CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

Second Stakeholder Meeting for Nonresidential HVAC (2 of 2)

Proposals Based on ASHRAE 90.1-2016: Equipment Efficiency

March 29, 2017

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1. Background

Introduction to Equipment Efficiency

- Mandatory equipment efficiency requirements exist in Title 24, Part 6 for:
  - Air conditioners
  - Heat pumps
  - Water chillers
  - Packaged Terminal Air Conditioners & Heat Pumps
  - Single Package Vertical Air Conditioners & Heat Pumps
  - Heat exchangers
  - Cooling towers
  - Condensers
  - Variable Refrigerant Flow (VRF) Air Conditioners & Heat Pumps
  - Furnaces
  - Boilers

Relevant Code History

- Federal law requires the US Department of Energy (DOE) to review ASHRAE 90.1 equipment efficiency updates
- DOE typically adopts ASHRAE's equipment efficiency levels and they become mandatory minimum federal requirements
- States have the opportunity to adopt equipment efficiency values in 90.1 using a simplified process before they become federally required
- Cost effectiveness analysis is not required

2. Proposed Code Changes

Proposed Code Change

- Mandatory code change to include:
  - **Single Package Vertical Air Conditioners (SPVAC):** increase EER and COP for weatherized units <65,000 Btu/h
  - **Single Package Vertical Heat Pumps (SPVHP):** increase EER and COP for weatherized units <65,000 Btu/h
  - **Propeller or axial fan closed-circuit Cooling Towers:** increase gpm/hp
  - **Variable Refrigerant Flow Air Conditioners (air-cooled):** increase IEER
  - **Variable Refrigerant Flow Heat Pumps (air-cooled, cooling mode):** increase IEER
  - **Variable Refrigerant Flow Heat Pumps (water-source, cooling mode):** increase IEER and add EER and IEER requirements for ≥ 240,000 Btu/h size category
  - **Variable Refrigerant Flow Heat Pumps (water-source, heating mode):** increase COP and add COP requirements for <65,000 Btu/h and ≥ 240,000 Btu/h size categories

Proposed Code Change

- Mandatory code change to include addition of new requirements:
  - **Air Conditioners and Condensing Units Serving Computer Rooms:** set minimum COP for air-cooled, water-cooled, and glycerol-cooled units

- Consideration of including the following requirements:
  - **Vapor Compression Based Indoor Pool Dehumidifiers:** set minimum MRE for single package and split system units
  - **Electrically Operated DX-DOAS Units:** set ISMRE and ISCOP for units with and without heat recovery

Why Are We Proposing This Code Change

- Support ZNE goals
- Achieve significant energy savings
- Align with model codes
- Keep up with ASHRAE 90.1 as required by federal statues

What about pool dehumidification and DX-DOAS?

3. Technical and Market Barriers

Technical and Market Barriers

- No technical or market barriers are identified
- Manufacturers and industry professionals settled on these updated efficiencies based on available products
- We do not anticipate any barriers to designers, suppliers, or manufacturers in adopting these updates

4. Compliance and Enforcement

Compliance Process

Design Phase

- What happens during design phase
  - No change from current requirements
  - Design teams will still need to ensure that equipment they are specifying meets mandatory equipment efficiency requirements

Compliance Process

Permit Application Phase

- What happens in permit application phase?
  - No change from current requirements

Compliance Process

Construction Phase

- What happens in construction phase?
  - No change from current requirements

Compliance Process

Inspection Phase

- What happens in permitting phase?
  - No change from current requirements

Compliance and Enforcement Barriers

- Compliance or enforcement barrier #1
  - Manufacturers selling equipment that does not comply with the standard
  - Resolution is to ensure designers, engineers, and plan checkers are familiar with the code updates

What do you think? (Discussion)

- Did we capture technical and market barriers?
- Did we capture compliance and enforcement barriers?
- Are there other barriers — or solutions — we haven't discussed?

5. Cost-Effectiveness and Energy Impacts

Definition of Baseline and Proposed Conditions

Model Assumptions

- Prototype modeling for SPVAC & SPVHC in schools and small offices
- Prototype modeling for closed circuit cooling towers in high rise residential
- No verified modeling technique for VRF (not currently modeled)
- Single zone computer room modeling for computer room air conditioning

Baseline Conditions

- Minimally compliant with 2016 Standards or industry standard practice

Proposed Conditions

- Compliant with prescriptive equipment efficiency

Cost-Effectiveness Analysis

Incremental Costs

- Cost effectiveness analysis is not required by the California Energy Commission to adopt mandatory equipment efficiency updates

Annual Energy Savings Per Square Foot

Climate Zone	TDV Energy Savings (TDV kBtu/yr)	15/30 Year TDV Energy Cost Savings ($2020)
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Annual Energy Savings calculations in progress, but all savings will be positive across all climate zones

