Kitchen Ventilation Proposals Stakeholder Meeting #3

California Statewide Utility Codes and Standards Program

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ASHRAE 5 – Kitchen Ventilation
Agenda

- Current Code – T24, 90.1
- Proposal 1 –Scope and Definitions
- Proposal 2 – No Short Circuit Hoods
- Proposal 3 – Must Use Available Transfer Air
- Proposal 4 – Maximum Hood CFMs
- Proposal 5 – Required Energy Features: DCV, or ERV, or…
- ACM – Baseline
- Acceptance Tests

ASHRAE 5 – Kitchen Ventilation

Current Code Requirements

- No Current Kitchen Ventilation Requirements in T24
- ASHRAE 90.1-2007:
  - Kitchen Hoods. Individual kitchen exhaust hoods larger than 5000 cfm shall be provided with makeup air sized for at least 50% of exhaust air volume that is
    - unheated or heated to no more than 60˚F and
    - uncooled or cooled without the use of mechanical cooling.
- ASHRAE 90.1-2010:
  - Major changes from 90.1-2007
  - The proposed requirements on the following slides are the same as 90.1-2010 with minor changes

ASHRAE 5 – Kitchen Ventilation
Proposal 1 –Scope and Definitions

Scope

- Make it clear that kitchen ventilation cannot use the process exception

Nonresidential Standard Section 3.2 Definitions

Add new terms:

- Makeup Air = direct OA into kitchen
- Transfer Air = air from nearby zone (e.g. dining)
- Replacement Air = makeup + transfer + infiltration
- Other necessary terms listed in ASHRAE Standard 154

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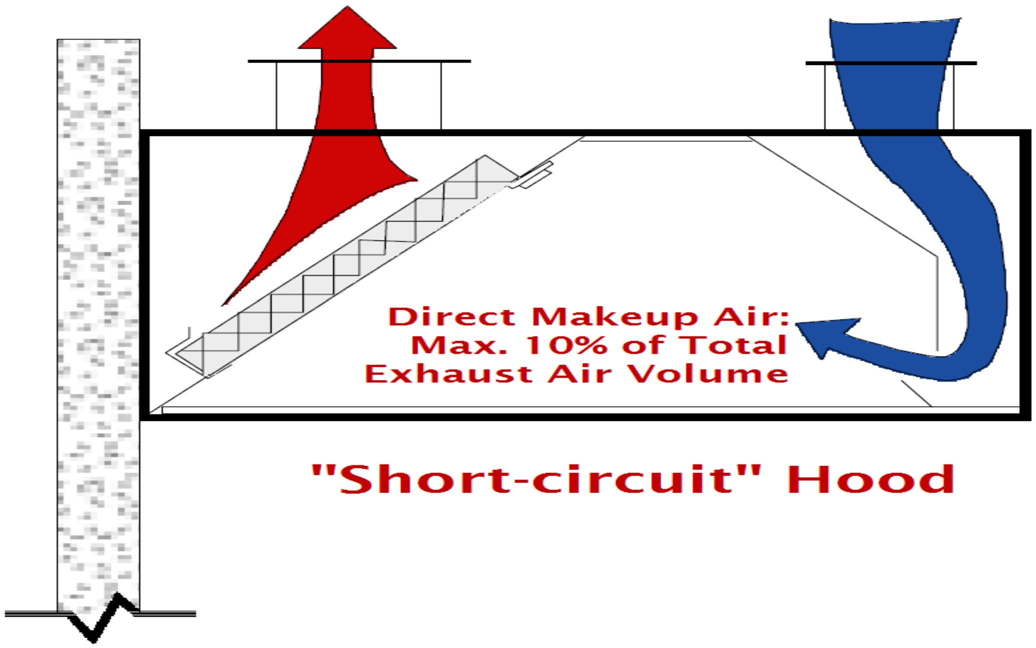
Proposal 2 – Direct Replacement of Hood Exhaust Air Limitation: Code Statement



Proposed Code Statement:

Replacement air introduced directly into the hood cavity of kitchen exhaust hoods shall not exceed 10% of the hood exhaust airflow rate.

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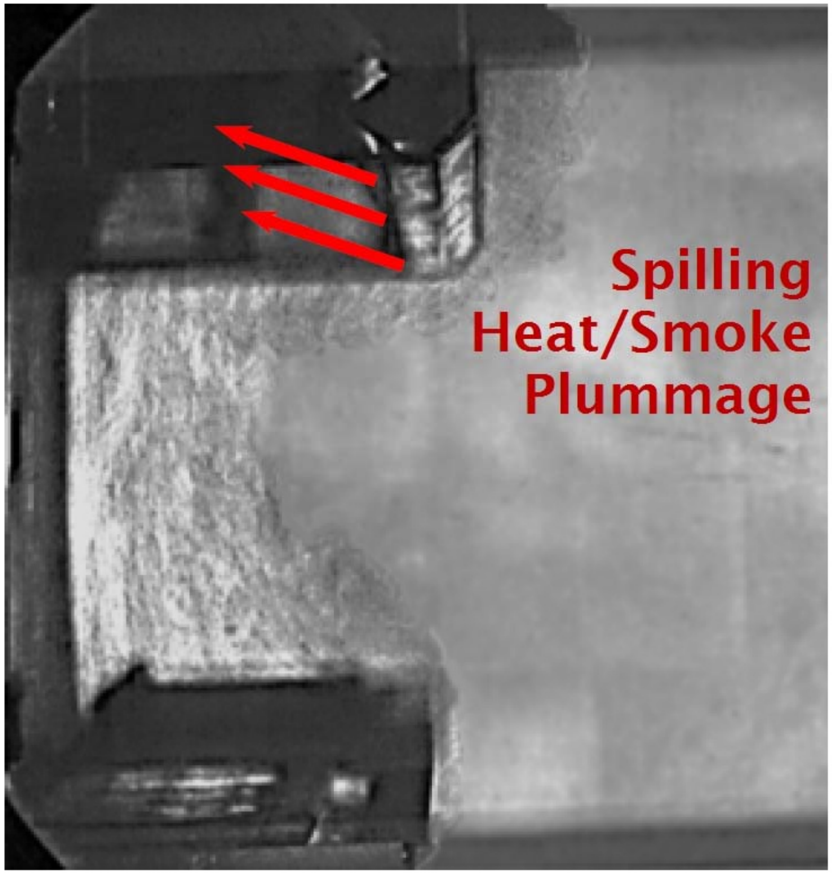
Proposal 2 – Direct Replacement of Hood Exhaust Air Limitation: Rationale

