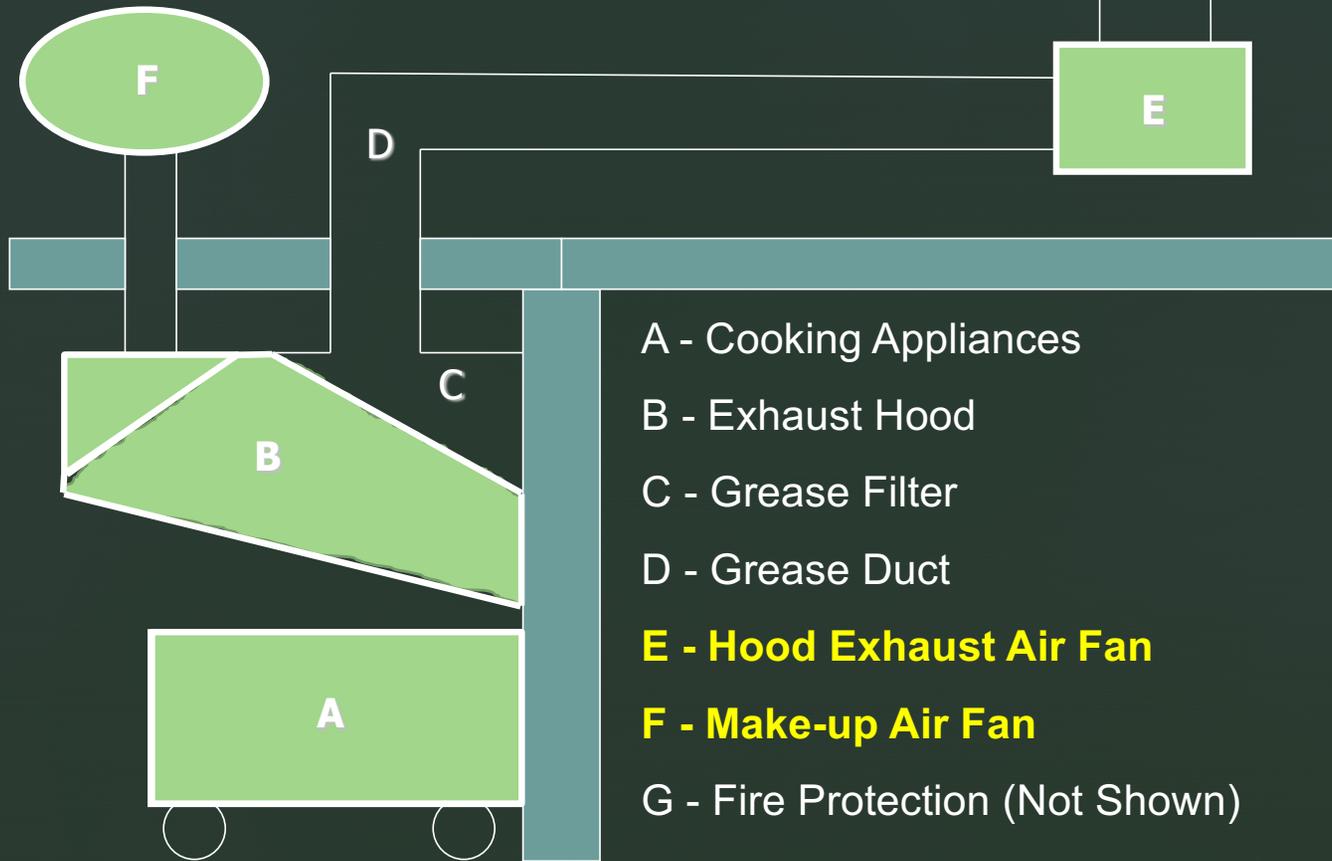
Re-use of Kitchen Exhaust Hoods

New Buildings or Retrofits

- **IMC 105.5 Material, equipment and appliance reuse.** Materials, *equipment*, appliances and devices shall not be reused unless such elements have been reconditioned, tested and placed in good and proper working condition and *approved* (i.e. deemed acceptable by the code official).
- IMC, WSEC standard performance requirements ***DO APPLY*** to reconditioned kitchen exhaust hoods.



Commercial Kitchen Systems



DEMAND CONTROL KITCHEN VENTILATION (DCKV). A system that provides automatic, continuous control over exhaust hood and make-up air fan speed in response to one or more sensors that monitor cooking activity or through direct communication with cooking appliances.