Annual Energy Savings Per Square Foot

Climate Zone	Annual Electricity Savings (kWh/yr)	Annual Natural Gas Savings (kWh/yr)	Peak Electric Demand Reduction (kW)
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Annual Energy Savings calculations in progress, but all savings will be positive across all climate zones

Let's move on to…

Transfer Air for Exhaust Air Make-up

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A STATEWIDE UTILITY PROGRAM

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Proposals Based on ASHRAE 90.1-2016: Transfer Air for Exhaust Air Make-up

March 29, 2017

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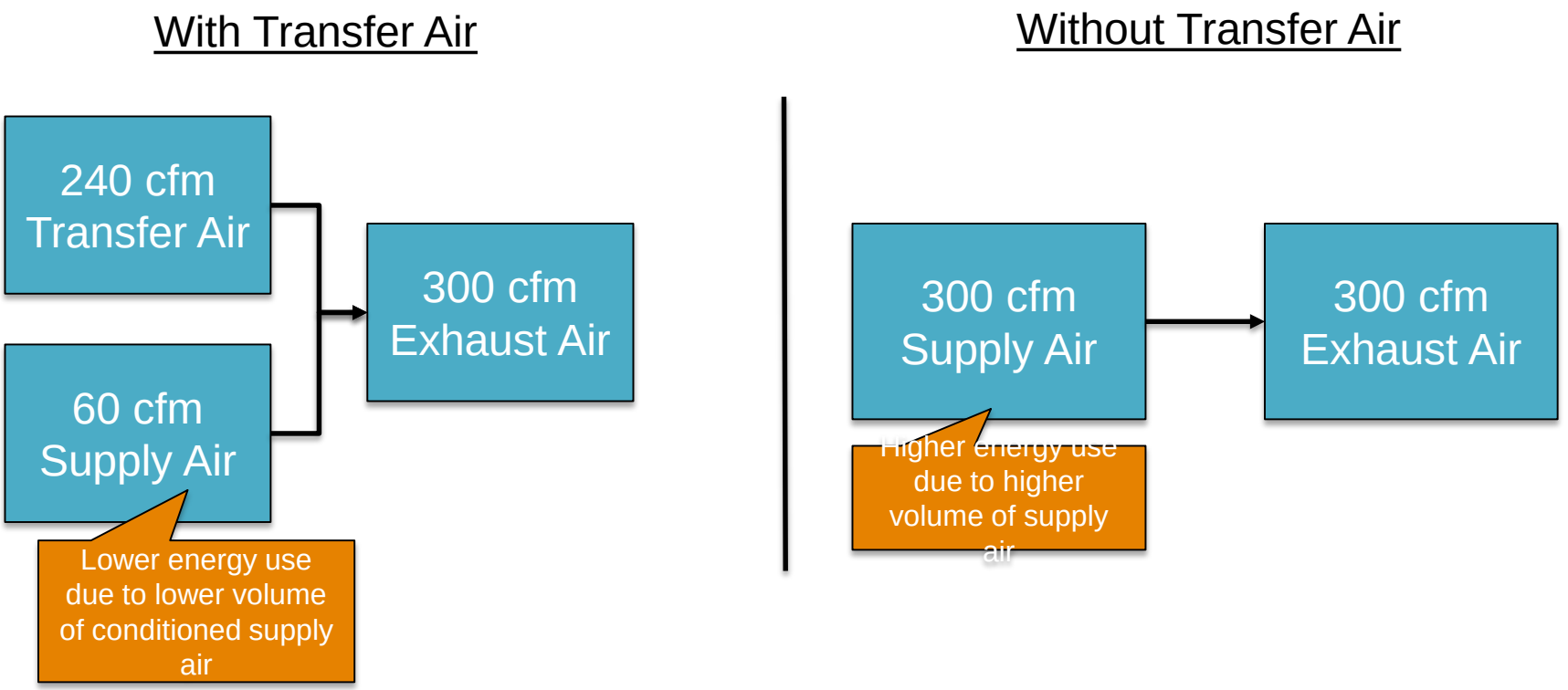
1. Background

Introduction to Transfer Air for Exhaust Air Makeup

- Many space types have mandatory exhaust air requirements, set by the California Mechanical Code
  - e.g. restrooms, copy rooms, kitchens, art classrooms
  - Rates vary from 0.25 to 1.5 cfm/ft2
- Ventilation requirements for these space types are often much lower
  - Typically 0.15 cfm/ft2
- Supply air required to condition the space is usually lower than the exhaust makeup requirement
- Many designers simply match the supply flow to the exhaust flow which results in excessive reheating of the supply flow
- It is much more efficient to limit the supply flow to that needed for the space heating/cooling load and then use transfer air for the balance of the exhaust makeup.