- AGA and CEC have shown direct supply greater than 10% of hood exhaust in Short-circuit Hoods significantly reduces Capture and Containment (C&C)
- Poor C&C does not remove cooking heat and smoke from kitchen
- Exhaust rates generally higher to offset poor C&C
  - Higher exhaust fan energy
- Higher Exhaust rates increase Room Makeup Air rates
  - Higher MUA fan and conditioning energy



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Proposal 2 – Direct Replacement of Hood Exhaust Air Limitation: Analysis

- Lifecycle Cost Analysis Comparing
  A. Short-circuit exhaust system
  B. Equally effective C&C Non-short-circuiting hood system
  - Equipment Cost and Power Differential

1,500 CFM Exhaust Only Hood System		**3,000 CFM Short-circuit Hood**	
Hood Cost	$ 1,339	Hood Cost	$ 2,283
Exhaust Fan Cost	$ 700	Exhaust Fan Cost	$ 816
		Additional MUA Cost	$ 544
Total	$ 2,039	Total	$ 3,643
Cost Difference		$ 1,604	

1,500 CFM Exhaust Only Hood System	BHP	**3,000 CFM Short-circuit Hood**	BHP
1,500 CFM Exhaust Only Hood	0.405	3,000 CFM Short-Circuit Hood	0.935
		1,500 CFM MUA	0.302
Total	0.405	Total	1.237
BHP Difference		0.83 hp	

(Cost Data provided by equipment vendors)

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Proposal 2 – Direct Replacement of Hood Exhaust Air Limitation: Statewide Savings

- Short-circuit Hoods represent approximately:
  - 20% of U.S. Market
  - 1% of California Market

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Proposal 3 – Conditioned Makeup Air Limitations: Code Statement

Mechanically cooled or heated makeup air delivered to any space with a kitchen hood shall not exceed the greater of:

a) The supply flow required to meet the space heating and cooling load

b) The hood exhaust flow minus the available transfer air from adjacent spaces.

– Available transfer air is that portion of outdoor ventilation air serving adjacent spaces not required to satisfy other exhaust needs, such as restrooms, not required to maintain pressurization of adjacent spaces, and that would otherwise be relieved from the building.

Proposal 3 – Conditioned Makeup Air Limitations: Rationale

- Supplying conditioned makeup air when transfer air is available is a wasteful design practice and should be prohibited.
- Using available transfer air saves energy and reduces the first cost of the kitchen makeup unit and the exhaust system in the adjacent spaces.
- A previous version of this proposal did not allow makeup air if 100% transfer air was available (i.e. a recirc unit was required for conditioning). It turns out, however, that a MAU unit is more efficient than a recirc unit so this version of the proposal is now the same as the 90.1 requirement. This is more efficient because of the many economizer hours available in our climate.

Proposal 3 – Conditioned Makeup Air Limitations: T24 Ventilation Code

Section 121 – REQUIREMENTS FOR VENTILATION

Mechanical Ventilation

The conditioned floor area of the space times the applicable ventilation rate from TABLE 121-A OR 15 cfm per person times the expected number of occupants.

EXCEPTION:

Transfer Air

The rate of outdoor air required may be provided with air transferred from other ventilated spaces if:

A. None of the spaces from which air is transferred have any unusual sources of indoor air contaminants

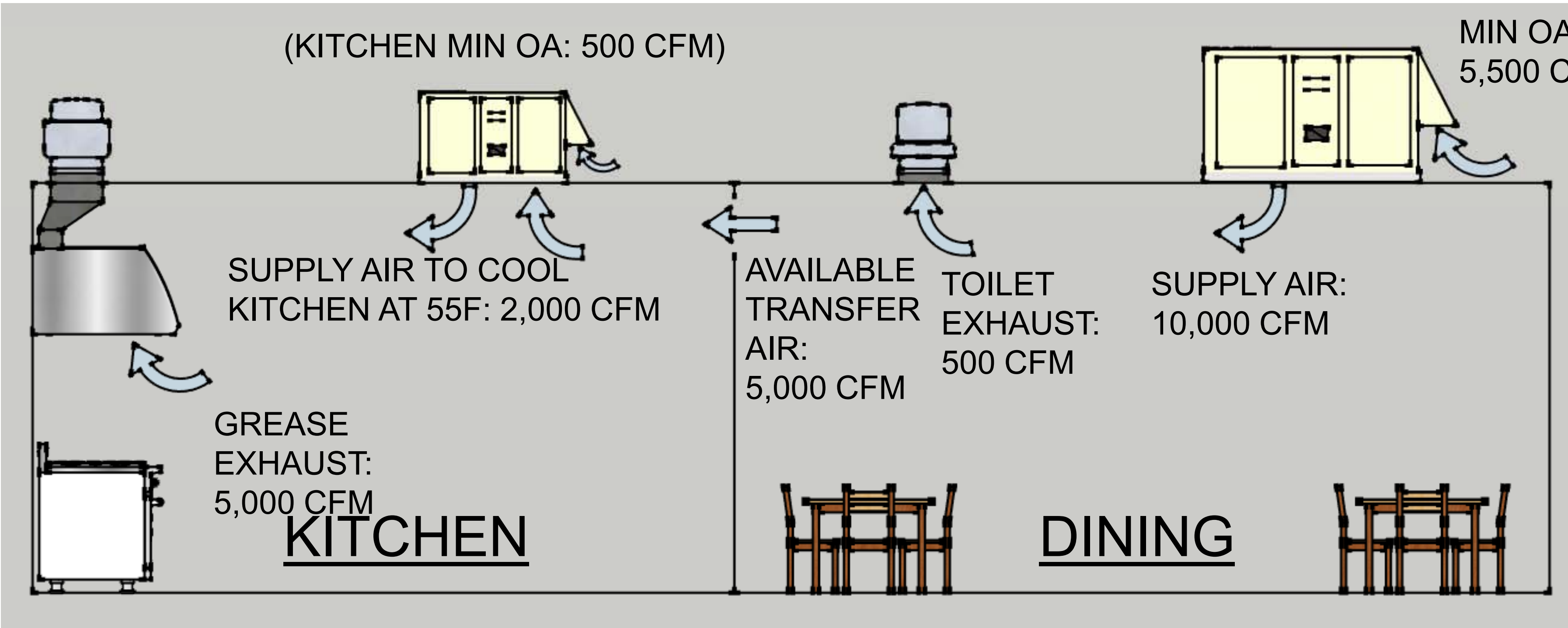
AND

B. The outdoor air that is supplied to all spaces combined, is sufficient to meet the requirements for each space individually.