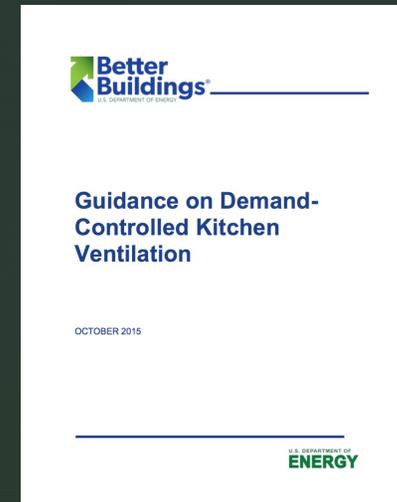


Image courtesy of Better Buildings - US DOE

Kitchen Exhaust & Make-up Air Controls

DCKV System

- Modulates the speed of the kitchen exhaust hood fan and supply/make-up air fan(s) based on the presence of heat, steam and smoke within the hood.
- Maintains the correct airflow level in response to the actual cooking load.
- Lower exhaust airflow is permitted under no-load or low-load conditions per NFPA 96.
- Not to be confused with DCV (demand-controlled ventilation), which is occupant-based ventilation air control.



<https://betterbuildingsolutioncenter.energy.gov/sites/default/files/attachments/Guidance-on-Demand-Controlled-Kitchen-Ventilation.pdf>

2021 WSEC-C – Kitchen Exhaust & Make-up Air Controls

WSEC C403.7.7.1.3 Kitchen exhaust hood system

- DCKV is required on **Type I hoods** where kitchen or kitchen/dining facility has total kitchen hood exhaust airflow rate **greater than 2,000 cfm**.
- Shall be configured to reduce exhaust & replacement airflow by at least 50% in response to kitchen appliance operation.
- Must maintain full capture of smoke, effluent and combustion products during cooking AND idle operation.
- Exceptions:
 - UL 710 medium & light duty hoods where design max exhaust airflow rate is ≤ 250 cfm per LF and total kitchen hood exhaust is $< 5,000$ cfm
 - Kitchen exhaust systems with 40% energy recovery (ER) effectiveness or ER is applied to $\geq 50\%$ of total hood exhaust airflow

2021 IFGC – Exhaust Hood Interlock Controls

IFGC 505.1.1 Commercial cooking appliances vented by exhaust hoods

- Appliances shall be interlocked with the exhaust hood system to prevent *appliance* operation when the exhaust hood system is not operating.
- For appliances equipped with standing pilot burner ignition systems, the method of interlock between the exhaust hood system and the appliances shall not cause the pilot to be extinguished.
- Where a solenoid valve is installed in the gas *pipng* as part of an interlock system, gas *pipng* shall not be installed to bypass such valve.
- **Exception:** An interlock is not required where heat sensors or other *approved* control method automatically activate the exhaust hood system when cooking occurs.

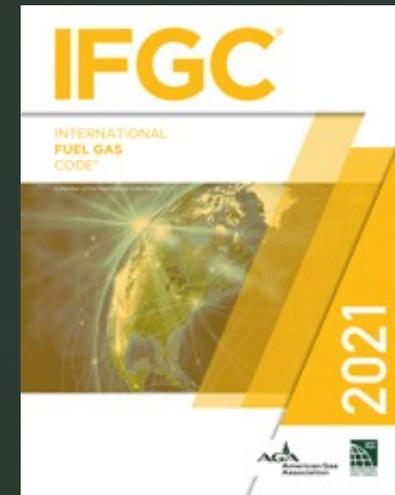
2021 IFGC – Exhaust Dampers

IFGC 505.1.1 Commercial cooking appliances vented by exhaust hoods

- Dampers shall not be installed in the exhaust system.
- Dampers can impede the proper exhaust of grease and cooking fumes, potentially compromising safety and functionality.
- Most DCKV systems rely on modulating fan speeds and specialized sensors to adjust ventilation airflow based on cooking activity.

However, per UL 710...

- Balancing dampers **can be** included in kitchen exhaust systems **only if** they are listed and installed per UL 710; meaning they must be specifically designed and tested for use in commercial kitchen ventilation systems.



Replacement Air Definition

REPLACEMENT AIR. Outdoor air that is used to replace air removed from a building through an exhaust system.

Replacement air may be derived from one or more of the following:

- Makeup air
- Transfer air
- Supply air
- Infiltration

When replacement air exceeds exhaust, the result is exfiltration (building pressurization).

2021 IMC – Kitchen Makeup Air / Exhaust Air Balance

IMC 508.1 Makeup air.

- Makeup air systems shall be automatically controlled to start and operate simultaneously with the exhaust system.
- The amount of makeup air supplied to the building from all sources shall be approximately equal to the amount of exhaust air for all exhaust systems serving the building.
- **NOTE** – Pressure differential of dining areas adjacent to kitchens may be slightly positive to minimize odor intrusion from the kitchen.

Importance of Replacement Air Balance

- Makeup air is a critical element for the proper operation of kitchen exhaust systems.
- ***It must must be approximately equal to the amount of exhaust air.***
- Without enough makeup air, excessive negative pressures may develop, resulting in the loss of draft in appliance vents and chimneys or a possible discharge of combustion byproducts back into the building.



