Multifamily Ventilation Code Change Proposal – Final Report

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1. Table of Contents

2. Overview of Proposed Code Changes

These code change proposals are a result of research conducted for the Unique Multifamily Code Relevant Measures (UMCRM) PIER project. The ventilation component of this research evaluated:

- Current California code requirements for indoor air quality ventilation of multifamily buildings;[1]
- Existing California multifamily building stock, construction practices, and ventilation systems;
- Modeled energy use and airflow of individual unit vs central shaft exhaust systems; and
- Measured energy use and ventilation airflow from field retrofits of one high-rise multifamily building with central shaft exhaust ventilation systems.

This final report proposes changes to the 2016 California Title 24 Building Energy Efficiency Standards regarding indoor air quality ventilation of multifamily buildings. In summary, we recommend (a) unifying all multifamily residential ventilation requirements by extending current requirements for new low-rise multifamily buildings to new high-rise multifamily buildings, and (b) for high-rise multifamily buildings that use central shaft ventilation systems, two new requirements that are necessary to ensure that these systems perform as energy efficiently as possible and do not under- or over-ventilate homes.

The 2008 Title 24 Part 6 residential standards began requiring mechanical ventilation of new low-rise homes by incorporating most of the requirements of ASHRAE Standard 62.2-2007—*Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*.[2] The 2013 residential standards reference a version of Standard 62.2-2010 that for the first time specifically addresses multifamily buildings--particularly the need for "compartmentalization" or air-sealing between homes in low-rise multifamily buildings to limit the transfer of potentially polluted indoor air between attached homes. [3]

Meanwhile, the ventilation and indoor air quality needs of apartment/homes in high-rise multifamily buildings--which are much more similar to the needs of homes in low-rise multifamily buildings than to any nonresidential occupancy--have been long neglected. High-rise residential buildings in California are covered by Title 24 nonresidential standards, which do not clearly or adequately address those needs.

In addition to extending low-rise residential ventilation requirements to high-rise residential buildings, we also propose new requirements for improving the energy efficiency and ventilation performance of high-rise residential buildings that use central shaft ventilation instead of a separate ventilation system for each apartment. Unless these vertical ventilation shafts are well-sealed to minimize air leakage, and the ducts connecting each apartment to the central ventilation shaft have dampers that automatically maintain a constant airflow, the rooftop ventilation fans at the top of each central shaft waste significant energy, and apartments tend to be over- or under-ventilated during most of the year.

[1] "Indoor air quality" ventilation is distinct from ventilation of unoccupied spaces such as attics and crawlspaces.
[2] ASHRAE is the American Society of Heating, Refrigerating, and Air Conditioning Engineers.
[3] CEC. 2010. ASHRAE Standard 62.2-2010 – *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings.*

2.1. Description of Proposed Code Changes

The proposed code changes will reduce space heating, air conditioning, and ventilation fan energy use; improve ventilation consistency and indoor air quality, and clarify ventilation requirements for high-rise multifamily buildings. The change will affect both residential and non-residential sections of Title 24.

The key aspects of the proposed code changes are:

1) Extending low-rise multifamily ventilation requirements to high-rise multifamily buildings. This single change includes:
    - Requiring *mechanical* ventilation of homes in high-rise multifamily buildings,
    - Reducing current high-rise ventilation *rates* to match low-rise ventilation rates, and
    - Limiting *indoor air transfer* between homes in high-rise multifamily buildings.
2) Requiring that high-rise multifamily buildings that use central ventilation shafts:
    - Seal central ventilation shaft *leakage* to no more than 5% of total rooftop fan flow, and
    - Install self-balancing *dampers* in the ventilation grille of each apartment.

Requirements for ventilation of multifamily buildings in California are currently based on two distinct sets of Title 24 codes: high-rise multifamily is covered by the nonresidential standards and low-rise multifamily is covered by the residential standards. Without any clear technical rationale for having two significantly different sets of ventilation requirements for occupancies with identical use patterns, we propose to use the most appropriate set of ventilation requirements to address all multifamily buildings.

We propose extending low-rise residential ventilation requirements to high-rise multifamily buildings in California. This proposed change is necessary because current Title 24 requirements for ventilation of high-rise residential buildings are unclear, out-of-date, and inadequate to ensure both energy efficiency and a consistent supply of outdoor air in high-rise multifamily apartment/homes. That this change is also prudent is evidenced by ASHRAE's 2014 decision to extend Standard 62.2 residential ventilation requirements to high-rise residential buildings on a national level.[4] By unifying low- and high-rise multifamily ventilation requirements in the 2016 code, California will not only be aligned with national energy code trends, but will also be taking a significant step toward enabling all new multifamily buildings to become zero net energy (ZNE) as soon as possible.

