BIC Meeting of October 15, 2014

Agenda Item #9

SFDPH Environmental HEALTH
improving environments protecting health

SAN FRANCISCO
PLANNING DEPARTMENT

Article 38 of the San Francisco Health Code
Summary of Meeting on May 7, 2014

Background

San Francisco Planning Department (1650 Mission Street, Room 431A) hosted a meeting on May 7th, 2014 with building developers, mechanical engineers, and multiple City agency representatives, who are listed at the end of this document. The purpose of the meeting was to discuss ventilation design and cost in residential buildings of different sizes with respect to Health Code Article 38 requirements for enhanced ventilation when building sensitive use developments in the defined Air Pollution Exposure Zone.

After a brief presentation from Karen Cohn (DPH) illustrating the background of existing and proposed Article 38 requirements, and feedback received during earlier community outreach and stakeholder meetings, the following questions were discussed by meeting participants:

<u>(Q1) Standard building requirements versus Article 38 requirements</u>

In your professional practice, how has Article 38 affected mechanical engineering standard practices and other regulatory requirements (e.g., Title 24) for different residential building categorized by number of units, levels and heights.

<u>(Q2) Constrained Sites</u>

Within the mid-rise category, new construction in San Francisco often results in the construction of wood-frame (less than 65-foot-tall) medium-sized residential buildings on a constrained site (e.g., limited widths or depths). Therefore, we would also like an understanding of how Article 38, existing and proposed, affects standard practices for these types of sites.

<u>(Q3) Z-Ducts</u>

For these types of new buildings (wood-frame mid-rise residential buildings), developers are often choosing to install a Z-duct system. How can one effectively provide MERV13 equivalent filtration of air through z-ducts and air coming in through the "skin" of buildings? Has it ever been done here or in other jurisdictions? If it is feasible, will it adversely affecting interior noise levels or other building code requirements? What would this design entail in terms of effectiveness and cost?

<u>(Q4) Enhanced Ventilation Additional Cost</u>

A comparison of costs (installation and operational, if known) associated with standard practices and other regulatory requirements (e.g., Title 24) versus Article 38 requirements for residential buildings. In general, at what building size, if any, does it make sense economically to use a centralized system as opposed to units at the individual residences?

<u>(Q5) Other Factors</u>

Aside from code requirements, what other factors as a mechanical engineer do you consider when proposing a non-Article 38 system? What effect does client preference have on how the mechanical engineer specifies a system design? Is there a difference between priorities depending on building size or material type? Are there other factors we have not discussed?

Responses
Participants often answered several of the above questions at once:

a. Single-family homes and townhouses:
We did not spend much time on this item, as most agreed it is relatively easy to provide Whole House Ventilation as mandated by Title 24 (mechanical ventilation rather than operable windows, required as of July 1, 2014), and include MERV 13 filtration as part of air handling system. This is feasible even if not using a central forced air furnace system for heating.

b. Low-rise (≤ 3 stories) and Mid-rise multi-unit buildings (> 3 stories, < 75 feet), often in zero lot lines:

- For a decentralized system, the estimated minimum additional cost is about $8,000 per unit.
- John O'Conner (RBA) and Paul O'Neil (CB Engineers) agreed that the additional costs are more difficult to overcome for smaller buildings.
- Toby Lee (MHC Engineers) agreed with the estimated additional cost. Toby also stated that the proper design is through a supply air fan and positive pressure in the building. MHC Engineers regularly discourages the use of Z-ducts (negative pressure in building).
- There were concerns about the space needed to locate a centralized supply ventilation mechanical system, due to limited roof space and noise considerations for building occupants.
- Decentralized systems are more difficult to maintain as entry into the individual units is necessary or relies on the unit occupant to maintain.
- David Penney (DPC Consulting Engineers) noted that, in general, the supply type designs discussed for enhanced ventilation are the future of the mechanical engineering field in relation to the previously used, exhaust-only type systems. He also emphasized that each building has unique design challenges, otherwise his services wouldn't be needed. He has designed supply ventilation systems in tandem with corridor systems (Rene Cazanave Apts, 25 Essex St.), and SF Mechanical Code has certain configurations allowed which reduce the need for expensive fire/smoke dampers.