Kitchen / Dining Ventilation & Exhaust Air

IMC TABLE 403.3.1 MINIMUM VENTILATION RATES				
OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY (# / 1,000 SF)	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE (CFM / PERSON)	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE (CFM / SF)	EXHAUST AIRFLOW RATE (CFM / SF)
FOOD AND BEVERAGE SERVICE				
Bars, cocktail lounges	100	7.5	0.18	-
Cafeteria, fast food	100	7.5	0.18	-
Dining rooms	70	7.5	0.18	-
Kitchens, cooking ^b	20	7.5	0.12	0.7

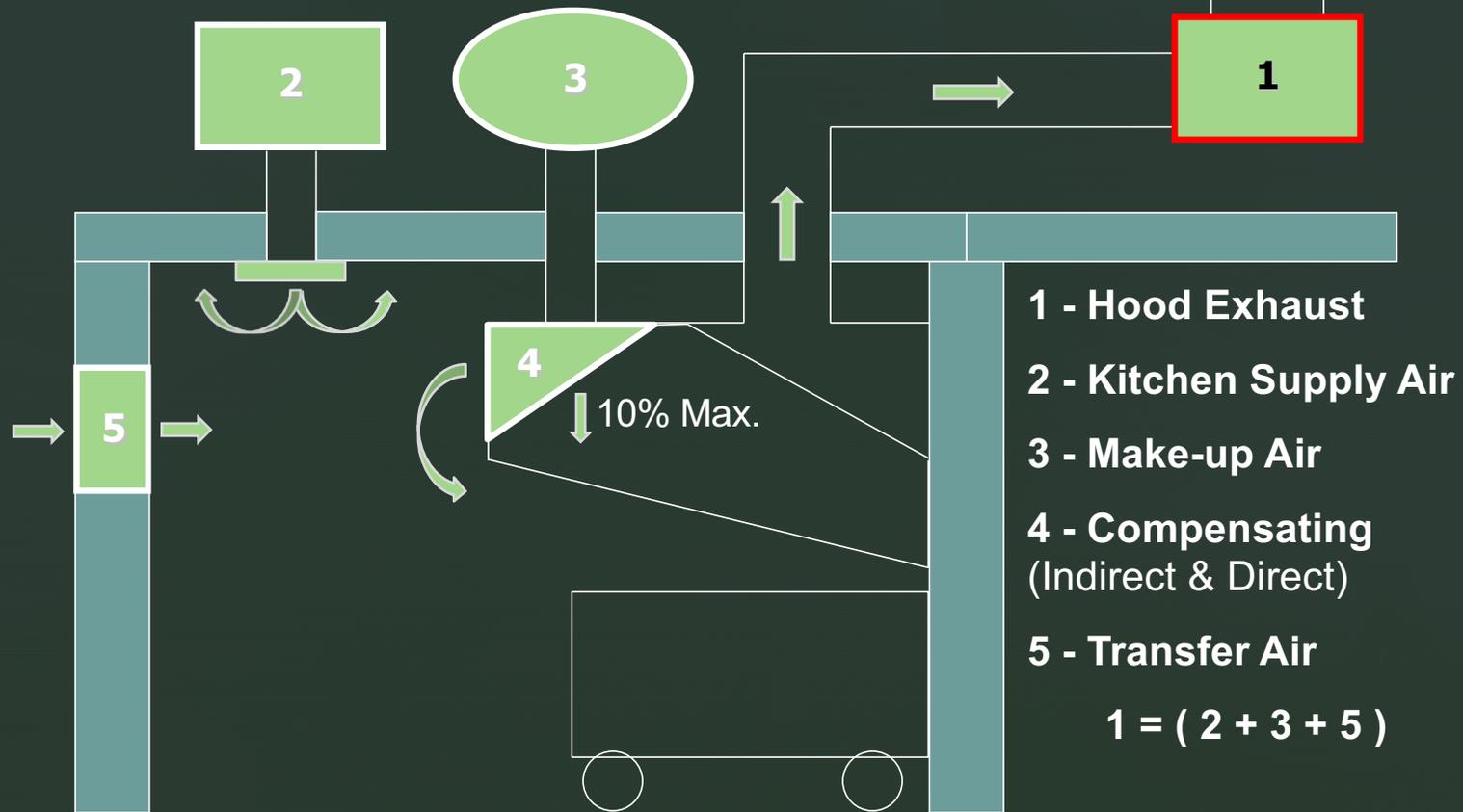
2021 IMC – Kitchen Makeup Air / Exhaust Air Balance

IMC 508.1.2 Air balance.

- Design plans for a facility with a commercial kitchen ventilation system ***shall include a schedule or diagram*** indicating the design outdoor air balance.
- Outdoor air balance shall indicate all exhaust and replacement air for the facility, plus the net exfiltration if applicable.