The other proposed code change is necessary to ensure the energy efficiency of central shaft ventilation systems, which are sometimes used in high-rise residential buildings instead of installing a separate "individual unit" ventilation system in each apartment. Central shaft systems use a rooftop fan to ventilate several apartments at once. Each rooftop fan sits at the top of a large vertical sheet metal shaft, which connects to individual apartments by smaller horizontal ducts that end at the ventilation grille in each apartment/home. Each high-rise building typically has several central ventilation shafts, each serving at least one apartment on each floor. The rooftop exhaust fans operate continuously to draw air from each home, which is replaced by air being pulled into the home from "outside" areas.

[4] Bruce Wilcox. Feb 2014. *Personal communication with Judy Roberson*.

Central shaft ventilation systems are prone to two major problems that impact energy efficiency and indoor air quality. The first problem is basically duct leakage on a large scale, as leaks in the central shafts compromise energy efficiency by introducing excess air from spaces other than the apartments. Our literature review and field measurements indicate that central shaft leakage is often 25% or more of total fan flow. Limiting central shaft leakage to 5% of fan flow will reduce this performance penalty. The energy and airflow modeling conducted for this project confirm that unless central shafts are sealed to ≤ 5% leakage, rooftop fans must move significantly more air--and use significantly more energy--in order to ensure at least the minimum ventilation rate in every apartment served by the central shaft system.

The second issue affecting the performance of central shaft ventilation systems in high-rise buildings is stack effect--a natural force that generates pressure and drives vertical airflow in buildings in response to indoor-outdoor temperature differences. The taller the building, the greater the stack effect, which is also stronger in winter when outdoor temperatures are lower and excess outdoor air is to be avoided. Stack effect drives infiltration and exfiltration, and causes apartments on the lowest floors to be under-ventilated while apartments on the highest floors are chronically over-ventilated. Central shaft systems facilitate the stack effect by providing vertical “chimneys” that enable vertical airflow and contribute to inconsistent ventilation rates among apartments on different floors of the same high-rise building.

To mitigate this problem, we propose that the 2016 energy code require *self-balancing dampers* in the ventilation grille of each apartment served by a central shaft system. These dampers maintain a constant, factory-calibrated airflow (e.g., 30 cfm) through a duct whenever the pressure across the duct is within a given range, such as 0.2 to 0.8 inches water gauge, which is 50-200 Pascals. The energy and airflow modeling and field measurements previously reported for this project confirm that--in conjunction with sealing central shafts to ≤ 5% leakage—these self-balancing dampers ensure that:

- Each apartment receives an adequate amount of ventilation,
- Ventilation rates among apartments in the same building are more consistent, and
- Rooftop ventilation fans use no more energy than needed to provide adequate ventilation.

These proposed code changes would require that if a central ventilation system is used in a new high-rise multifamily building, the shaft (duct) leakage shall be no more than 5% of the total fan flow and that self-balancing dampers are installed in each apartment served by the central shaft system. These changes will help ensure that central shaft ventilation systems work as intended to improve indoor air quality in high-rise multifamily apartments without wasting rooftop ventilation fan energy.

2.2. Type of Changes

The proposed measures would introduce new mandatory measures for ventilation of California high-rise residential buildings. They would require high-rise residential buildings to be included in the language in Section 150(o) *Ventilation for Indoor Air Quality* of Part 6 of Title 24, and that a sub-section be added to describe new mandatory measures for central shaft ventilation. Language would also need to be added to Section 4.6 *Indoor Air Quality and Mechanical Ventilation* of the Residential Compliance Manual. We recommend that these new measures not be prescriptive, because their absence would significantly and negatively affect high-rise multifamily indoor air quality and ventilation system energy performance.

2.3. Energy Benefits

These proposed code changes to multifamily ventilation would result in significant energy savings for high-rise multifamily buildings across multiple California climate zones (CZs). Yearly savings estimates in Tables 1-3 below are based on a 30-year life cycle, an EnergyPlus model of a six-story multifamily building (described in previous reports for this project) in California's three most populous climate zones. TDV values weight energy savings according to its availability and cost each hour of the year.

