Proposal Summary

2022 California Energy Code (Title 24, Part 6)

Air Distribution - High-Performance Ducts/Updates to Fan Power Limits

Updated: Wednesday, October 30, 2019

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Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on November 5, 2019. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by November 19, 2019.

Measure Description

The fan power limits were updated in Title 24-2019 and will take effect January 1, 2020. This measure proposes to reform fan power limits methodology and increase the stringency of prescriptive efficiency requirements for fan systems in nonresidential buildings. Reduced fan power consumption can be achieved by reducing the static pressure in air duct systems, (2) reducing pressure drop through system components, such as filters, or (3) employing higher efficiency fans, motors, and transmissions.

In this proposal, the Statewide CASE team improves the fan power limits by:

1. Including fan transmission and motor efficiency by changing input measurement from fan brake horsepower to fan electrical input power. The budget fan electrical input power calculation is based on the Air Movement and Controls Association (AMCA)-208-18, and budget pressure losses to determine budget fan power for each fan system.
2. The boundaries of fan systems are clearly defined with the addition of definitions for:
    - Supply fan systems
    - Exhaust/Return/Relief fan systems
    - Transfer fan systems
3. Clarifies the requirement to use VAV system pressure drop values.
4. Reduces the threshold for fan system compliance to 1 kW fan electrical input power from the current 5 shaft brake horsepower.

Draft Code Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2019 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions). Expected sections or tables of the proposed code (but not specific changes at this time) are highlighted in yellow.

SECTION 100.1 – DEFINITIONS AND RULES OF CONSTRUCTION

(b) Definition.

- Fan system: All the fans that contribute to the movement of air through a point of a common duct or plenum.
- Fan system, supply: A fan system that exclusively provides ventilation and/or recirculated air to conditioned spaces.
- Fan system, exhaust/relief: A fan system dedicated to the removal of air from conditioned or semi-conditioned spaces to the outdoors.
- Fan system, return: A fan system dedicated to removing air from conditioned or semi-conditioned spaces where some or all the air is to be recirculated except during 100% economizer operation.
- Fan system, transfer: A fan system that exclusively moves air from one occupied space to another.
- Fan system design conditions: operating conditions that can be expected to occur during normal system operation that result in the highest supply airflow rate to or from the conditioned spaces served by the fan system.
- Fan system input power (kW): the sum of the fan electrical input power in kilowatts of all fans that are required to operate at fan system design conditions to supply air from the heating or cooling source to the conditioned spaces, return it to the source, exhaust it to the outdoors, or transfer it to another space.

SECTION 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

(c) Fan Systems. Each fan system ~~having a total fan system motor nameplate horsepower 5 HP~~ used for space conditioning shall meet the requirements of Items 1, 2, and 3 below. Total fan system power demand equals the sum of the power demand of all fans in the system that are required to operate at design conditions in order to supply air from the heating or cooling source to the conditioned space, and to return it back to the source or to exhaust it to the outdoors.

1. ~~Fan Power Limitation. At design conditions each fan system shall not exceed the allowable fan system power of option 1 or 2 as specified in Table 140.4-A~~ For each fan system with fan system input power greater than 1 kW, fan system input power at fan system design conditions shall not exceed W_{budget} as calculated below. All air flows will be converted to standard airflow. When exhaust/relief fans or return fans are present, the values for supply fan systems, exhaust/relief fan systems and return air systems shall be calculated separately. The pressure loss values in Table 140.4-B are only to be used to calculate this value.

In order to use the budget duct, plenum and inlet/outlet losses for a Multi-Zone VAV system, the fan system must meet the following requirements:

- Fan system must serve three or more space-conditioning zones and airflow to each must be individually controlled based on heating, cooling and/or ventilation requirements.
- Sum of the minimum airflows for each HVAC Zone must be 40% or less of the fan system design conditions. The fan system meets the requirements of section 140.4 (m).

Exception to 140.4(c)1 Hospital, vivarium, and laboratory systems that use flow control devices on exhaust and/or return to maintain space pressure relationships necessary for occupant health and safety or environmental control may use variable-volume fan power limitation.