Replacement Air Balance



2 – Kitchen Supply Air

- Most of the cooking-related cooling load in a kitchen is removed by the kitchen exhaust hoods.
- Frequently, the required IMC minimum ventilation and exhaust airflow rates in a kitchen are sufficient to satisfy the kitchen area cooling loads.
- Supply air from kitchen areas cannot be recirculated to other spaces, but may be recirculated to serve the kitchen per IMC Table 403.3.1 Footnote b.

3 – Makeup Air

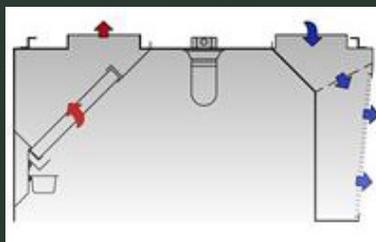
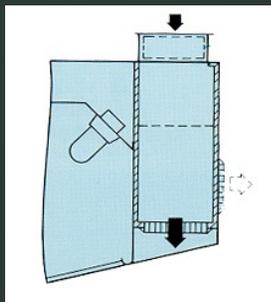
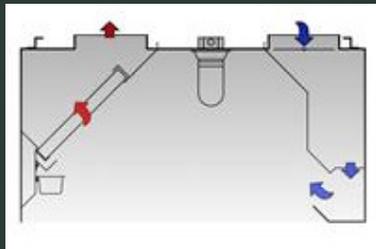
Kitchen Make-up Air Volume

- Total kitchen make-up airflow from all sources shall be approximately equal to the total kitchen exhaust airflow, including the exhaust hoods and minimum required kitchen exhaust CFM.

IMC 508.1.1 Makeup Air Temperature

- Make-up air shall be tempered to within 10° F of the design setpoint temperature of the conditioned kitchen area, unless...
- ...the heating & cooling load introduced by the make-up air does not exceed the capacity of the kitchen supply air system.

4 – Compensating Section



- **Short Circuit** – Integral plenum directs make-up air from within the hood and up into the canopy.
 - “Short-circuit hoods require higher airflows to effectively contain smoke.” *DOE: Kitchen Exhaust*
 - C403.7.7.1.1 – Replacement air introduced directly into the exhaust hood cavity shall not be greater than 10% of the hood exhaust airflow rate.
- **Better** – Down-discharge or Air Curtain
 - Integral plenum directs make-up air downward from the bottom of the front face of the canopy.
- **Best** – Front-face or side-face discharge (compensating)
 - Integral plenum directs make-up air away from canopy and into the kitchen space.

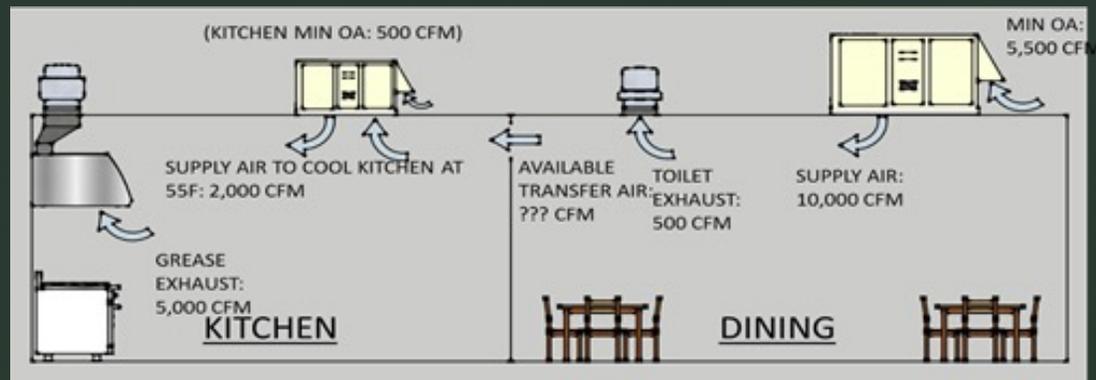
Images courtesy of Larkin Industries

5 – Transfer Air

Goal – Utilize conditioned supply air *that would otherwise be exhausted* as replacement air for the kitchen exhaust hood system.

Includes:

- Outdoor air not required to satisfy other exhaust needs such as toilet exhaust, building pressurization, etc.
- Outdoor air not prohibited from being recirculated per the IMC.