Table 1: Energy and TDV Savings Due to Adopting Code Changes in CZ 3 (San Francisco Bay Area)

Climate Zone 3	Electricity Savings (kWh/yr)	Natural Gas Savings (Therms/yr)	TDV Electricity Savings (TDV kBtu)	TDV Gas Savings (TDV kBtu)	TDV Net Savings (TDV kBtu)
Per six-story multifamily building	-689	1,749	-31,981	88,881	**56,900**
Per square foot	-0.024	0.061	-1.110	3.086	**1.976**

Table 2: Energy and TDV Savings Due to Adopting Proposed Code Changes in CZ 8 (Los Angeles Area)

Climate Zone 8	Electricity Savings (kWh/yr)	Natural Gas Savings (Therms/yr)	TDV Electricity Savings (TDV kBtu)	TDV Gas Savings (TDV kBtu)	TDV Net Savings (TDV kBtu)
Per six-story multifamily building	-1,050	816	-30,263	42,944	**12,681**
Per square foot	-0.036	0.028	-1.051	1.491	**0.440**

Table 3: Energy and TDV Savings Due to Adopting Code Changes in CZ 12 (Sacramento Area)

Climate Zone 12	Electricity Savings (kWh/yr)	Natural Gas Savings (Therms/yr)	TDV Electricity Savings (TDV kBtu)	TDV Gas Savings (TDV kBtu)	TDV Net Savings (TDV kBtu)
Per six-story multifamily building	-114	2,048	1,568	106,608	**108,176**
Per square foot	-0.004	0.071	0.054	3.702	**3.756**

2.4. Non-Energy Benefits

The proposed code changes would also yield the indoor air quality benefits of improved reliability and consistency of ventilation rates in apartment/homes in high-rise multifamily buildings. Extending low-rise ventilation requirements to high-rise buildings will ensure reliable *mechanical* ventilation, and the requirement for compartmentalization of attached multifamily dwellings will limit transfer of polluted indoor air--which often includes tobacco smoke, cooking odors and excess moisture--between homes.

High-rise multifamily buildings with central shaft ventilation systems will also experience improved indoor air quality, occupant comfort and satisfaction as a result of more consistent ventilation rates among homes on different floors. This in turn will translate into reduced occupant turnover rates.

Another invaluable non-energy benefit of adopting these code change proposals is the positive impact on the multifamily building design and construction community as a result of clarifying and unifying ventilation requirements for low- and high-rise multifamily buildings. Designers and contractors will save time by meeting one set of requirements, and compliance with the energy code should also improve.

2.5. Technology Measures

The technology associated with our proposed changes to multifamily ventilation requirements involve:

- Mechanical ventilation systems in high-rise residential buildings,
- Automatic (as well as manual) duct sealing methods, and
- Self-balancing airflow dampers.

All of these technologies are readily available and already in use in high-rise multifamily buildings.

Standard 62.2-2010 includes a compartmentalization requirement for attached homes. Envelope air sealing requires training and skill but no particular technology. However, the best practice for verifying that envelope leakage does not exceed 0.2 CFM50/ft^2 envelope area is to blower door test at least a sample of homes in each multifamily building. While there are several "advanced" blower door testing methods in use for multifamily buildings, there is currently no standard ASTM method for this purpose.[5]

2.5.1. Measure Availability

Requiring mechanical ventilation of homes in high-rise buildings will not be constrained by a lack of suitable ventilation equipment. Many high-rise multifamily buildings already provide mechanical ventilation to each home, using either individual unit or shared central shaft ventilation systems. If anything, the clarified requirements for mechanical ventilation of homes in high-rise multifamily buildings will spur innovative new strategies for optimizing indoor air quality and energy efficiency. For example, our survey of multifamily building professionals and ventilation experts for this project found an interest in using more effective supply ventilation strategies, as an alternative to exhaust ventilation.

Methods for sealing ductwork to reduce air leakage and energy waste have evolved in recent years. Automated duct sealing technologies have yielded excellent results in both new construction and retrofit projects, and are particularly suited to larger buildings, and whenever manual duct sealing is difficult or impossible because of the inability to physically access ductwork. For the field retrofit component of this research project we used an aerosol duct sealing technology to rapidly seal and monitor the level of sealing existing central shaft ductwork that could not be manually sealed.