c. High-rise multi-unit buildings (> 75 feet definition of SF Fire Code)

- Paul McGrath and Saied Nazeri (WSP Group) estimated an additional cost of $10,000-$15,000 per unit in mechanical cost for a centralized system.
  - Includes cost of fire/smoke dampers ($1,000-$1,500 each) at every unit for life safety buildings (>75 feet).
  - Centralized systems are ideal for system maintenance as there is no need to enter the individual units or rely on unit occupants for maintenance.
- Steve Poe (Critchfield Mechanical) has designed individual unit heat pumps, each with their own MERV 13 filtration for 45 Lansing Street which is currently under construction. He stated they are more cost-effective due to less up-front cost. The units of this building will sell at a high enough price to justify providing a heat pump system, which gives each unit heat and AC.
  - The heat pumps required slightly larger fan motors to accommodate the MERV 13 filter resistance.
  - Fan must overcome pressure drop which leads to acoustical concerns. However, Paul O'Neil (CB Engineers) said the extra acoustical lining is a nominal cost.
  - Individual unit heat pump system requires unit occupant to maintain or to alert a maintenance work force of any problems, so others did not like this choice.

d. Z-ducts

- Paul O'Neil (CB Engineers) had previously worked with a manufacturer on a possible filter box, Z-duct design with MERV 13 filtration. He stated that the manufacturer eventually abandoned the design because it was not feasible for many reasons.
- Toby Lee (MHC Engineers) stated that he has discontinued using Z-ducts for multiple reasons, including moisture infiltration, residents taping over the openings due to discomfort with cold air intake, and inability to provide adequate filtration.

e. Other Design Examples

- Mohsin Shaikh (DBI Mechanical) showed a sample blue print where exterior Z ducts allow outside air to be ducted to a mechanical fan system located in an enclosed area of a unit's bathroom or laundry room, where it can be filtered by MERV 13 filtration before being delivered to the occupied space. Multiple engineers pointed out potential concerns including space limitations from ductwork, need to install noise dampening features, and maintenance challenges, but Mr. O'Connor of RBA was interested in exploring this option for building in more constrained spaces that cannot easily accommodate supply system ductwork throughout the building.
- Paul O'Neil (CB Engineers) stated that, although rarely feasible in terms of cost and effectiveness, individual HRV/ERV units with MERV 13 filters can be used as was the case with the student housing project at 1321 Mission.

f. Other factors

- According to meeting participants, this is the critical factor—what type of building the client wants to build for what cost and for what sale price.

g. Next steps/action items

Paul O'Neil (CB Engineers) introduced a concept for which he designed a building in Seattle, where *Seattle Mechanical Code Section 601.2.6* allows a corridor to serve as ventilation systems pathway for dwelling units. He stated that by installing MERV 13 filter on corridor ventilation system, the need for supplemental mechanical filters/ booster fans and ducts could all be eliminated for both low and high rise projects. And that a fire smoke damper could be added on this 'interior z duct' to maintain an active smoke control zone. He stated this would be less expensive than all other solutions proposed or being currently implemented in the City for Article38 compliance.

Meeting Attendees	Affiliation
Angus McCarthy	President of SF Building Inspection Commission
John O'Connor	Board member, Residential Builders Association
Saied Nazeri, Paul McGrath	WSP Group
Toby Lee	MHC Engineers
Paul O'Neill	CB Engineers
David Penney	DPC Consulting Engineers
Steve Poe	Critchfield Mechanical, Inc.
Tamsen Drew	Office of the Mayor
Jessica Range	SF Planning Dept., Environmental Review
Wade Wietgrefe	SF Planning Dept., Environmental Review
James Zhan	SF Dept. of Building Inspection, Mechanical
Mohsin Shaikh	SF Dept. of Building Inspection, Mechanical
Karen Cohn	SF Dept. of Public Health, Environmental Health
June Weintraub	SF Dept. of Public Health, Environmental Health
Jonathan Piakis	SF Dept. of Public Health, Environmental Health

SAN FRANCISCO ARTICLE 38
'AIR QUALITY ASSESSMENT AND VENTILATION REQUIREMENT FOR URBAN INFILL RESIDENTIAL DEVELOPMENTS'.