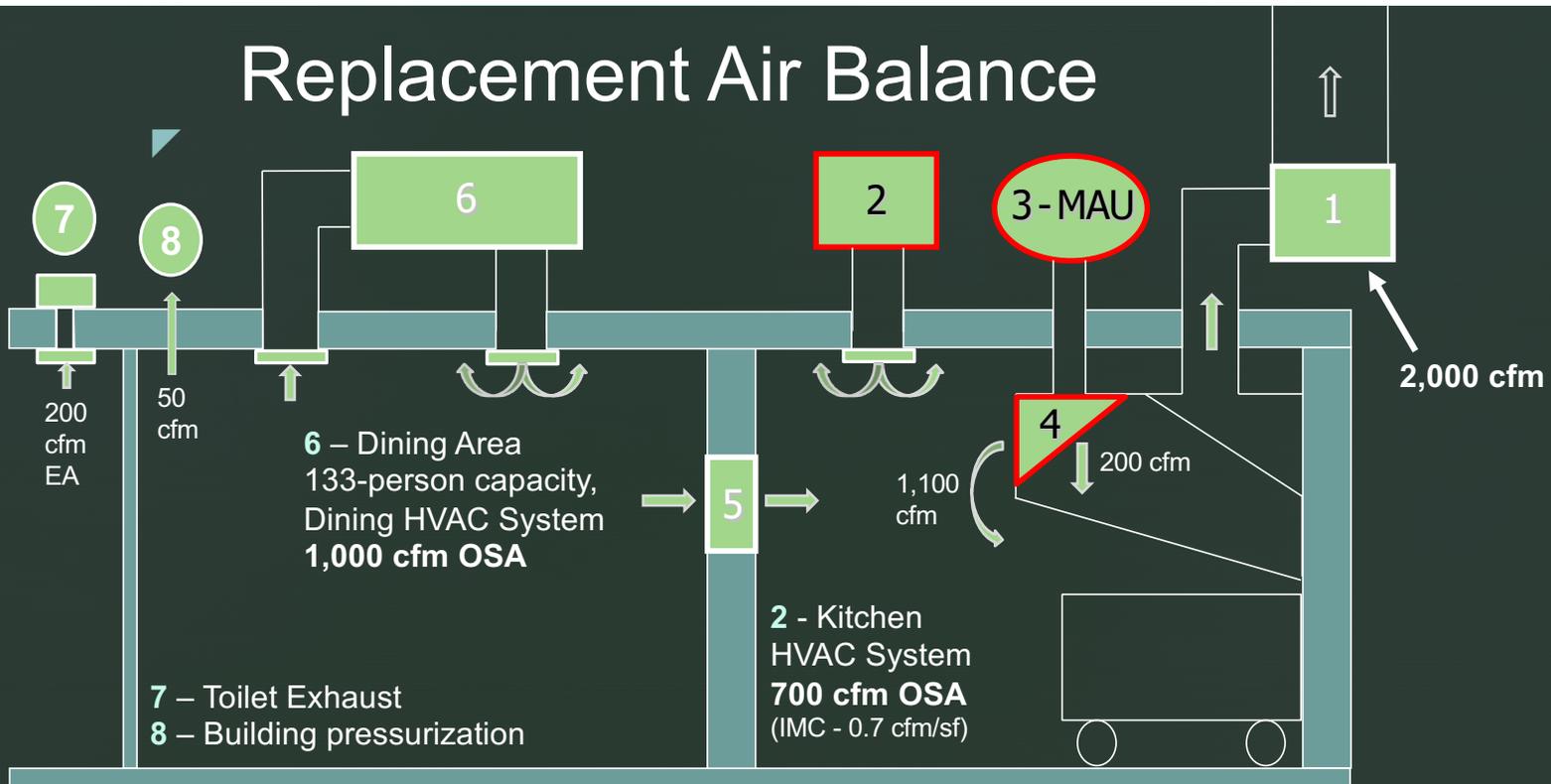


5 –Transfer Air

Where it can come from ...

- Spaces nearby or adjacent to the kitchen (free flow)
- Restaurant dining room, seating area for fast food, bakery, etc
- School cafeterias
- Food court seating & common areas in student union buildings, shopping malls, airports, sports arenas, etc
- Conference and assembly areas in hotels, motels, resorts
- Food preparation and packaging facilities