Self-balancing dampers is a generic term for factory-calibrated devices that are designed to be installed between two sections of ductwork for the purpose of maintaining a consistent airflow through the duct. Depending on the manufacturer, these dampers are either passive devices that require no power or

[5] ASTM is the American Society of Testing and Materials

electronic controls, or active devices that electronically control airflow based on feedback from sensors. They are used to control airflow rates at the ventilation grille of apartments connected to a central shaft ventilation system, and have been used successfully to improve the ventilation consistency and energy efficiency of high-rise multifamily buildings in other parts of this country. Those most commonly used in residential buildings are American Aldes passive Constant Airflow Regulators (CAR-II). For higher airflows, Trox makes passive or active Volume Flow Limiters (VFL), and Belimo offers active Pressure Independent Valves (PIV).

2.6. Performance Verification

The 2013 residential energy code requires third-party HERS verification that minimum required airflow is delivered by whole-home ventilation systems in low-rise buildings. Adopting these 2016 code change proposals would extend these HERS verification requirements to ventilation systems in high-rise multifamily buildings. This process will be similar to that described in the Reference Residential Appendix section RA3.7--*Field Verification and Diagnostic Testing of Mechanical Ventilation Systems*, with the potential provision that an approved sampling process could be used to verify a portion of systems in the same large multifamily building.

Just as HERS verification is also required for duct leakage in low-rise homes, HERS verification should be required for leakage of central shaft ventilation systems in high-rise residential buildings. The process would be similar to that laid out in the Reference Residential Appendix section RA3.1—*Field Verification and Diagnostic Testing of Air Distribution Systems*. The language may need to be modified slightly for distribution systems in high-rise attached homes; draft language is offered in Section 4 of this report.

Standard 62.2-2010 states that one way to verify compliance with its compartmentalization requirement for multifamily homes is to use a blower door to confirm ≤ 0.2 cfm50 per square foot of total envelope area. Blower door testing is currently the only way to measure envelope leakage, but blower door tests are more challenging in attached multifamily homes than in single-family homes, for several reasons.

HERS verification should be required to confirm the multifamily compartmentalization requirement is met, and a sampling method is appropriate to avoid testing every unit in larger multifamily buildings. The process for demonstrating compliance with envelope tightness requirements is to conduct blower door tests in accordance with ANSI/ASTM-E779-03, *Standard Test Method for Determining Air Leakage Rate by Fan Pressurization,* or ANSI/ASTM-E1827 *Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door*.

2.7. Estimated Cost of Proposed Measures

Our survey of current high-rise multifamily building HVAC practices indicated that most of these buildings in California already use mechanical ventilation systems. This is likely the result of the difficulty of adequately and consistently ventilating high-rise apartments *without* using mechanical ventilation. For that reason, the information in Table 4 is based on the assumption that high-rise residential buildings already include mechanical ventilation, and there is no additional cost for its installation.

Table 4. Estimated Cost of Applying Proposed Code Changes in High-Rise Multifamily Buildings.

Proposed Measure	Impact	Estimated Cost		
		Labor and Materials		Testing
Extend low-rise mechanical ventilation and rate requirements to high-rise multifamily buildings	Require mechanical ventilation of high-rise multifamily buildings, and reduce minimum ventilation rates	N/A[6]		HERS verification
Compartmentalize high-rise multifamily dwellings to ≤ 0.2 CFM50/ft^2 of envelope area	Reduce transfer of indoor air between attached homes in high-rise multifamily buildings	1 bed, 800 ft^2	$400[7]	$25[8]
		2 bed 1,100 ft^2	$500	$25
		3 bed 1,500 ft^2	$600	$25
Require self-balancing dampers in apartments served by central shaft ventilation	Improve consistency of ventilation rates among apartments on different floors of the building	$85 per unit[9]		N/A
Require sealing of central shaft ventilation ducts to 5% or less of total rooftop ventilation fan flow	Reduce HVAC energy use of buildings with central shaft ventilation systems	$35 per unit[10]		$50 per unit[11]

[6] Assuming the incremental cost of installing smaller ventilation fans is negligible.
[7] Assuming a labor rate of $70/hr and a 20% markup on labor and materials, the cost was estimated by the number of hours required to seal penetrations in a typical apartment.
[8] Assuming each apartment contributes 10% of the cost of a blower door envelope leakage test.
[9] Based on the cost of installing one CAR-II damper in an apartment.
[10] Based on the cost to manually seal a duct rise between floors assuming a riser serves one apartment per floor.
[11] Based on the distributed cost for labor required to conduct a blower door leakage test on a 10-story building.