Proposal 3 – Conditioned Makeup Air Limitations: DCV

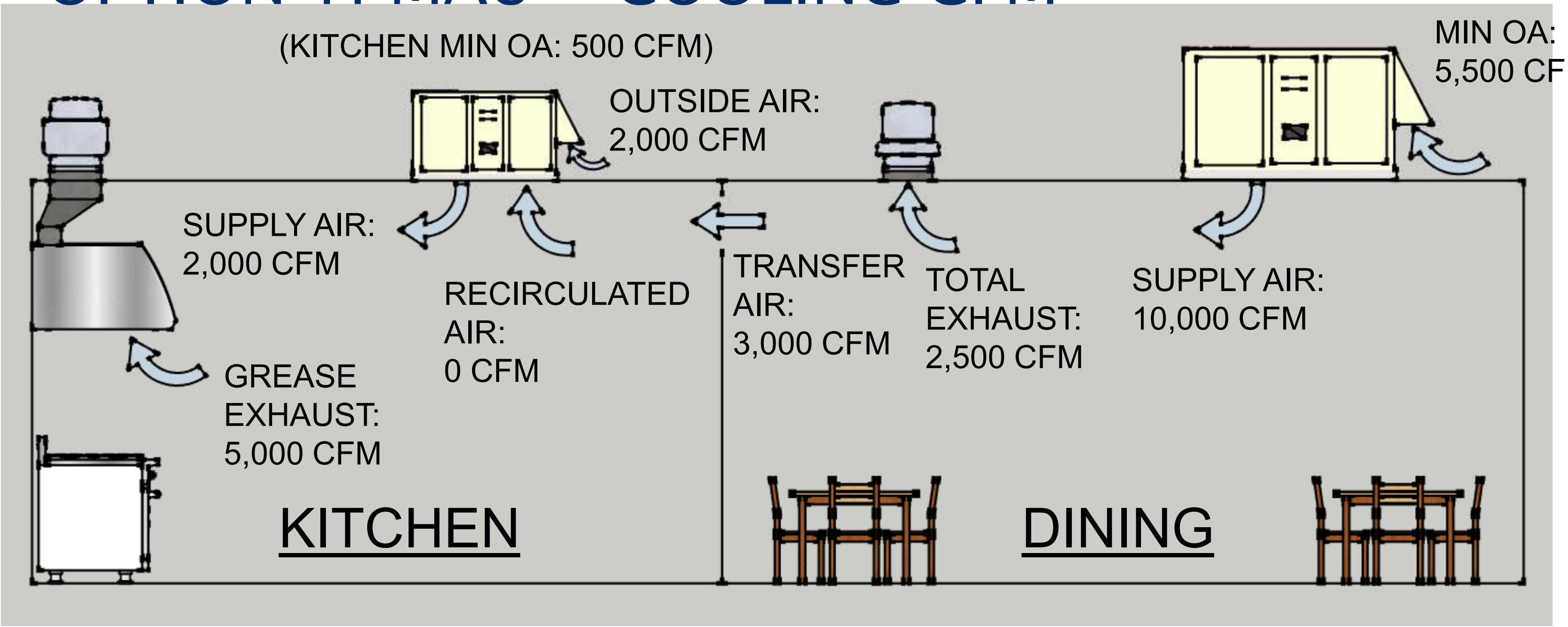
- Note that the dining room is exempt from the DCV requirement per:
  - EXCEPTION 2 to Section 121(c)3: Where space exhaust is greater than the design ventilation rate specified in Section 121(b)2B minus 0.2 cfm per ft 2 of conditioned area.
- We will clarify in the users manual that "space exhaust" includes kitchen hood exhaust in adjacent spaces.

Proposal 3 – Conditioned Makeup Air Limitations: System Schematic



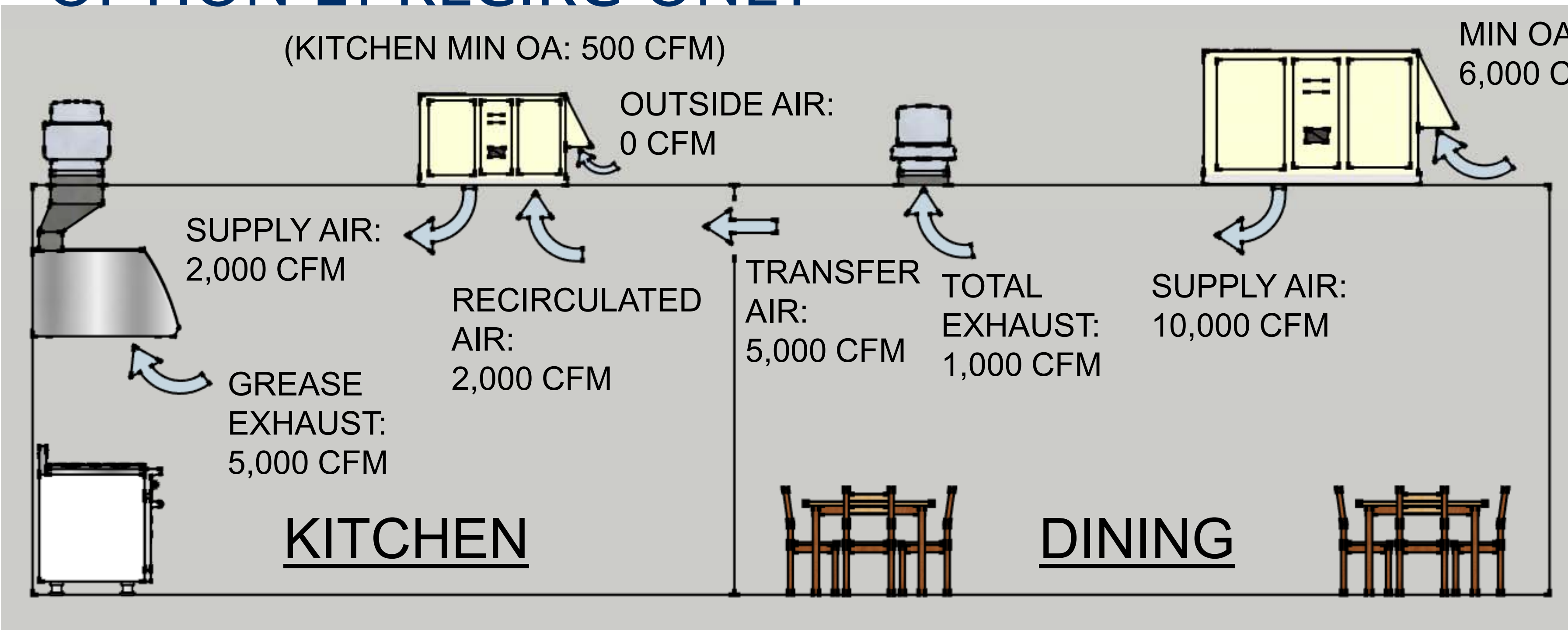
Proposal 3 – Conditioned Makeup Air Limitations: System Schematic