Replacement Air Balance

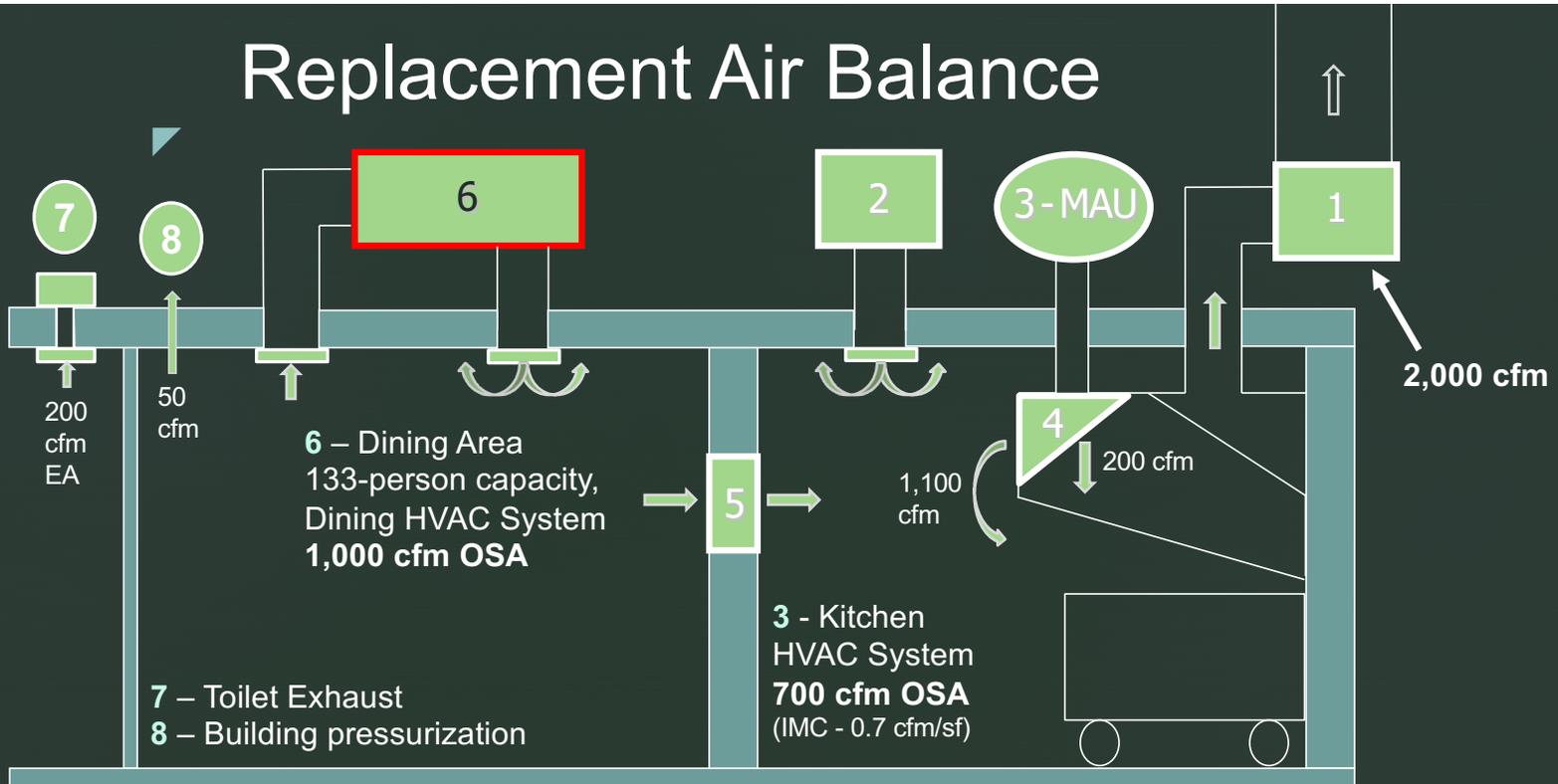


- 1 – Kitchen Exhaust Hood = 2,000 cfm
- 2 – Kitchen HVAC System = 700 cfm OSA

Per (2) Kitchen Supply Air with MAU:
 2,000 cfm Hood – 700 cfm Kitchen OSA =
1,300 cfm Make-up Air Required (3)

(4) Compensating Hood w/ Integral MAU:
 200 cfm (10% Max) + 1,100 cfm Front-Face
 Discharge = 1,300 cfm