Introduction to Transfer Air for Exhaust Air Makeup

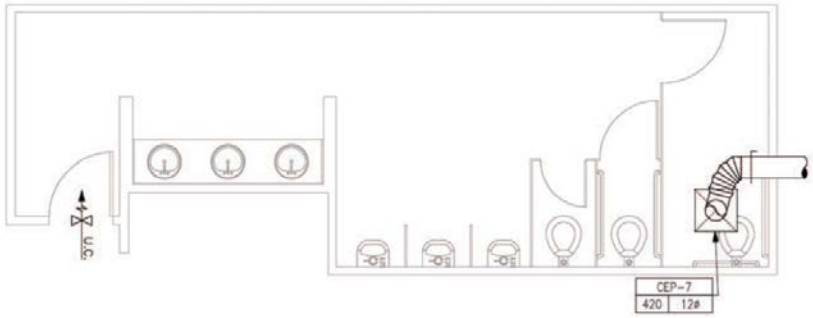
- Example of transfer air for Toilet exhaust makeup:



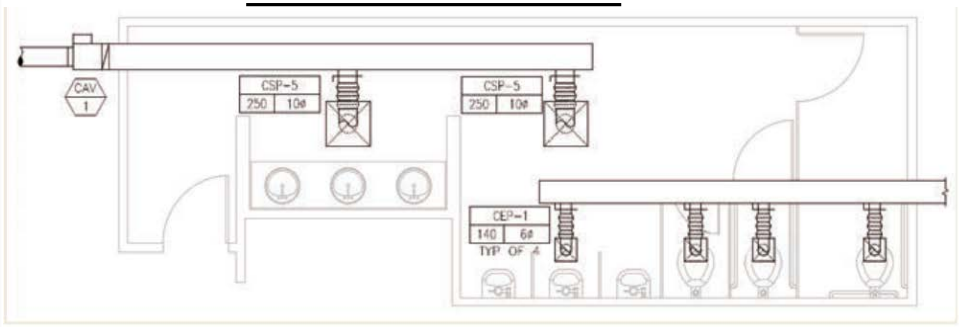
Introduction to Transfer Air for Exhaust Air Makeup

- Example of transfer air for Toilet exhaust makeup:

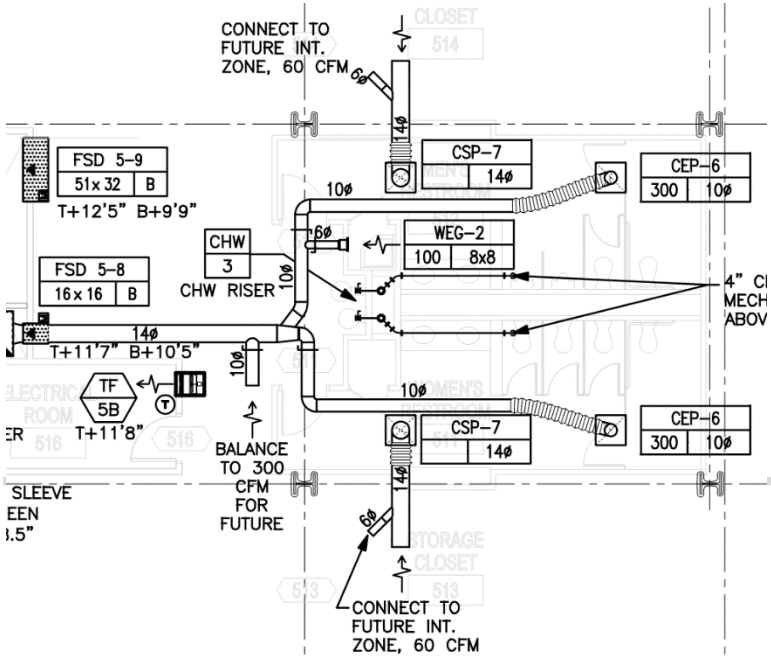
With 100% Transfer Air



Without Transfer Air



With 80% Transfer Air



Relevant Code History

- There are existing requirements in Title 24, Part 6
  - Title 24 Section 140.9
  - Applies to Kitchen exhaust only
- Other Relevant Code Requirements
  - ASHRAE 90.1-2016 includes exact same transfer air requirements being proposed here

2. Proposed Code Changes

Proposed Code Change

- Prescriptive code change applies to:
  - Spaces that have process exhaust airflow higher than:
    - Airflow required for heating or cooling
    - Airflow required for ventilation
  - That are adjacent to spaces that do not have high exhaust requirements
- In this situation, the code change requires transfer air
- Several exceptions including BSL3, Vivariums, and “class of air” recirculation limits.
- Revision to existing requirement
- All nonresidential buildings impacted
- Applies to additions but not to alterations and repairs
- Aligns with ASHRAE 90.1

Proposed Code Change

(o) **Exhaust System Transfer Air.** Conditioned supply air delivered to any space with mechanical exhaust shall not exceed the greater of

1. the supply flow required to meet the space heating or cooling load
2. the ventilation rate required by the authority having jurisdiction, the facility Environmental Health and Safety department, or by Section 120.1
3. the mechanical exhaust flow minus the available transfer air from conditioned spaces or return air plenums on the same floor, not in different smoke or fire compartments, and that at their closest point are within 15 feet of each other. Available transfer air is that portion of outdoor ventilation air that
   A. is not required to satisfy other exhaust needs,
   B. is not required to maintain pressurization of other spaces, and
   C. is transferable according to applicable codes and standards and to the class of air recirculation limitations in the California Mechanical Code

EXCEPTION 1 to Section 140.4(o): Biosafety level classified laboratories 3 or higher.