Paul O'Neill, PE –Principal - CB Engineers

Introduction

This paper is created to stimulate a dialogue between the various San Francisco Building, Fire, Mechanical and Health Departments and members of the Professional Engineering design community in creating pragmatic and cost effective HVAC solutions to meet San Francisco's Health Department Article 38.

By way of background, based on a 2008 law adopted by the City and County, San Francisco amended the 2010 California Building by adding section 1203.5 requiring that '*Newly constructed buildings containing ten or more dwelling units located within the Potential Roadway Exposure Zone and having a PM 2.5 concentration at the proposed building site greater than 0.2 ug/m³ attributable to Local Roadway Traffic Sources, pursuant to Article 38 of the San Francisco Health Code shall have ventilation systems designed and constructed to remove >80% of ambient PM 2.5 from habitable areas of dwelling units.* '

More recently, San Francisco Planning and Department of Public Health published the Air Pollution Exposure Zone map to identify the pollution hot spots within the City boundaries for reference in determining if a project is required to have an enhanced outside air ventilation system with high efficiency filtration. Introduced as part of a proposed amendment to the existing Health Code Article 38 and Building Code Section 1203.5, this map identifies combined roadway, stationary, train and maritime pollution in reference to health-based criteria. If the amendment is adopted, then a development located in the Air Pollution Exposure Zone will need to comply with Article 38 mandates, regarding enhanced ventilation and disclosure to buyers and leasees.To comply with Article 38, outside air entering a dwelling unit must be filtered to a Minimum Efficiency Reporting Value (MERV) of 13.

This paper outlines the various ventilation code requirements, their application to both low-rise and high-rise residential projects, how conventional types of HVAC systems are currently integrated with Article 38 and to discuss a simpler alternative system approach that provides code equivalency for both ventilation and building life safety concerns.

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RESIDENTIAL VENTILATION

The 2013 California Energy code separates residential projects into 2 categories.

- Low Rise: Single family and multi-family up to 3 stories in height.
- High Rise: Multi-family dwellings 4 or more stories in height.

Each category has differing ventilation requirements; low-rise projects are required to comply with ASHRAE 62.2 – 'Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings' while high-rise projects comply with ASHRAE 62.1 – 'Ventilation for Acceptable Indoor Air Quality'.

In applying these ASHRAE standards we provide the following information:

Low-Rise Projects

California's Energy Code section 150.0 (o) refers to ASHRAE 62.2 and disallows the use of operable windows to fulfill requirements for outside air in California and effectively requires 15 cfm of outside per person for a single bedroom or studio dwelling and 15 cfm per person for each additional bedroom. A typical 2 bedroom would require a minimum ventilation rate of 45 cfm. Furthermore, the standard outlines options on how the 45 cfm should be delivered to the dwelling. Most designers opt for the exhaust method; dual speed bathroom fans with low speed running on a 24x7 basis drawing outside air into the unit.

Title 24 Part II, California Building Code (CBC), and City of San Francisco interior noise level requirements states "if interior noise levels are met by requiring that windows be un-openable or closed, the design for the structure must also specify a ventilation or air-conditioning system to provide a habitable interior environment. The ventilation system must not compromise the dwelling unit or guest room noise reduction." For environmental sound impacted residential units, designers have typically employed simple acoustic transfer boots located in the exterior wall construction to comply with the sound ordinance. These acoustic transfer ducts, also known as 'Z-ducts' are passive devices and provide a pathway for outside air into the unit when negative pressure is created by exhaust systems inside the unit and maintaining interior acoustic comfort.