Replacement Air Balance

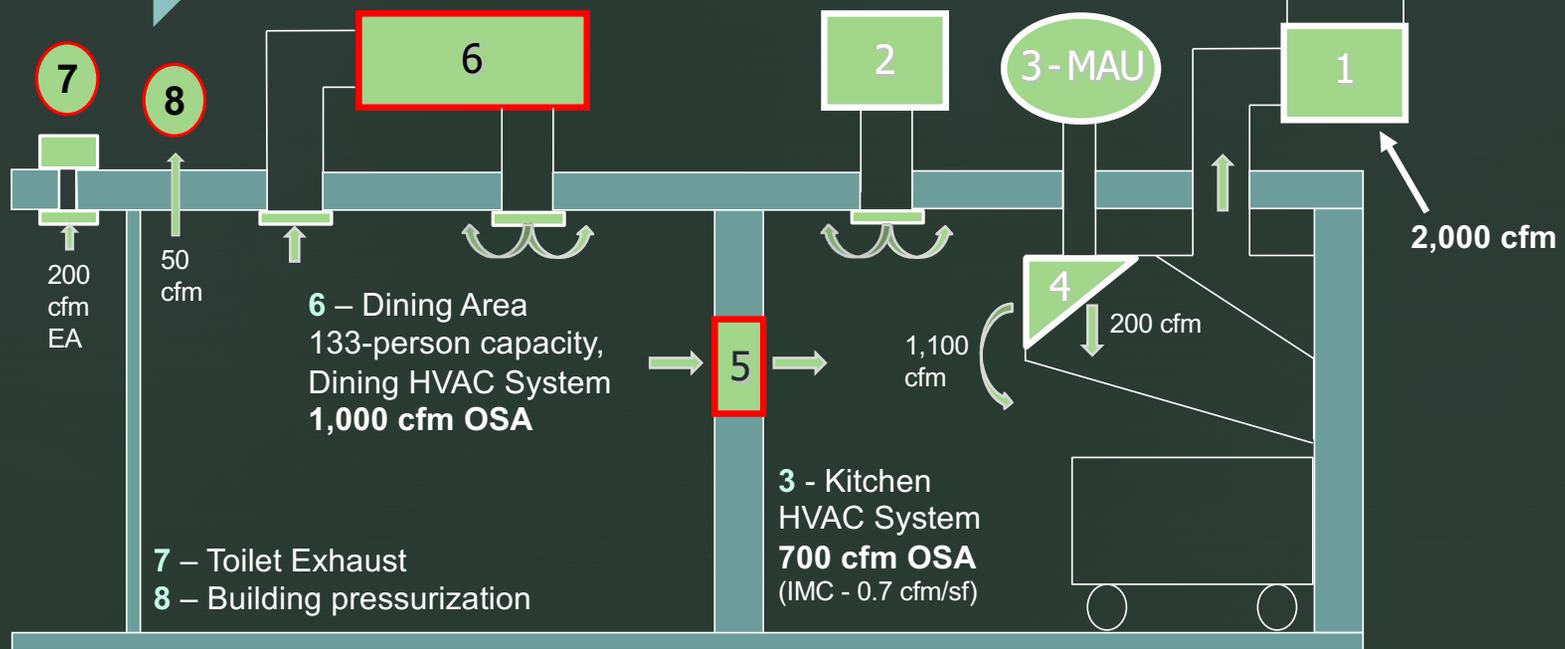


6 – Dining Area OSA

$$7.5 \text{ cfm} * 133 \text{ people} = 1,000 \text{ cfm}$$

1,300 cfm Make-up Air Required

Replacement Air Balance



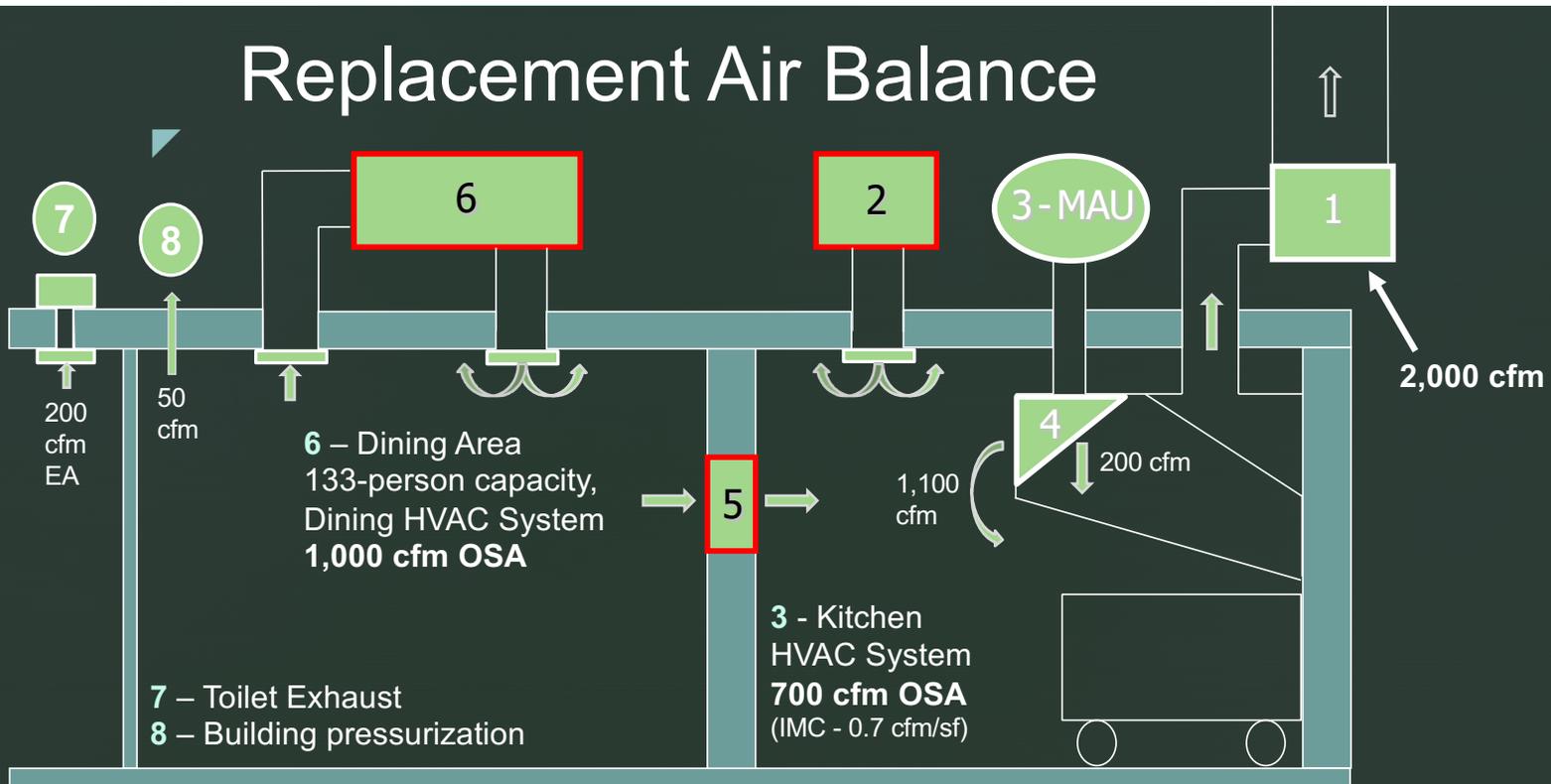
5 - Available Transfer Air

- 1,000 cfm Dining OSA (6)
- 200 cfm toilet EA (7)
- 50 cfm building pressurization (8)

Transfer Air = 750 cfm

1,300 cfm Make-up Air Required

Replacement Air Balance



- 1 – Kitchen Exhaust Hood = 2,000 cfm
- 2 – Kitchen HVAC System = 700 cfm OSA
- 5 – Dining Transfer Air = 750 cfm OSA

2,000 cfm Hood – (700 cfm Kitchen OSA + 750 cfm Dining Area Transfer Air) = **550 cfm Make-up Air required when dining area OSA system is at 100%**

1,300 cfm Make-up Air Required

2021 WSEC-C – Dining Area DCV

WSEC C403.7.1 Demand control ventilation in dining facilities

- Required for spaces with occupant load ≥ 15 people / 1,000 SF or occupant outdoor airflow rate ≥ 15 cfm/person per IMC.
- Each space required to have DCV shall have controls configured to automatically change the quantity of outdoor air supplied to the space based upon the output of a CO₂ sensor.
- Exception 1 - Dining areas where $> 75\%$ of design outdoor airflow is ***transfer air*** utilized for make-up air supply to an adjacent commercial kitchen.

2021 IMC and WSEC-C – Energy Recovery Ventilation Systems

IMC 514.2 Energy recovery ventilation systems

- ERV systems are prohibited for the following applications:
 - Hazardous exhaust
 - Clothes dryer exhaust
 - Systems that convey explosive or flammable vapors fumes or dust
 - **Commercial kitchen exhaust systems serving Type I hoods**
 - Smoke control systems