OPTION 1: MAU = COOLING CFM



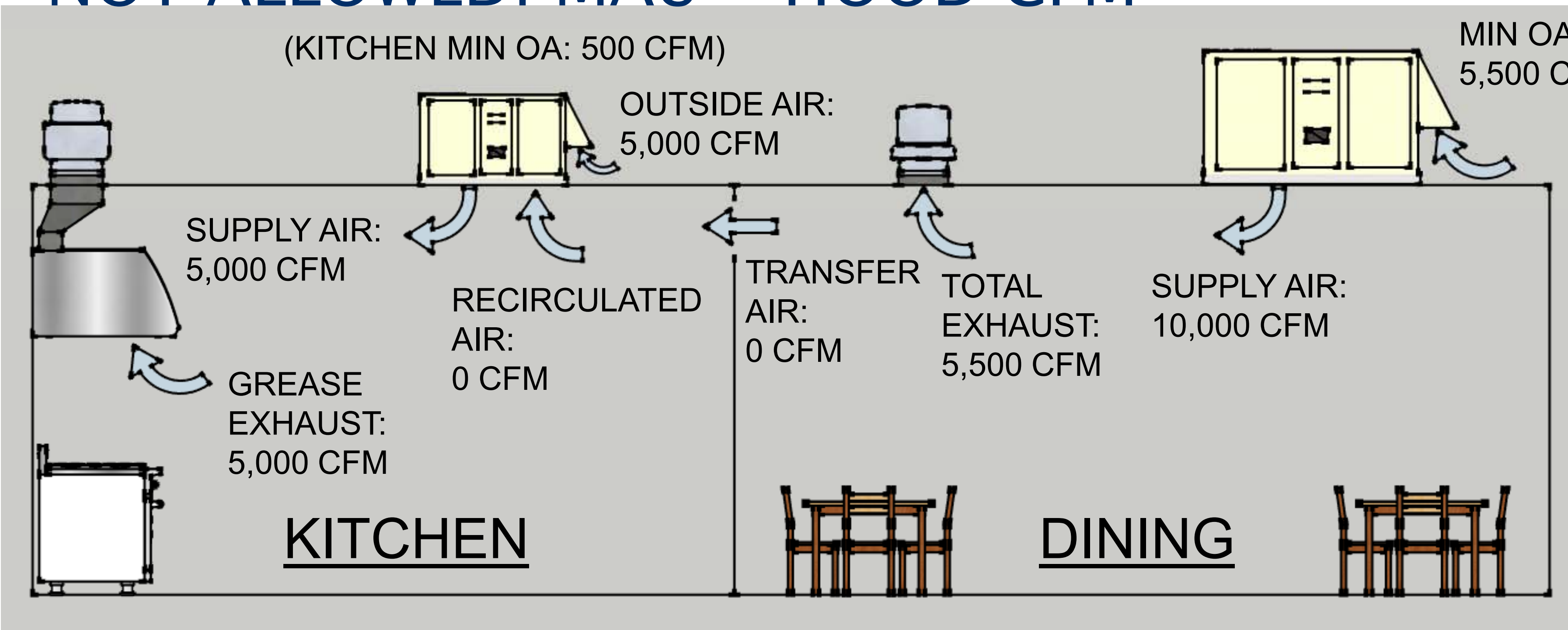
Proposal 3 – Conditioned Makeup Air Limitations: System Schematic