EXCEPTION 2 to Section 140.4(o): Vivarium spaces.

EXCEPTION 3 to Section 140.4(o): Spaces that are required by applicable codes and standards to be maintained at positive pressure relative to adjacent spaces. For spaces taking this exception, any transferable air that is not directly transferred shall be made available to the associated air-handling unit and shall be used whenever economizer or other options do not save more energy.

EXCEPTION 4 to Section 140.4(o): Spaces where the highest amount of transfer air that could be used for exhaust makeup may exceed the available transfer airflow rate and where the spaces have a required negative pressure relationship. For spaces taking this exception, any transferable air that is not directly transferred shall be made available to the associated air-handling unit and shall be used whenever economizer or other options do not save more energy.

Proposed Code Change - ACM

- Expand the following kitchen modeling rules to all spaces:
  - Proposed Model - All exhaust systems and associated makeup air systems shall be explicitly modeled in the proposed case — e.g., toilet rooms must be modeled.
  - Baseline Model – Software shall calculate the heat/cool load and available transfer air each hour and shall maximize the use of transfer air while meeting the heat/cool load.

Why Are We Proposing This Code Change

- Eliminate the practice of provide 100% supply or 100% outside air to spaces to make up air for high exhaust rates
- Support ZNE goals
- Achieve significant energy savings
- Reduces first costs
- Align with model codes
- Keep up with ASHRAE 90.1

What do you think? (Discussion)

- What are your thoughts on the proposed code changes?
- Any questions or concerns?

3. Technical and Market Barriers

Technical and Market Barriers

- Ensuring design engineers understand how to properly implement this code requirements
- Proposed solution is to include training and classes on code changes

What do you think? (Discussion)

- Did we capture technical and market barriers?
- Are there other barriers — or solutions — we haven't discussed?

4. Compliance and Enforcement

Compliance Process

Design Phase

- What happens during design phase
  - Designers will need to be aware of code changes and apply them correctly to their designs.
  - Design teams that do not collaborate will now need to

Compliance Process

Permit Application Phase

- What happens in permit application phase?
  - No change in the process for the permit application phase
  - Added complexity for plan checker to check for compliance

Compliance Process

Construction Phase

- What happens in construction phase?
  - No change in the process for the permit application phase
  - Added need for coordination between disciplines

Compliance Process

Inspection Phase

- What happens in permitting phase?
  - No change in the process for the permitting

Compliance and Enforcement Barriers

Barrier 1

- Enforcement of this requirement is difficult, and calculations will need to be done to determine if adequate transfer air is being used
- Possible solutions includes training for permit officials

Barrier 2

- Designers could avoid compliance by claiming higher than actual heating/cooling loads or claiming exceptions that do not apply
- Possible solutions includes training for permit officials and designers on the ease of complying and intent behind this measure

What about compliance and enforcement barriers?

5. Cost-Effectiveness and Energy Impacts

Definition of Baseline and Proposed Conditions

Baseline Conditions

- Minimally compliant with 2016 Standards or industry standard practice
- Mixed office and laboratory prototype building
- No transfer air to make up laboratory exhaust air

Proposed Conditions

- Compliant with proposed code change
- List key assumptions
- Mixed office and laboratory prototype building
- Transfer air to make up laboratory exhaust air

Cost-Effectiveness Analysis

Incremental Costs

- Incremental First Cost
  - Zero incremental first cost is anticipated
- Incremental Maintenance Costs over 15-year period of analysis
  - Zero maintenance cost is anticipated

- **Total Incremental Cost over 15-year period of analysis = $0.00**

Cost-Effectiveness Analysis

Incremental Cost Savings (Benefits)

- Energy Cost Savings over 15/30-year period of analysis
  - **Total Energy Cost Savings = range of $x,xxx to $y,yyy depending on climate zone**
  - *Energy cost savings explained in more detail in following slides.*
- **Total Incremental Cost Savings (Benefit) over 15/30-year period of analysis = $x,xxx**

Annual Energy Savings calculations in progress, but all savings will be positive across all climate zones

Benefit-to-Cost Ratio

Climate Zone	Benefit to Cost
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Cost-Effective in All Climate Zones

If Benefit-to-Cost Ratio is over 1, measure is cost-effective.