Step 1: Calculate the budget fan brake horsepower (bhp_{budget})

$$bhp_{budget} = \frac{(Q_i + Q_o)(P_{budget} + P_o)C_A}{6343 \cdot 0.66 \cdot FEI_{budget}}$$

Where

bhp_{budget} = Budget Fan system brake horsepower (hp)

Q_i = Actual airflow at fan system design conditions (acfm)

Q_o = 250 acfm

P_{budget} = The sum of the budgeted fan system pressure losses from Table 140.4-B (in. H_2O)

P_o = 0.4 in. H_2O

C_A = Altitude density correction from Table 140.4-A

FEI_{budget} = 1.0 for return and exhaust/relief systems, and 1.2 for all other systems

Step 2: Calculate the budget belt-drive transmission efficiency.

$\eta_{trans,budget} = (bhp_{budget} / (bhp_{budget} + 2.2))^{0.05}$

Where

$\eta_{trans,budget}$ = The calculated efficiency of the reference transmission.

bhp_{budget} = Budget Fan system brake horsepower (hp)

Step 3: Calculate the budget reference transmission horsepower input.

$$H_{t,budget} = \frac{bhp_{budget}}{\eta_{trans,budget}}$$

Where

$H_{t,budget}$ = The budget reference transmission horsepower input.

bhp_{budget} = Budget Fan system brake horsepower (hp)

$\eta_{trans,budget}$ = The calculated efficiency of the reference transmission.

Step 4: Calculate the budget motor efficiency.

$$\eta_{mtr,budget} = A \cdot [\log_{10}(H_{t,budget} \times 0.7457)]^4 + B \cdot [\log_{10}(H_{t,budget} \times 0.7457)]^3 + C \cdot [\log_{10}(H_{t,budget} \times 0.7457)]^2 + D \cdot [\log_{10}(H_{t,budget} \times 0.7457)]^1 + E$$

Where

$\eta_{mtr,budget}$ = The budget motor efficiency.

$H_{t,budget}$ = The budget reference transmission horsepower input.

Constants are found in Table 140.4-C

Step 5: Calculate the budget fan system electrical power input

$$W_{budget} = \frac{H_{t,budget}}{\eta_{mtr,budget}}$$

Where

W_{budget} = Maximum allowed fan system input power

$H_{t,budget}$ = The budget reference transmission horsepower input.

$\eta_{mtr,budget}$ = The budget motor efficiency.

Table 140.4-A Correction Air Density by Altitude

Altitude (ft)	Correct factor
0	1.000
500	0.982
1,000	0.964
1,500	0.947
2,000	0.930
2,500	0.913
3,000	0.896
3,500	0.880
4,000	0.864
4,500	0.848
5,000	0.832
5,500	0.817
6,000	0.801
6,500	0.786
7,000	0.772
7,500	0.757
8,000	0.743
8,500	0.729
9,000	0.715
9,500	0.701
10,000	0.688
10,500	0.674
11,000	0.661

Table 140.4-B Budget Pressure Fan System Pressure Losses for Calculating P_{budget}

Budget Pressure Loss Components	**Multi-Zone VAV System[1]**	**Other Systems**
Select one of the following:		
Supply fan system duct, plenum and outlet	2.75	1.75
Exhaust/relief and return iinlet, plenum and duct	1.00	0.5
Particle filtration[2,3]		
Filter up to MERV 12	0.50	
Filter up to MERV 13 to MERV 16	0.90	
HEPA Filter	1.50	
Gas-phase filtration (select only 1)		
General odor control	0.50	
Special system allows reduction of annual outside air intake by 50%	1.00	
Heating		
Hydronic heating coil	0.30	
Electric heat	0.20	
Gas heat	0.20	
Cooling and dehumidification		
Hydronic or DX cooling coil	0.60	
Desiccant system – solid or liquid	0.70	
Series heat recovery	0.60	
Reheat coil	0.30	
Evaporative humidifier/cooler in series with a cooling coil	Pressure loss at 400 fpm or maximum velocity allowed by the manufactuere, whichever is less	
Energy recvoery[4] (applies 1 time each to both supply and exhaust/return fan systems)		
Enthalpy recovery	1.10	
Sensible only	0.60	