OPTION 2: RECIRC ONLY



Proposal 3 – Conditioned Makeup Air Limitations: System Schematic

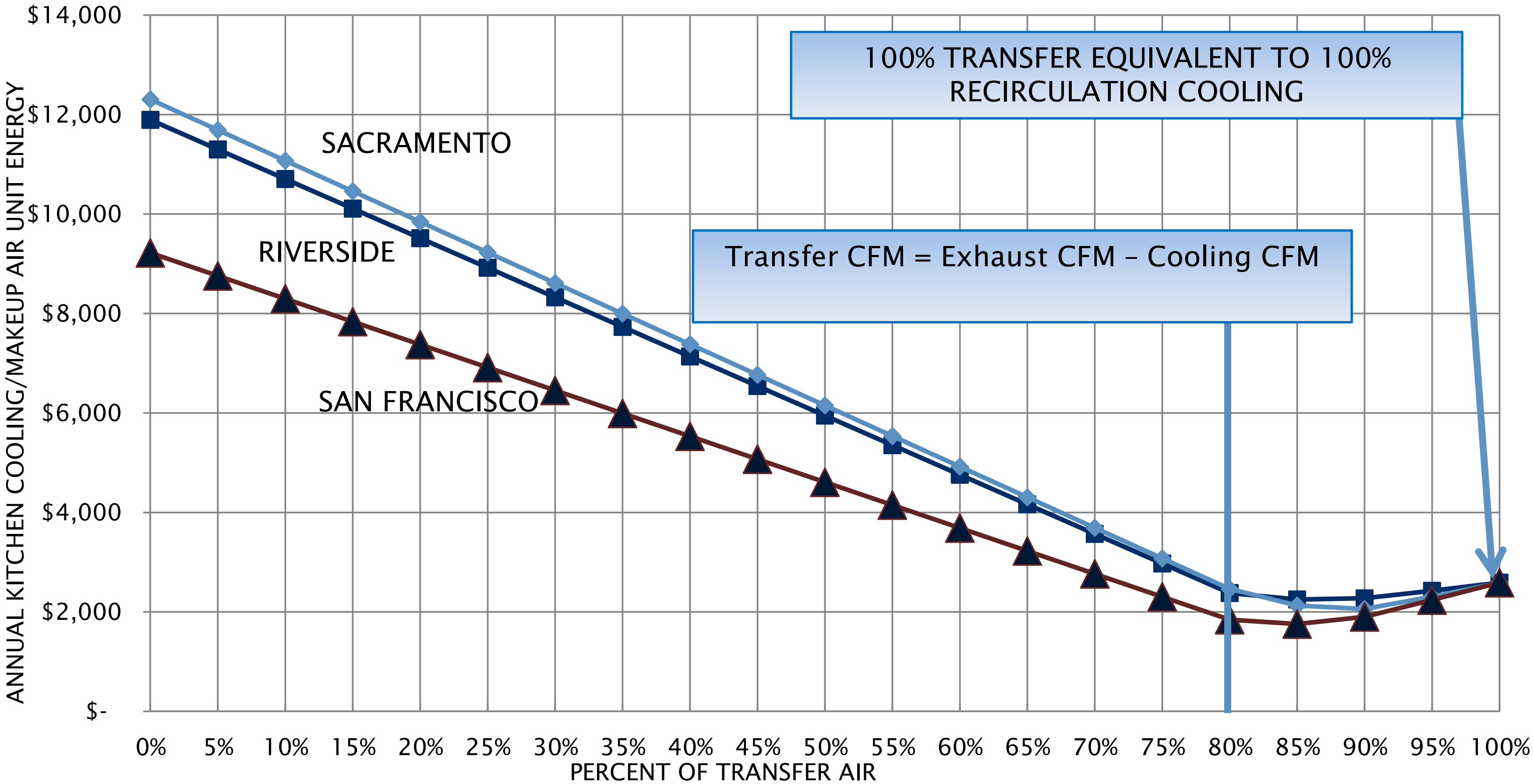
NOT ALLOWED: MAU = HOOD CFM



Proposal 3 – Conditioned Makeup Air Limitations: Cost Analysis

- Cost Analysis Comparison
  - Examine the makeup heating/cooling energy costs at all transfer rates
  - Analyze a typical kitchen exhaust and heating/cooling scenario
  - Markets: San Francisco, Sacramento, Riverside
  - Cooling CFM: 2,000 cfm
  - Exhaust CFM: 10,000 cfm
  - Most Cost Effective when transfer CFM equals Exhaust CFM minus COOLING CFM

Proposal 3 – Conditioned Makeup Air Limitations: Analysis



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Proposal 3 – Conditioned Makeup Air Limitations: Statewide Savings

- Current estimated number of restaurants in California by type:
  - 30,000 quick serve restaurants (e.g. McDonalds)
  - 30,000 full serve restaurants (e.g. Applebee's)
  - 30,000 institutional kitchens (e.g. school cafeterias)
  - Estimated CA: 178M sf Food Service, 276M Exh CFM.
- Estimated that 2.75 million square feet of kitchen is being built per year
- Estimated 15% savings in makeup fan electrical usage and demand using available transfer air
- Estimated savings of 50% when heating and cooling energy savings are included

Proposal 4 – Exhaust Hood Airflow Limitations: Code Statement

Proposed Code Statement:

- **Type I Exhaust Hood Airflow Limitations**. For kitchen/dining facilities having total Type 1 and Type II kitchen hood exhaust airflow rates greater than 5,000 cfm, each Type 1 hood shall have an exhaust rate that complies with Table 1. If a single hood, or hood section, is installed over appliances with different duty ratings, then the maximum allowable flow rate for the hood or hood section shall not exceed the Table 4 values for the highest appliance duty rating under the hood or hood section. Refer to the ASHRAE Standard 154 for definitions of hood type, appliance duty, and net exhaust flow rate.

Proposal 4 – Exhaust Hood Airflow Limitations: Code Statement

Proposed Code Statement:

Table 4: Maximum Net Exhaust Flow Rate, CFM per Linear Foot of Hood Length

Type of Hood	Light Duty Equipment	Medium Duty Equipment	Heavy Duty Equipment	Extra Heavy Duty Equipment
Wall-mounted Canopy	140	210	280	385
Single Island	280	350	420	490
Double Island	175	210	280	385
Eyebrow	175	175	Not Allowed	Not Allowed
Backshelf/ Pass-over	210	210	280	Not Allowed

- Exceptions:

  75% of all the replacement air is transfer air that would otherwise be exhausted.