Annual Energy Savings Per [unit]

Climate Zone	TDV Energy Savings (TDV kBtu/yr)	15/30 Year TDV Energy Cost Savings ($2020)
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Annual Energy Savings Per [unit]

Climate Zone	Annual Electricity Savings (kWh/yr)	Annual Natural Gas Savings (kWh/yr)	Peak Electric Demand Reduction (kW)
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Let's move on to…

Demand Controlled Ventilation for Classrooms

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1. Background

Introduction to Demand Controlled Ventilation

- Demand controlled ventilation (DCV) resets the minimum airflow setpoint in most high density spaces based on the number of occupants in the space
- It uses CO_2 levels to estimate the number of occupants

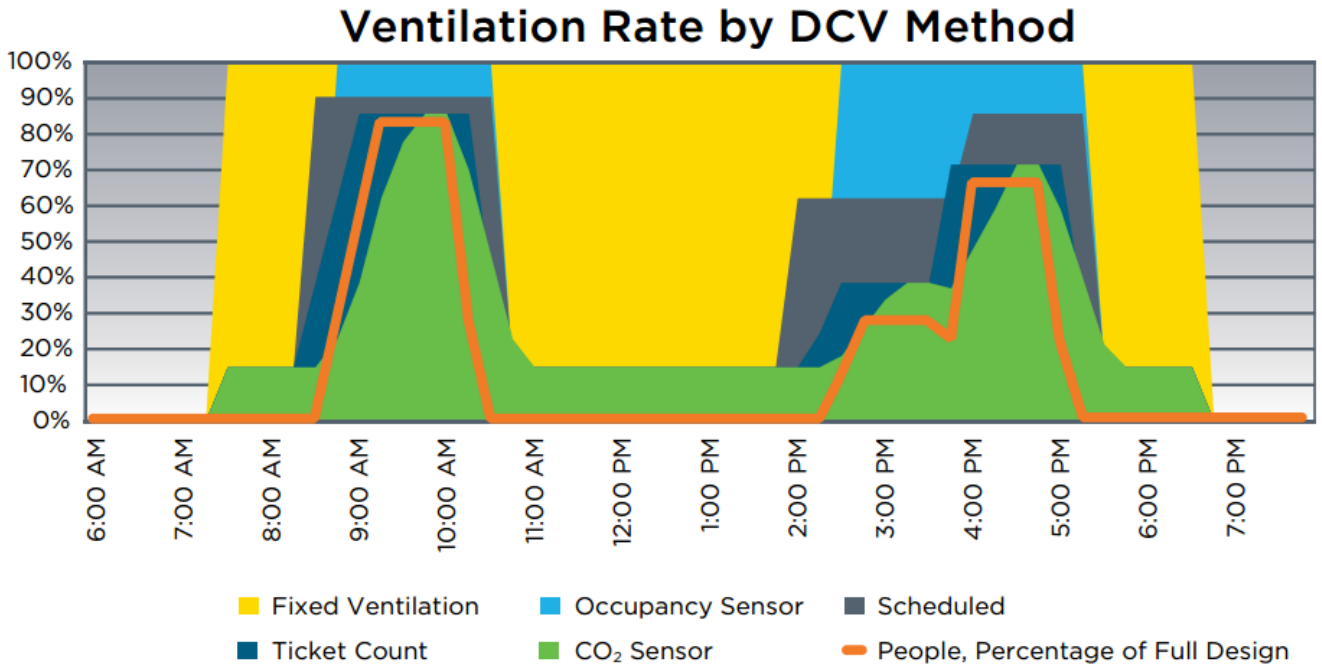

Figure 1. Ventilation rates provided with fixed ventilation and DCV alternatives

Relevant Code History

- There are existing requirements in Title 24, Part 6
  - DCV has been allowed in high density spaces since 1992
  - DCV has been mandatory in most densely occupied spaces since 2001 including: conference rooms, break rooms, auditoria, dining rooms, lobbies, religious worship, mall common areas, sports arena seating, museums, courtrooms, health clubs, casinos.
  - Section 120.1(c) outlines the requirement, including accuracy, factory calibration, failsafe controls, etc.
- Other Relevant Code Requirements
  - DCV has been mandatory in ASHRAE 90.1 since 1999 for most high density spaces, including classrooms

2. Proposed Code Changes

Proposed Code Change

- Update Section 120.1(c)3 to:
  - Require DCV in the same high density spaces covered by 90.1, including classrooms
    - Exceptions: correctional cells, daycare sickrooms, science labs, barber shops, beauty and nail salons, and bowling alley seating
  - Require DCV only when the system includes:
    - Air economizer, or
    - Modulating outdoor air control, or
    - Design outdoor air flow rate > 3,000 cfm
  - Remove exception for Occupant Sensor Ventilation Controls
- Mandatory measure
- Impacts all nonresidential buildings with high density spaces
- Applies to newly installed HVAC systems in additions
- Does not apply to alterations

Proposed Code Change

3. **Required Demand Control Ventilation.** Demand ventilation controls complying with 120.1(c)4 is required for a spaces with a design occupant density, or a maximum occupant load factor for egress purposes in the CBC, greater than or equal to 25 people per 1000 square feet (40 square feet or less per person) if the system serving the space has one or more of the following:

   A. an air economizer

   B. modulating outside air control

   C. design outdoor airflow rate > 3000 cfm

   EXCEPTION 1 to Section 120.1(c)3: ~~Classrooms, call centers, office spaces served by multiple zone systems that are continuously occupied during normal business hours with occupant density greater than 25 people per 1000 ft² as specified by Section 120.1(b)2B, healthcare facilities and medical buildings, and public areas of social services buildings are not required to have demand control ventilation.~~ Spaces with one of the following occupancy categories as defined in the California Mechanical Code: correctional cells, daycare sickrooms, science labs, barber shops, beauty and nail salons, and bowling alley seating.