3. Recommended Language for the Standards and Reference Appendices

The base-case language below for which we propose 2016 modifications is from the ***2013 Building Energy Efficiency Standards***, May 2012, CEC-400-2012-004-CMF. Our recommended changes are indicated by ~~strike-through~~ for deletions and underscore for additions. Multiple ellipses (………) indicate that the text before and after the ellipses is not continuous.

3.1. Building Energy Efficiency Standards: Title 24, Part 6

SECTION 120.1 – REQUIREMENTS FOR VENTILATION

All nonresidential, high-rise residential, and hotel/motel occupancies shall comply with the requirements of Section 120.1(a) through 120.1(e).

(a) General Requirements.

1. All enclosed spaces in a building shall be ventilated in accordance with the requirements of this section and the CBC.

   EXCEPTION 1 to Section 120.1(a)1. High-rise residential (multifamily) buildings shall comply with the mandatory requirements of Section 150.0(o) Ventilation for Indoor Air Quality.

   EXCEPTION 2 to Section 120.1(a)1. Refrigerated warehouses and other spaces or buildings that are not normally used for human occupancy and work.

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EXCEPTION to Section 120.1(b)1A: Naturally ventilated spaces in ~~high-rise residential dwelling units and~~hotel/motel guest rooms shall be open to and within 25 feet of operable wall or roof openings to the outdoors.

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TABLE 120.1-A MINIMUM VENTILATION RATES

TYPE OF USE	CFM PER SQUARE FOOT OF CONDITIONED FLOOR AREA
Auto repair workshops	
Barber shops	
Bars, cocktail lounges and casinos	
Beauty shops	
Coin-operated dry cleaning	
Commercial dry cleaning	
High-rise residential	~~Ventilation Rates Specified by the CBC~~ See Section 150.0(o) Ventilation for Indoor Air Quality
Hotel guest rooms (less than 500 ft2)	
Hotel guest rooms (500 ft2 or greater)	
Retail stores	
All others	

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SECTION 150.0 – MANDATORY FEATURES AND DEVICES

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(o) Ventilation for Indoor Air Quality. All low-rise and high-rise residential dwelling units shall meet the requirements of ASHRAE Standard 62.2, Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings. Window operation is not a permissible method of providing the Whole-Building Ventilation airflow required in Section 4 of ASHRAE Standard 62.2. Continuous operation of central forced-air system air handlers used in central fan integrated ventilation systems is not a permissible method of providing the whole-building ventilation airflow required in Section 4 of ASHRAE Standard 62.2.

Attached dwelling units in low-rise and high-rise residential buildings shall meet the requirements of Section 8 of Standard 62.2. For multifamily buildings, the term "building" in Section 4 of that Standard refers to a single dwelling unit.

1. Central Ventilation Shafts. Multifamily buildings that utilize shared vertical exhaust/supply ducts that traverse multiple floors of a building shall comply with the requirements of this section.

A. Constant airflow control dampers that are factory-calibrated to maintain a specified airflow rate (in cfm) across the range of expected operating pressures shall be installed between every central shaft and each apartment served by that shaft.

B. Each central ventilation shaft that traverses multiple floors of a building shall be sealed to a leakage rate of no more than 5% of the total flow of the corresponding rooftop ventilation fan.

2. Field Verification and Diagnostic Testing. ~~Additionally, all dwelling units shall meet the following requirements:~~

A. **Airflow Performance.** All dwelling units shall meet the following requirement: The Whole-Building Ventilation airflow required by Section 4 of ASHRAE Standard 62.2 shall be confirmed through field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Residential Appendix RA3.7.

B. **Central Ventilation Shaft Sealing**. Multifamily buildings that utilize central shaft ventilation systems shall meet the following requirement: The maximum air leakage rate of each ventilation shaft in a multifamily building shall be confirmed through field verification and diagnostic testing in accordance with applicable procedures specified in Reference Residential Appendix RA3.1.

3.1.1. 2013 Residential Appendices

RA3.1 *Field Verification and Diagnostic Testing of Air Distribution Systems*

RA3.1.1 Purpose and Scope

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RA3.1 applies to air distribution systems in both new and existing low-rise residential buildings, and to central shaft ventilation systems in high-rise residential buildings.