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Proposal 4 – Exhaust Hood Airflow Limitations: Rationale

- Exhaust airflow rates in Table 4 are 30% below the minimum airflow rates in ASHRAE Standard 154-2003, which are for unlisted hoods
- Values in Table 4 are supported by ASHRAE RP-1202 for listed hoods
- Intended to eliminate wasteful common practice of specifying excessive exhaust airflow by selecting hoods that are not listed or have not been subjected to a recognized performance test
- Should not increase first cost and in many cases will reduce first cost through downsizing of exhaust, supply and cooling equipment

Proposal 4 – Exhaust Hood Airflow Limitations: Planned Analysis

- Lifecycle Cost Analysis Comparing
  - BASE CASE: Hood design using unlisted hood and code minimum (ASHRAE Standard 154 rates) exhaust rates
  - PROPOSED CASE: Hood design using listed hood and 30% better than ASHRAE Standard 154 Rates
  - EQUIPMENT COSTS SAVINGS:

	Exhaust Hood CFM	Exhaust Hood Cost	Exhaust Fan Cost	Makeup Unit Cost	Net Cost
Unlisted Hood System, ASHRAE Std 154	5,550	$1,300	$2,090	$16,830	**$20,220**
Listed Hood System, 30% Better than Std 154	3,850	$1,300	$1,463	$11,781	**$14,544**

  - FAN ENERGY COST SAVINGS (Excluding Heating/Cooling Savings)

	Exhaust Hood CFM	Exhaust Hood HP	Makeup Unit HP	Annual **Electrical Costs**
Unlisted Hood System, ASHRAE Std 154	5,500	2.98	4.37	**$3,552**
Listed Hood System, 30% Better than Std 154	3,850	2.32	1.88	**$2,029**

(Equipment selections and costs provided by equipment vendors)

ASHRAE 5 – Kitchen Ventilation

Proposal 5 – Makeup Airflow Limitations: Code Statement

If a kitchen/dining facility has a total kitchen hood exhaust airflow rate greater than 5,000 cfm then it shall have one of the following:

a) At least 50% of all replacement air is transfer air that would otherwise be exhausted.

b) Demand ventilation system(s) on at least 75% of the exhaust air. Such systems shall:

- a) Include controls necessary to modulate airflow in response to appliance operation and to maintain full capture and containment of smoke, effluent and combustion products during cooking and idle
- b) Include failsafe controls that result in full flow upon cooking sensor failure
- c) Allow occupants the ability to temporarily override the system to full flow
- d) Be capable of reducing exhaust and replacement air system airflow rates to the larger of:
  - a) 50% of the total design exhaust and replacement air system airflow rates
  - b) The ventilation rate required per Section 121

c) Listed energy recovery devices with a sensible heat recovery effectiveness of not less than 40% on at least 50% of the total exhaust airflow.

d) A minimum of 75% of makeup air volume that is:

- a. Unheated or Heated to no more than 60°F
- b. Uncooled or Cooled without the use of mechanical cooling.

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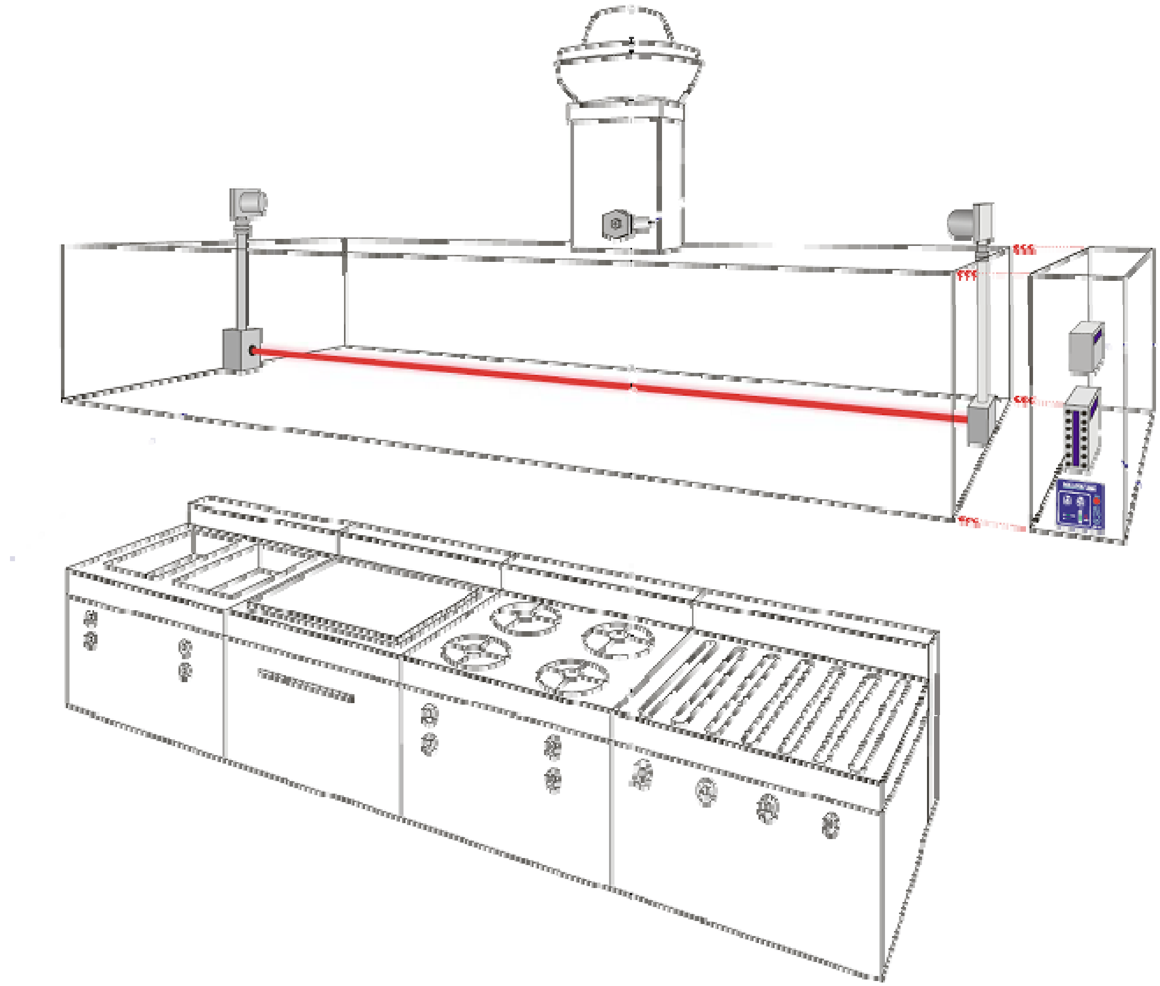
Proposal 5 – Makeup Airflow Limitations: Demand Control Ventilation Systems (DCV)



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Proposal 5 – Makeup Airflow Limitations: Demand Control Ventilation Systems (DCV)

- **Common Kitchen Exhaust Systems**
- Typical control strategy: ON/OFF, Exhaust and Makeup Air fans full speed or off
- Reality:
  - Food not being cooked at all times
  - Peak exhaust requirements not necessary at all times
  - Fans often run 24/7 to avoid fire alarms when operators forget to turn on the hood
- **DCV Exhaust Systems**

(e.g. – Melink, Halton MARVEL, CaptiveAire EMS)

- Reduce exhaust and make up air fan speeds
- Use sensors to determine min. exhaust required for C&C
- In the event the operator forgets to turn the fan switch on in the morning, the system will automatically turn on as the duct temperature rises above 90F degrees. Similarly, the system will automatically turn off as the temperature drops below 75F.