Special exhaust and return system requirements	
Return or exhaust systems required by code or accreditation standards to be fully ducted, or systems required to maintain air pressure differentials between adjacent rooms	0.5
Return and/or exhaust airflow control devices	0.5
Laboratory and vivararium exhaust systems	2.15
Laboratory and vivararium exhaust systems in high-rise buildings	0.25 per 100 ft of vertical duct exceeding 75 ft
Biosafety cabinet	Pressure drop of device at fan system design condition
Exhaust filters, scrubbers, or other exhaust treatment requried by code or standard	Pressure loss at 400 sfpm or maximum velocity allowed by the manufacturer, whichever is less
Other	
Air blender	0.2
Sound attenuation section (fans serving spaces with design background noise goals below NC35}	0.15
Velocity pressure to include airflow in termnial units that do not have a fan	0.25

1. See section for requirements 140.4 (c) 1 for Multi-Zone VAV System
2. Filters are to be counted only in the supply fan system
3. Each type of filter may only be counted once. Not more than 2 of the filters may be selected
4. Applied 1 time each to both supply and exhaust/relief or return fan systems

Table 140.4-C Constants for Budget Motor Efficiency Equation

Constants	$H_{t,budget}$ <250 hp	$H_{t,budget}$ ≥250 hp
A	-0.003812	0
B	0.025834	0
C	-0.072577	0
D	0.125559	0
E	0.850274	0.962

~~*TABLE 140.4 - A Fan Power Limitation*~~

	Limit	Constant Volume	Variable Volume
Option 1: Fan system motor nameplate hp	Allowable motor nameplate hp	$hp \leq cfm_s \times 0.0011$	$hp \leq cfm_s \times 0.0015$
Option 2: Fan system bhp	Allowable fan system bhp	$bhp \leq cfm_s \times 0.00094 + A$	$bhp \leq cfm_s \times 0.0013 + A$
[1]cfm_s = maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute hp = maximum combined motor nameplate horsepower for all fans in the system bhp = maximum combined fan-brake horsepower for all fans in the system A = sum of (PD x cfm_D/4131) PD = each applicable pressure drop adjustment from Table 140.4 – B, in inches of water cfm_D = the design airflow through each applicable device from Table 140.4 – B, in cubic feet per minute			

~~*TABLE 140.4-B – Fan Power Limitation Pressure Drop Adjustment*~~

Device	Adjustment Credits
Return or exhaust systems required by code or accreditation standards to be fully ducted, or systems required to maintain air pressure differentials between adjacent rooms	0.5 in. of water
Return and/or exhaust airflow control devices	0.5 in. of water
Exhaust filters, scrubbers, or other exhaust treatment	The pressure drop of device calculated at fan system design condition
Particulate Filtration Credit: MERV 16 and greater and electronically enhanced filters	Pressure drop calculated at 2 x clean filter pressure drop at fan system design condition
Carbon and other gas-phase air cleaners	Clean filter pressure drop at fan system design condition
Biosafety cabinet	Pressure drop of device at fan system design condition
Energy recovery device, other than coil runaround loop	For each airstream [(2.2 x Energy Recovery Effectiveness) – 0.5] in. of water
Coil runaround loop	0.6 in. of water for each airstream
Exhaust systems serving fume hoods	0.35 in. of water

2. Variable air volume (VAV) systems.

A. Static Pressure Sensor Location. Static pressure sensors used to control variable air volume fans shall be placed in a position such that the controller set point is no greater than one-third the total design fan static pressure, except for systems with zone reset control complying with Section140.4(c)2B. If this results in the sensor being located downstream of any major duct split, multiple sensors shall be installed in each major branch with fan capacity controlled to satisfy the sensor furthest below its setpoint; and

B. Setpoint Reset. For systems with direct digital control of individual zone boxes reporting to the central control panel, static pressure setpoints shall be reset based on the zone requiring the most pressure; i.e., the set point is reset lower until one zone damper is nearly wide open.