   EXCEPTION 2 to Section 120.1(c)3: Where space exhaust is greater than the design ventilation rate specified in Section 120.1(b)2B minus 0.2 cfm per ft² of conditioned area.

   EXCEPTION 3 to Section 120.1(c)3: Spaces that have processes or operations that generate dusts, fumes, mists, vapors, or gases and are not provided with local exhaust ventilation, such as indoor operation of internal combustion engines or areas designated for unvented food service preparation, or beauty salons shall not install demand control ventilation.

   EXCEPTION 4 to Section 120.1(c)3: Spaces with an area of less than 150 square feet, or a design occupancy of less than 10 people as specified by Section 120.1(b)2B.

   ~~**EXCEPTION 5 to Section 120.1(c)3:** Spaces with an area of less than 1,500 square feet complying with Section 120.1(c)5.~~

Why Are We Proposing This Code Change

- Support ZNE goals
- Achieve significant energy savings
  - Occupant sensor ventilation controls no longer required for classrooms
- Insure adequate ventilation is provided at all times
  - Airside economizers often fail in the position of not supplying any outside air at all (or manually disabled, or poorly calibrated)
  - Without DCV controls this condition can persist undetected for years.
  - Title 24 requires failsafe controls and requires CO_2 sensor readings to be displayed continuously and trended.
- Align with model codes
- Keep up with ASHRAE 90.1

What do you think? (Discussion)

- What are your thoughts on the proposed code changes?
- Any questions or concerns?

3. Technical and Market Barriers

Technical and Market Barriers

- There are no anticipated technical or market barriers
  - Demand controlled ventilation is an already common practice and CO_2 sensors are widely available and inexpensive
  - There will be a small increase to the number of spaces covered

4. Compliance and Enforcement

Compliance Process

Design Phase

- What happens during design phase?
  - There are no anticipated design phase changes
  - Designers are used to implementing existing DCV requirements and this only adds a small number of spaces

Compliance Process

Permit Application Phase

- What happens in permit application phase?
  - There are no anticipated permit application phase changes
  - Plan checkers are used to DCV and know what to look for

Compliance Process

Construction Phase

- What happens in construction phase?
  - There are no anticipated construction phase changes

Compliance Process

Inspection Phase

- What happens in permitting phase?
  - There are no anticipated permitting phase changes

Compliance and Enforcement Barriers

There are no anticipated compliance or enforcement barriers

What do you think? (Discussion)

- Did we capture technical and market barriers?
- Did we capture compliance and enforcement barriers?
- Are there other barriers — or solutions — we haven't discussed?

5. Cost-Effectiveness and Energy Impacts

Definition of Baseline and Proposed Conditions

Baseline Conditions

- Minimally compliant with 2016 Standards or industry standard practice
- Large classroom prototype building
- No DCV in classroom spaces
- Constant ventilation during occupied hours

Proposed Conditions

- Compliant with proposed code change
- Large classroom prototype building
- DCV added in classroom spaces
- Ventilation volume changes based on CO_2 concentration and occupant schedule

Cost-Effectiveness Analysis

Incremental Costs

- Incremental First Cost
  - CO_2 Sensor ($260/room)
  - **Total Incremental First Cost ($260/room)**
- Zero Additional Maintenance Costs over 15-year period of analysis

- **Prototype Models (assumes 60% classrooms, 1000 sf each)**

– **Small School (24,000 sf):**	**15 classrooms**	**$3,800**	**$0.21/sf**
– **Large School (210,000 sf):**	**128 classrooms**	**$33,300**	**$0.21/sf**

Cost-Effectiveness Analysis

Incremental Cost Savings (Benefits)

- Energy Cost Savings over 15-year period of analysis
  - **Total Energy Cost Savings = range of $x,xxx to $y,yyy depending on climate zone**
  - *Energy cost savings explained in more detail in following slides.*
- **Total Incremental Cost Savings (Benefit) over 15/30-year period of analysis = $x,xxx**

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Annual Energy Savings Per [unit]

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Let's move on to…

Occupant Sensor Ventilation Requirements

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1. Background

Introduction to Occupant Sensor Ventilation

- Occupant sensor ventilation involves using occupant sensors to shut-off ventilation air when a space is unoccupied
- Can be tied into lighting occupancy sensors