Proposal 5 – Makeup Airflow Limitations: Planned Analysis

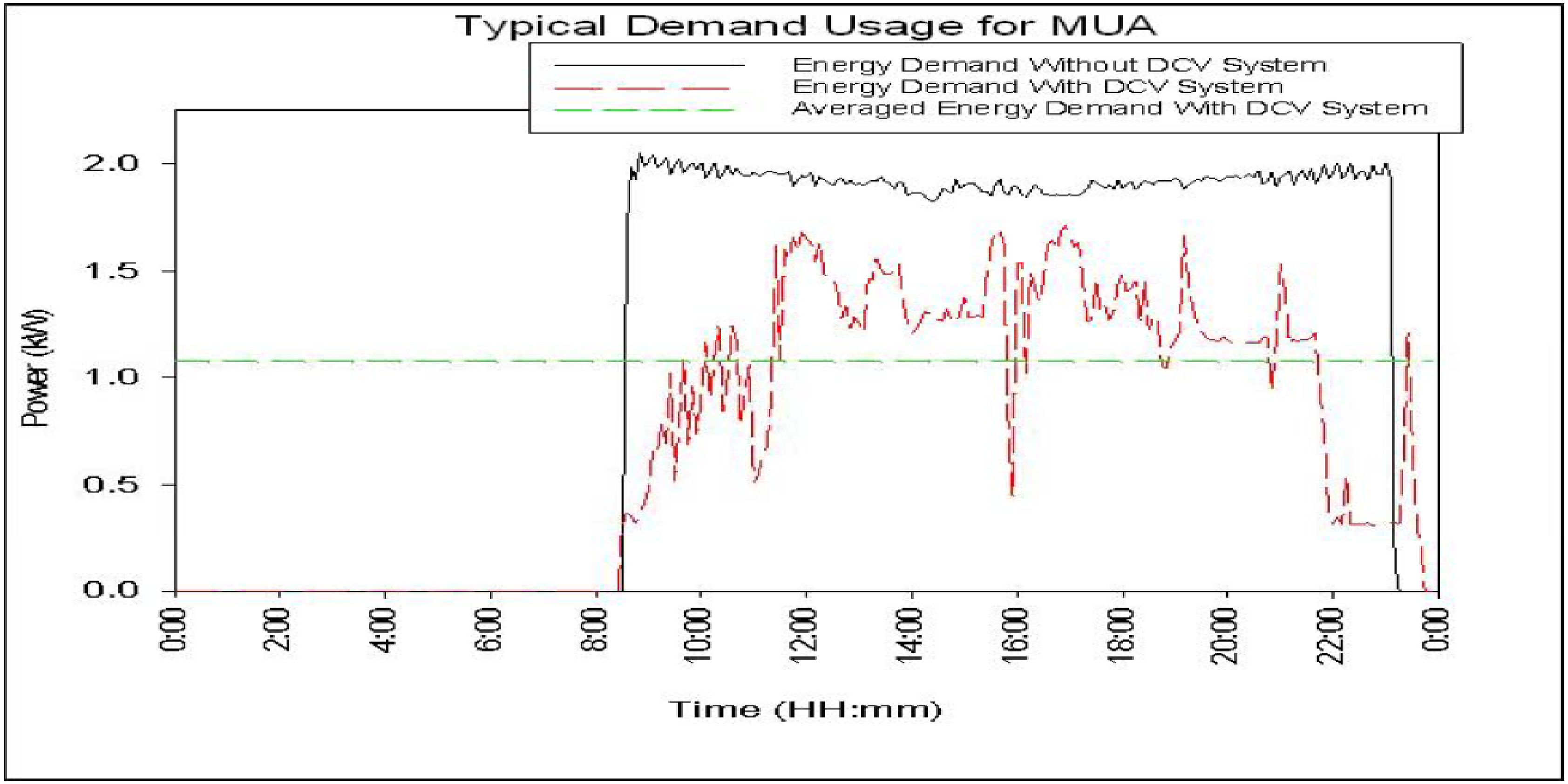
- Lifecycle Cost Analysis Comparing
  - Base case: A kitchen system based on a non-modulating exhaust airflow and non-modulating makeup airflow
  - Proposed case: A kitchen system based on a modulating demand control exhaust airflow and modulating makeup airflow
- Data Required
  - Use the real life case studies presented in "Demand Control Ventilation for Commercial Kitchen Hoods", SCE/FSTC, 2009
  - Based on Melink installations in El Pollo Loco, Panda Express, and Farmer Boys restaurants, Desert Springs Marriot, Westin Mission Hills
  - Study includes installation costs, measured energy savings, and estimates of incremental maintenance costs for DCV

Proposal 5 – Makeup Airflow Limitations: Cost Analysis – El Pollo Loco

- Test Case: El Pollo Loco, El Monte, CA
- Retrofit Melink DCV with Variable Volume Exhaust Hood and Makeup Air System in Quick Service application.
- Retrofit Costs: $15,500 for 2 DCV Hoods (Est. New Construction Cost with Mature DCV market: $11,625)
- Annual Fan Savings: 9,871 kWh per year (Exhaust and Makeup fan savings only)
- Annual Fan Savings (@ 2010 TDV $0.17): $1,678
- Est. Annual Maintenance (Sensors, VFD's): $400
- Simple Payback using Retrofit Construction Costs: 12.13 years
- Simple Payback using Est. New Construction Costs: 9.10 years
- This is a Worst Case Scenario. (i.e.-Retrofit, Low HP, Low Diversity, excluding heating/cooling savings)
- Shorter payback in new construction, High HP, High diversity applications.(e.g. – Hotels)

Proposal 5 – Makeup Airflow Limitations: Measured Demand Reduction – El Pollo Loco

- Exhaust Fan and Makeup Air Unit Electrical Demand Before and After the DCV Retrofit. No Heating/Cooling Savings.