Table RA3.1-2 – Duct Leakage Verification and Diagnostic Test Protocols and Compliance Criteria

Case	User Application	Leakage Compliance Criteria (% of Air Handler Airflow)	Procedure(s)
Sealed and tested new duct systems in single-family homes and townhomes	Installer Testing at Final HERS Rater Testing	6%	RA3.1.4.3.1
Sealed and tested new duct systems in single-family homes and townhomes	Installer Testing at Rough-in, Air Handling Unit Installed	6% Installer Inspection at Final	RA3.1.4.3.2 RA3.1.4.3.2.1 RA3.1.4.3.3
Sealed and tested new duct systems in single-family homes and townhomes	Installer Testing at Rough-in, Air Handling Unit Not Installed	4% Installer Inspection at Final	RA3.1.4.3.2 RA3.1.4.3.2.2 RA3.1.4.3.3
Sealed and tested new duct systems in multifamily homes regardless of duct system location	Installer Testing at Final HERS Rater Testing	12%Total Duct Leakage	RA3.1.4.3.1
Sealed and tested new duct systems in multifamily homes regardless of duct system location.	Installer Testing at Final HERS Rater Testing	6% Leakage to Outside	RA3.1.4.3.4
Verified Low Leakage Air Handler with Sealed and Tested Duct System Compliance Credit	Installer Testing at Final HERS Rater Testing	compliance target values 6% or less as specified on the Certificate of Compliance	RA3.1.4.3.1 and RA3.1.4.3.9
Verification of ducts located entirely in directly conditioned space, and Low leakage ducts in conditioned space compliance credit	Installed Testing HERS Rater Testing	25 CFM Leakage to Outside	RA3.1.4.3.8
Sealed and tested altered existing duct systems	Installer Testing HERS Rater Testing	15% Total Duct Leakage	RA3.1.4.3.1
Sealed and tested altered existing duct systems	Installer Testing HERS Rater Testing	10% Leakage to Outside	RA3.1.4.3.4
Sealed and tested altered existing duct systems	Installer Testing and Inspection HERS Rater Testing and Verification	Fails Leakage Tests but All Accessible Ducts are Sealed Inspection and Smoke Test with 100% Verification	RA3.1.4.3.5 RA3.1.4.3.6 RA3.1.4.3.7
Sealed and tested new central ventilation shaft systems in multifamily buildings	Installer Testing at Final HERS Rater Testing	≤ 5% Total Duct Leakage	RA3.1.4.3.10

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RA3.1.4.3.10 **Diagnostic Duct Leakage from Fan Pressurization of Central Ventilation Shafts**

The objective of this procedure is for an installer to determine or a rater to verify the total leakage of a new or altered central shaft ventilation system. The total ventilation shaft system leakage, including ductwork that connects individual dwellings to the central shaft, shall be determined by pressurizing the entire duct system to a pressure of 25 Pa (0.1 inches water) with respect to outside (positive pressure for supply ventilation systems and negative pressure for exhaust ventilation systems). The following procedure shall be used for the fan pressurization tests:

(a) Verify that the exhaust/supply ventilation fan and all connectors, transition pieces, duct boots and registers are installed. The entire duct system shall be included in the total leakage test.

(b) Seal all the exhaust/supply grilles.

(c) Remove the ventilation fan and attach the fan flowmeter device to the duct system.

(d) Install a static pressure probe at a ventilation register located close to the ventilation fan.

(e) For supply ventilation ducts, adjust the fan flowmeter to produce a positive 25 Pa (0.1 inches water) pressure at the supply fan connection with respect to the outside. For exhaust ventilation ducts, adjust the fan flowmeter to produce a negative 25 Pa (0.1 inches water) pressure at the exhaust fan connection with respect to the outside.

(f) Record the flow through the flowmeter; this is the leakage flow at 25 Pa (0.1 inches water).

(g) Divide the leakage flow by the total fan flow based on ventilation fan design specifications. If the leakage flow rate is equal to or less than the compliance criterion from Table RA3.1-2 the system passes.

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RA3.7 *Field Verification and Diagnostic Testing of Mechanical Ventilation Systems*

RA3.7.1 Purpose and Scope

RA3.7 contains procedures for measuring the airflow in mechanical ventilation systems to confirm compliance with the requirements of ASHRAE 62.2.

RA3.7 is applicable to mechanical ventilation systems in low-rise and high-rise residential buildings.