With the passing of Article 38, exterior Z-ducts can no longer be used because the exhaust systems within the dwelling are not capable of creating large enough negative pressure to overcome a MERV 13 filter pressure drop even if the filter was installed in the z-duct pathway. Depending on the type of HVAC system a booster fan assist is required to draw the required outside air volume into the unit for electric heat or radiant heating only. Forced air furnaces, hydronic fan coil heating and split system heat pumps, can in most cases, integrate a MERV 13 into the forced air system. Designers, contractors and project sponsors all agree that the adoption of Article 38 has increased mechanical system first costs and energy costs for Low-Rise residential projects.

High-Rise Projects:
ASHRAE 62.1 is a commercial ventilation standard that computes the minimum outside volume differently to ASHRAE 62.2. The standard requires 0.06 cubic feet per minute (CFM) for each square foot of dwelling area and 5cfm for each person. By way of example, a 800sf two bedroom condominium or rental apartment would require 800sf x 0.06cfm/sf + (5 cfm x 3 persons) = 63 cfm.

Interestingly, this standard does allow the use of operable windows for natural ventilation for spaces up to 25 ft from a window. In San Francisco, a project located outside the Article 38 pollution hot spot zones and in an area without environmental noise concerns, may use operable windows. This is very rare condition. The vast majority of high-rise residential projects have typically employed the use of Z-ducts to provide a passage of air to the unit in sound impacted locations but they can no longer do so within the pollution hot spot zones similar to low rise projects.

Water source heat pumps are frequently used in high-rise residential projects when project sponsors desire air-conditioning. Heat pumps are categorized into 2 types:

- Closet style unit – These units can be furnished with MERV 13 filtration, filtering 100% of the total supply fan volume but the unit then runs at a higher static pressure to overcome the high efficiency filter pressure drop, increasing fan energy and requiring additional acoustic mitigation, increasing operating cost and installation costs.
- Vertical stacking heat pumps – These units are low static, almost ductless units that cannot be fitted with MERV 13 filters. To comply with the Article 38, an additional filter box and booster fan is required to deliver the outside air to the return side of the heat pump. This approach also increases HVAC system costs and maintenance over the life of the building for each owner /renter and will be conceivably turned off or poorly maintained, bypassing the long term health benefit the system provides.

Designers, contractors and project sponsors all agree that the adoption of Article 38 has increased the mechanical system first costs and energy costs for high–rise residential projects.

CORRIDOR VENTILATION

San Francisco amended the 2013 California Building code section 1203.4 that states..."*In lieu of required exterior openings for natural ventilation, a mechanical ventilating system may be provided. Such system shall be capable of providing two air changes per hour in public corridors, public hallways and other public spaces having openings into adjoining dwelling units, guest rooms, or congregate residences with R-2 occupancies, with a minimum of 7-1/2 cubic feet per minute (3-1/2 L/s) of outside air per occupant during such time as the building is occupied.*"

Furthermore air movement in corridors under CBC section 1018.5 states that corridors shall not serve as supply, return, exhaust, relief, or ventilation air ducts. Exception 1 states – "*Use of a corridor a source of make-up air for exhaust systems in rooms that open up directly onto corridors, including toilet rooms, bathrooms, dressing rooms and janitor closets, shall be permitted, provided that each such corridor is directly supplied with outdoor air at a rate greater than the rate of makeup air taken from the corridor*"

Although the San Francisco code requires 2 air changes of air movement, and a small volume of outside air based on the occupancy, most designers of multi-family residential projects, opt to employ a push / pull ventilation design with 100% outside air. Supply air is delivered at one end of the corridor and air then exhausted at the other end of the corridor in equal quantities to ensure that the corridor is not technically utilized as a source of make up air for spaces adjacent to the corridor.

This air volume is a large source of outside air relatively unused and then discharged from the building.

When corridors are maintained at equal airflow, elevator shaft movement, operable window operation on opposing building facades and building stack effects all contribute to cooking odors in corridors. All too often, in many completed projects, we note the corridor exhaust system fan has been turned off, therein pressurizing the corridor with outside air, and preventing residential cooking odors from migrating into the corridors. This outside air is transferred into the residential unit around the door. In these situations the corridor is supplying make up air to the dwellings and may be considered a code violation, but it occurs in practice.