Proposal 5 – Makeup Airflow Limitations: Installation Costs and Savings Summary– All Sites

	El Pollo Loco (Quick, Retrofit)	Panda Express (Quick, New Constr.)	Farmer Boys (Quick, New Constr.)	Desert Springs Marriot (Hotel, Retrofit)	Westin Mission Hills (Hotel, Retrofit)
Installation Costs ($)	$15,500	$8,000	$9,000	$28,000	$22,000
Annual Fan Energy Cost Savings (Avg.TDV $0.17/kWh)	$1,678	$2,560	$1,340	$25,532	$10,275
Est. Installation Costs for New Const. & Mature Technology	$11,625	$6,800	$7,650	$21,000	$16,500
Annual Maintenance Costs ($)	$400	$400	$600	$1,200	$600
Simple Payback Inc Maintenance (Years)	9.10	3.15	10.33	0.86	1.71

ASHRAE 5 – Kitchen Ventilation

ACM – Simulation Baseline

- Baseline MAU shall be 100% OA , direct evap. only if space temp exceeds 80F less than 10 hrs/yr.
  - 90% direct evap effectiveness, 1.5" TSP, 60% fan effic.
  - Sized for total exhaust
- Otherwise MAU shall be DX sized for larger of:
  - Cooling cfm
  - Total exhaust minus available transfer
    - Available transfer = the building minimum outside airflow less any exhaust airflows (not including the kitchen exhausts) and 0.05 cfm/sf for exfiltration.
- Total exhaust shall be:
  - Proposed case total if less than 5000 cfm
  - Table 4 rates if total is over 5000 cfm (user to input lineal feet of hood type and duty)
- If baseline does not qualify for direct evap or 50% transfer air (per above) then baseline shall include DCV on 75% of total exhaust
  - Defined fan fractional schedule for DCV
  - Defined fan schedule for on/off

ASHRAE 5 – Kitchen Ventilation

Acceptance / Functional Testing: Rationale

- This section is fundamental to the kitchen exhaust system commissioning and performance verification which protects public health and safety.
- Hood systems are a field assembly of various components including hoods, fans, replacement air systems, duct and distribution systems and require testing once installed to assure specified system performance is met.
- This section requires verification of hood system performance and operation, and supports Title 24 Acceptance Test purpose and scope.

ASHRAE 5 – Kitchen Ventilation

Acceptance / Functional Testing: Construction Inspection

NR & R APPENDICES – NA7.5.15 (Functional Tests)

The following shall be added to the NR Compliance Manual in the NA7 section

NA7.5.15 Kitchen Exhaust Systems with Type I Hood Systems

The following acceptance tests apply to commercial kitchen exhaust systems with Type I exhaust hoods. All Type I exhaust hoods used in commercial kitchens shall be tested.

NA7.5.15.1 Kitchen Exhaust Construction Inspection

Prior to Functional Testing, verify and document the following

1. Verify exhaust and replacement air systems are installed, power is installed and control systems such as demand control ventilation are calibrated
2. For kitchen/dining facilities having total Type 1 and Type II kitchen hood exhaust airflow rates greater than 5,000 cfm, calculate the maximum allowable exhaust rate for each Type 1 hood per Table 144-C.

ASHRAE 5 – Kitchen Ventilation

Acceptance / Functional Testing: All Systems

NA7.5.15.2.1 Functional Testing – Full Load Conditions

1. Operate all sources of outdoor air providing replacement air for the hoods
2. Operate all sources of recirculated air providing conditioning for the space in which the hoods are located
3. Operate all appliances under the hoods at operating temperatures
4. Verify that the thermal plume and smoke is completely captured and contained within each hood at full load conditions by observing smoke or steam produced by actual cooking operation and/or by visually seeding the thermal plume using devices such as smoke candles or smoke puffers. Smoke bombs shall not be used (note: smoke bombs typically create a large volume of effluent from a point source and do not necessarily confirm whether the cooking effluent is being captured). For some appliances (e.g., broilers, griddles, fryers), actual cooking at the normal production rate is a reliable method of generating smoke). Other appliances that typically generate hot moist air without smoke (e.g., ovens, steamers) need seeding of the thermal plume with artificial smoke to verify capture and containment.
5. Verify that space pressurization is appropriate (e.g. kitchen is slightly negative relative to adjacent spaces and all doors open/close properly).
6. Verify that each Type 1 hood has an exhaust rate that is below the maximum allowed.
7. Make adjustments as necessary until full capture and containment and adequate space pressurization are achieved and maximum allowable exhaust rates are not exceeded. Adjustments may include:
   a. adjust exhaust hood airflow rates
   b. add hood side panels
   c. Add rear seal (back plate)
   d. Increase hood overhang by pushing equipment back
   e. Relocate supply outlets to improve the capture and containment performance
8. Measure and record final exhaust airflow rate per Type 1 hood.

ASHRAE 5 – Kitchen Ventilation

Acceptance / Functional Testing: Systems with DCV

NA7.5.15.2.2 Functional Testing - Exhaust Systems with Demand Control Ventilation

1. Turn off all kitchen hoods, makeup air and transfer systems
2. Turn on one of the appliances on the line and bring to operating temperature. Confirm that:
   a. DCV system automatically switches from off to the minimum flow setpoint.
   b. The minimum flow setpoint does not exceed the larger of
      i. 50% of the design flow, or
      ii. the ventilation rate required per Section 121.
   c. The makeup air and transfer air system flow rates modulate as appropriate to match the exhaust rate
   d. Appropriate space pressurization is maintained.
3. Operate all appliances at typical conditions. Apply sample cooking products and/or utilize smoke puffers as appropriate. Confirm that:
   a. DCV system automatically ramps to full speed.
   b. Hood maintains full capture and containment during ramping to and at full-speed
   c. Appropriate space pressurization is maintained.

ASHRAE Measures – Kitchen Ventilation

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QUESTIONS & COMMENTS

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