- Exception - ERV equipment that recovers *sensible only* heat energy utilizing coil-type heat exchangers.

WSEC C403.7.6 Energy recovery ventilation systems (sensible & latent)

- Exception 1.1 – Identical to IMC 514.2 exception for kitchens

Energy Recovery - Kitchen Exhaust Systems

ER strategies for Type II hood exhaust systems

- Heat recovery coils & run-around loop
- Plate-and-frame heat exchangers

ER for Type I hood exhaust systems require specialized heat recovery coils

- Wide fin coils with clean-outs up and downstream of coil. Utilizes low fluid flow and high head within the coil to maximize heat transfer.
- Coil wash-down system that automatically cleans the coils with a detergent system.

Captured heat energy is used to preheat ventilation air or domestic hot water.

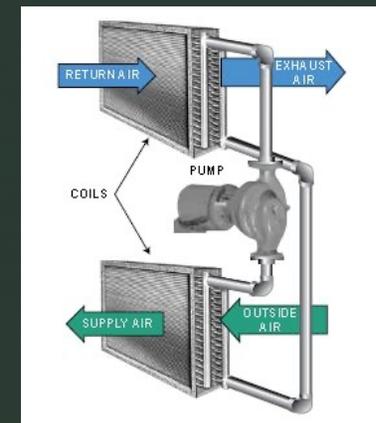


Image courtesy of Dynamic Air Corp

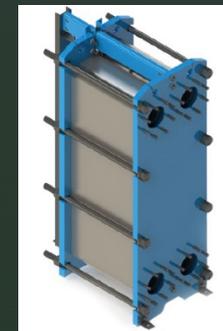


Image courtesy of Wessels-Wesplate

Applicable Exceptions in the 2021 WSEC-C

C403.1.1 HVAC TSPR exception

- Exception 13.8 - Restaurants and commercial kitchens with total cooking capacity greater than 100,000 Btu/h are exempt from the TSPR requirements.

C403.1.4 HVAC space heating equipment types exception

- Exception 10 - Make-up air for commercial kitchen exhaust systems required to be tempered by IMC 508.1.1 is permitted to be heated by using fossil fuel in Climate Zone 5 or electric resistance in Climate Zone 4 or 5.

Table C403.3.5 Occupancy classifications requiring DOAS exception

- Food processing establishments including commercial kitchens, restaurants and cafeterias are exempt from the DOAS requirements.

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