The reason the code was originally written to prohibit such operation was to protect the egress corridor from fire and smoke migration that might occur from adjacent rooms to the corridor for all types of occupancies. However since the corridor is required to be relatively free of combustibles, the code does not consider a fire in the corridor to be a likely event. Multi-family residential buildings however operate in a distinctive manner such that the units are inherently under negative pressure constantly to exhaust bathrooms, kitchen hoods and dryers. Smoke migration to the corridor will not occur with units under negative pressure and pressure differentials are further enhanced when a corridor is supplied with 100% outside air without any or with relatively little opposite corridor exhaust. This is the same principal applied to prevent smoke from entering stairwell vestibules in active smoke control high-rise life safety structures. Stair pressurization systems draw 100% outside air which is assumed to be free of smoke and inject it into the stairs. If this concept is acceptable and seen as an enhancement for a stair, it should be acceptable for a corridor.

A typical corridor serving 12 residential units back to back would require 2 air-changes per hour ventilation rate of approximately 400cfm. 12 units of 2 bedroom mix in a low rise building will require 540 cfm and in a high rise project approximately 756 cfm. It is clear that by delivering 100% outside air to meet the make up air of the dwelling units smoke will be prevented from migrating into the corridor. This author, as a Consulting Engineer designing multi-family residential projects in San Francisco for many years, believes there is an alternative path to comply with Article 38 ordinance.

We propose by pressurizing the egress corridor with 100% outside air filtered to MERV 13 efficiency at the central air-handling unit, installing interior z-ducts to the residential unit and eliminating exhaust from the corridor the following will occur:

- The Building Code ventilation rates will be achieved
- Acoustic privacy between the corridor and the residential unit will be maintained
- Smoke will not migrate from the negatively pressurized dwelling unit to the positively pressurized corridor. This will prevent smoke spread between units.
- MERV 13 filtered air is transferred to the unit complying with Article 38.
- The only additional cost is a single filter upgrade at the air handling unit
- Healthier buildings will result with the relocation of outside openings from the skin of the building to the interior eliminates water leaks and water intrusion concerns that create other health impacts, molds etc.
- Uncontrolled and unfiltered infiltration bypassing the benefit of Article 38 is reduced.

The reader should also be informed that the discussion to this point is the minimum ventilation rate. Low-rise minimum ventilation rate is only really achieved in single-family homes. When we design hi-density housing, we use vertical shafts to the roof with scavenger fans for kitchen, bathrooms and dryers. The constant draw of these exhaust risers will exceed the minimum ventilation rate by upwards of 100% or more. Therefore, in these types of projects the designer will need a method of accessing clean makeup air from a buffer zone, such as the corridor.

Anecdotally, The City of Seattle has a local 2012 amendment to the Washington State code section 601.2- 'Air Movement in Egress Elements' that allows corridors to be used as a make-up air source to dwellings with the proviso that the corridor is supplied with 100% outside air and that a ventilation system also exist in the dwelling unit. This code is structured to allow the use of trickle window vents for the minimum ventilation similar to ASHRAE but when larger exhaust systems in the units are activated, transfer air is taken from the corridor.

Our proposal is similar to this code without the need for a secondary air intake system inside the dwelling. Additionally, the Washington Building 2012 code was amended to add section 501.4 allowing equalization of room pressures with supply air, transfer air or outside air and specifically <u>excluding calculated building infiltration</u> as a method of correcting a make-up air deficiency. This mitigation or elimination of uncontrolled infiltration through the building envelope would be in keeping with the intent of the Article 38 Ordinance for low and high rise residential construction and points further to the importance of providing adequate make up air to negatively pressurized units via the corridor ventilation system, engineered for this purpose.