Relevant Code History

- There are existing requirements in Title 24, Part 6
  - Section 120.2(e)3 includes current requirements for spaces where occupant sensor ventilation controls are required, including:
    - Multipurpose rooms < 1000 ft^2
    - Classrooms > 750 ft^2
    - Conference rooms > 750 ft^2
  - Section 120.1(c)5 includes current requirements for occupant sensor ventilation control devices
    - When unoccupied first shut off supply air then cycle it to average 25% of ventilation rate over 2 hours
- Other Relevant Code Requirements
  - This is the same proposal that ASHRAE 90.1 approved for publication public review at the January 2017 ASHRAE meeting in Las Vegas

2. Proposed Code Changes

Proposed Code Change

- Updates to Section 120.1
  - Mandatory changes to clean up and simplify ventilation control devices requirements: when unoccupied and temperature is satisfied then shut off ventilation.
- Updates to Section 120.2
  - Mandatory changes to modify space types required to implement occupied standby controls to spaces:
    - required to have lighting controls, and
    - Where occupied standby is allowed by CBC and ASHRAE 62.1

Proposed Code Change

- Mandatory For:
  - enclosed offices < 250 ft^2
  - conference rooms
  - multipurpose/assembly rooms < 1000 ft^2
  - corridors
  - lobbies
  - lecture classrooms
  - hotel guestrooms

- NOT Mandatory For:
  - K-12 classrooms
  - office copy/print rooms
  - break rooms
  - computer rooms
  - penitentiary
  - laboratories
  - food (kitchens, dining rooms)
  - gambling
  - sports arenas

  Not Allowed

  - healthcare
  - multipurpose/assembly rooms > 1000 ft^2
  - enclosed offices > 250 ft^2
  - open plan offices
  - museums
  - courtrooms
  - religious worship
  - auditorium
  - supermarkets
  - sports arena spectator areas

  Allowed (Optional)

Proposed Code Change

occupied-standby mode: when a zone is scheduled to be occupied and an occupant sensor indicates zero population within the zone.

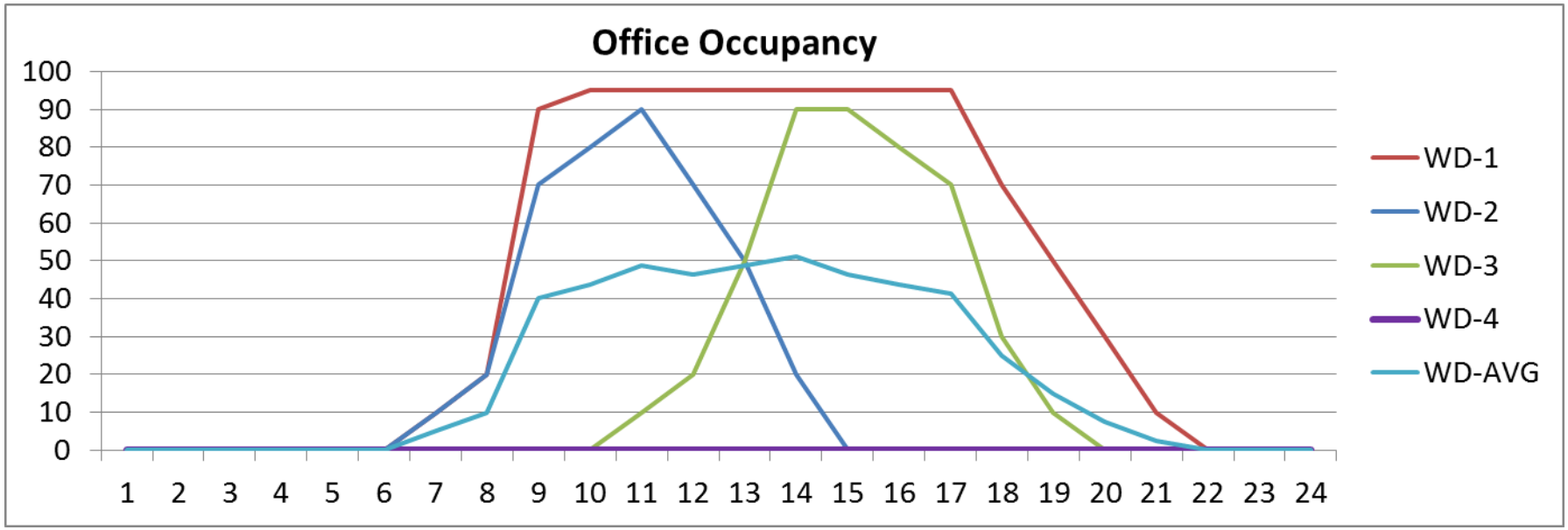
120.2(e)3 - Occupied Standby Controls. Zones serving only room(s) that are required to have occupant sensing lighting controls per sections 130.1(c)5 to 130.1(c)8, and where the ASHRAE Standard 62.1 occupancy category permits ventilation air to be reduced to zero when the space is in occupied-standby mode, shall meet the following within 5 minutes of all room(s) in that zone entering occupied-standby mode.

1. Active heating setpoint shall be setback at least 0.5^{o}F, and
2. Active cooling setpoint shall be setup at least 0.5^{o}F, and
3. All airflow supplied to the zone shall be shut-off whenever the space temperature is between the active heating and cooling setpoints

~~**EXCEPTION 5 to Sections 120.2(e)3:**. If Demand Control Ventilation is implemented as required by Section 120.1(c)3 and 120.1(c)(4).~~

Proposed Code Change - ACM

- New realistic schedules to incent occupied standby controls where it is optional (also needed to incent dual max controls and TAV)
- 4 separate weekday schedules randomly assigned to zones in the building on a daily basis. On the first weekday the first zone is assigned schedule WD-1, the second zone is assigned WD-2, etc. Each weekday each zone moves to the next schedule.



Why Are We Proposing This Code Change

- Support ZNE goals
- Achieve significant energy savings
- Align with model codes
- Keep up with ASHRAE 90.1
- Improve compliance with existing standards

What do you think? (Discussion)

- What are your thoughts on the proposed code changes?
- Any questions or concerns?

3. Technical and Market Barriers

Technical and Market Barriers

No technical or market barriers are anticipated

4. Compliance and Enforcement

Compliance Process

Design Phase

- What happens during design phase
  - There are no anticipated design phase changes
  - Designers are used to implementing existing occupant sensor ventilation requirements and this is only expanding and simplifying those requirements

Compliance Process

Permit Application Phase

- What happens in permit application phase?
  - There are no anticipated permit application phase changes
  - Performance compliance modelers should know how to take credit for optional use of occupied standby
  - Plan checkers are used to occupant sensor ventilation and know what to look for, but need to check that ventilation is set to turn down to zero in control strategies

Compliance Process

Construction Phase

- What happens in construction phase?
  - There are no anticipated construction phase changes

Compliance Process

Inspection Phase

- What happens in permitting phase?
  - There should be another acceptance test similar to “2016-NRCA-LTI-02-A-Lighting Control” and “2016-NRCA-MCH-06-A-Demand Control Ventilation” to functionally test Occupant Sensor Ventilation controls

Compliance and Enforcement Barriers

There are no anticipated compliance or enforcement barriers

What do you think? (Discussion)

- Did we capture technical and market barriers?
- Did we capture compliance and enforcement barriers?
- Are there other barriers — or solutions — we haven't discussed?

5. Cost-Effectiveness and Energy Impacts

Definition of Baseline and Proposed Conditions

Baseline Conditions

- Minimally compliant with 2016 Standards or industry standard practice
- Large office prototype building
- Occupant sensor ventilation included in spaces where it is currently required
- Ventilation air does not turn to zero when spaces are unoccupied

Proposed Conditions

- Compliant with proposed code change
- Large office prototype building
- Updated spaces that require occupancy sensor ventilation
- Added more complex controls to estimate amount of hours in a day spaces are unoccupied
- Turn down ventilation air to zero when spaces are unoccupied

Cost-Effectiveness Analysis

Incremental Costs

- Incremental First Cost
  - Upgraded Occupancy Sensor ($100/room)
  - **Total Incremental First Cost ($100/room)**
- Incremental Maintenance Costs over 15-year period of analysis
  - **Zero Incremental Maintenance Cost**

• **Small Hotel**	**1 room**	**$100**	**$0.00/sf**
• **High-Rise**	**1 room**	**$100**	**$0.00/sf**
• **Small office**	**4.5 rooms**	**$450**	**$0.08/sf**

Cost-Effectiveness Analysis

Incremental Cost Savings (Benefits)

- Energy Cost Savings over 15-year period of analysis
  - **Total Energy Cost Savings = range of $x,xxx to $y,yyy depending on climate zone**
  - *Energy cost savings explained in more detail in following slides.*
- **Total Incremental Cost Savings (Benefit) over 15/30-year period of analysis = $x,xxx**

Annual Energy Savings calculations in progress, but all savings will be positive across all climate zones

Benefit-to-Cost Ratio

Climate Zone	Benefit to Cost
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

Cost-Effective in All Climate Zones

If Benefit-to-Cost Ratio is over 1, measure is cost-effective.

Annual Energy Savings Per [unit]

Climate Zone	TDV Energy Savings (TDV kBtu/yr)	15/30 Year TDV Energy Cost Savings ($2020)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

Annual Energy Savings Per [unit]

Climate Zone	Annual Electricity Savings (kWh/yr)	Annual Natural Gas Savings (kWh/yr)	Peak Electric Demand Reduction (kW)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			

6. Next Steps

Next Steps

- Please send any additional feedback within 2 weeks to:
  - CASE Author (see contact info at end of this presentation)
  - Info@title24stakeholders.com

- Keep an eye on Title24Stakeholders.com for:
  - Presentations from today's meeting
  - Draft Code Change Language
  - Notes from today's meeting
  - Draft CASE Report (will be posted in April)

Let's move on to…

Fan System Power

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