FIRE AND SMOKE LIFE SAFETY

We recognize that this approach is a deviation from the existing code, and for this Article 38 proposal to be successful, we recognize the need to fully explore and vet its equivalency in terms of fire and smoke life safety. This requires careful attention to the placement of the corridor supply intake, and consideration for the pressures created by stack effect, wind, and the minimum pressure to prevent the spread of smoke due to expansion from elevated temperature. This expansion pressure is on the order of 0.02" water column (wc) in wc for smoke temperatures of 233 degrees F. as described in the IBC publication "Guide to Smoke Control in the 2006 IBC". This document also recognizes that the 0.05" wc value includes an appropriate safety factor. Anecdotal testing of smoke spread in sprinklered buildings by Klote showed a maximum pressure of 0.01" wc, away from the fire, as the smoke cools.

The requirements for corridors are described in CBC section 708 - Fire Partitions and 710 – as 'Smoke Partitions'. There are exceptions in code section 717.5.4 that allow HVAC ducting to pass through a fire partition without a fire damper when the duct is not connected with the corridor. In this proposal, clearly a fire damper would be required at the interior Z-duct as we have a direct connection to the corridor. The relative cost of fire dampers is a small cost to the project.

Smoke partitions in section 717.5.7 require a 'smoke damper when a transfer opening penetrates a smoke partition'. But as discussed above, smoke is not expected to pass into the corridor from a dwelling based on the pressure differentials created between the dwelling and the corridor and thus we believe smoke dampers could be omitted in non high-rise life safety buildings (under 75ft at the highest occupied floor elevation). Similar to vertical scavenger fans with 22" sub-ducts where the fans are maintained operational in a fire event, we would keep the central supply fan running for the required emergency standby time required in the code (90 minutes).

However, in seeking a simple prescriptive code change, rather than requiring low-rise projects to demonstrate (through Contam Modeling) that smoke would be contained inside the dwelling unit, we would not request omission of the smoke damper. We recommend the installation of a combination fire and smoke damper at each Z-duct connection to the corridor. A local duct detector at each fire smoke damper would close the damper.

If smoke is detected in the non life safety building corridor because of an event occurring in the corridor, we would shut that event corridor supply air system to prevent smoke from migrating out of the corridor to the dwelling units.

In high-rise life safety buildings, smoke control designers typically consider the residential unit as a passive zone, with the corridor as the active smoke control zone. In this case the corridor wall becomes a 'smoke barrier' per section CBC 717.5.5 and we would not seek an exemption to omit this smoke damper. Therefore in such projects we recommend the installation of a fire/smoke damper at the interior z-duct. In a fire event, all Z-duct fire smoke dampers would close on all floors, the corridor supply fan system would shut down as it normally does in conventional smoke control systems and a dedicated smoke exhaust shaft fire smoke damper would open to exhaust the fire floor to maintain negative pressure in the corridor relative to the stairwell vestibule doors. This exhaust shaft is always part of high-rise life safety corridor ventilation system anyway but it would be turned off for normal occupancy to pressurize the corridor. With this sequence of operation, with the shutting of the z-duct fire smoke dampers and supply fan, there is no further need to ventilate outside air as occupants are heading for the stairways to exit the building.

If smoke is detected in the life safety building corridor because of an event occurring in the corridor, we would shut that event corridor supply air system along with the Z-duct fire smoke damper so as not to draw smoke into the dwellings.

The reason corridors are not allowed to be 'supply ducts' or plenums dates back to earlier code adoption when fire /smoke dampers could not close fast enough to prevent smoke from entering the corridor. With today's 'dynamic' fire smoke dampers with 15 second closure times, the passage of smoke at the beginning of a event is virtually negligible. Tenability of the corridor can be easily maintained if the damper closes within 15 seconds.

CONCLUSION

We believe we have demonstrated the use of the corridor ventilation system when filtered to MERV 13 at one central location will be a cost effective solution for both Low-rise and High-rise residential construction for compliance with Article 38.

We welcome the opportunity to sit with the City of San Francisco's to discuss the contents of this document in greater detail and hopefully finalize a plan that meets the intent of all the related codes while providing a healthier living environment.