3. **Fractional HVAC Motors for Fans.**

HVAC motors for fans that are less than1 hp and 1/12 hp or greater shall be electronically-commutated motors or shall have a minimum motor efficiency of 70 percent when rated in accordance with NEMA Standard MG 1-2006 at full load rating conditions. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of a varying motor speed.

EXCEPTION 1 to Section 140.4(c)3: Motors in fan-coils and terminal units that operate only when providing heating to the space served.

EXCEPTION 2 to Section 140.4(c)3: Motors in space conditioning equipment certified under Section 110.1 or 110.2.

EXCEPTION ~~1~~ to 140.4(c): fan system power caused solely by process loads.

~~**EXCEPTION 2 to 140.4(c):** Systems serving healthcare facilities.~~

Standards

ANSI/AMCA Standard 208-2018- Calculation of the Fan Energy Index:
https://www.amca.org/publications-and-standards/standards/ansi/amca-standard-208-18-calculation-of-the-fan-energy-index.html

Proposal Summary

2022 California Energy Code (Title 24, Part 6)

Air Distribution – Fan Energy Index

Updated: Wednesday, September 25, 2019

Prepared by: Chad Worth, Energy Solutions

Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on November 5, 2019. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by November 19, 2019.

Measure Description

This submeasure proposes to implement a new efficiency metric for certain fans in the Title 24, Part 6 code language by requiring certain fans meet a minimum Fan Energy Index (FEI) at the design conditions. This measure is based in part on the recently adopted Addendum AO to ASHRAE Standard 90.1-2016 which sets an FEI of 1.0 for most fans generally not in packaged equipment (e.g. supply, exhaust fans, etc.) and an FEI of 0.95 for variable air-volume fans. The CASE Team is also considering higher FEI levels, such as those currently being considered in the ASHRAE 189.1 standard process where the FEI for most fans would be 1.1, or 10% more stringent than the 90.1 language. The FEI is an efficiency metric created by the Air Movement and Control Association (AMCA), an organization that sets standards for commercial and industrial air movement equipment. The metric and subsequent standards to develop FEI ratings have been pursued in collaboration with the Department of Energy and energy efficiency advocates, which started during a now-stalled federal rulemaking to develop commercial and industrial fan efficiency standards. FEI addresses a longstanding problem in characterizing fan efficiency; a fan's peak efficiency is often poorly correlated with its actual efficiency in typical operating conditions. The FEI metric is an easy method to encourage mechanical designers to make fan selections closer to a fan's peak efficiency, where the higher the FEI, the less energy is consumed.

Draft Code Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2019 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions). Expected sections or tables of the proposed code (but not specific changes at this time) are highlighted in yellow.

New Definitions

fan, embedded: A fan that is part of a manufactured assembly where the assembly includes functions other than air movement.

fan array: multiple fans in parallel between two plenum sections in an air distribution system.

fan nameplate electrical input power: the nominal electrical input power rating stamped on a fan assembly nameplate.

fan energy index (FEI): the ratio of the electric input power of a reference fan to the electric input power of the actual fan as calculated per AMCA 208 at fan system design conditions.

fan system electrical power: the sum of the fan electrical power of all fans that are required to operate at fan system design conditions to supply air from the heating or cooling source to the conditioned spaces and/or return it to the source or exhaust it to the outdoors.

Standard

Each fan and *fan array at fan system design conditions* shall have a *fan energy index (FEI)* of 1.00/ 1.XX or higher. Each fan and *fan array* used for a *variable-air-volume system* shall have an *FEI* of 0.95/ X.XX or higher *at fan system design conditions*. The *FEI* for *fan arrays* shall be calculated in accordance with AMCA 208 Annex C.

Where:

- All fans and associated FEI values shall be listed in the Air Movement and Controls (AMCA) FEI database or be derived from selection software that is AMCA certified to export FEI values.

Exemptions under consideration:

1. Fans that are not embedded fans with a motor nameplate horsepower of less than 1.0 hp or with a fan nameplate electrical input power of less than 0.89 kW.
2. Embedded fans and fan arrays with a combined motor nameplate horsepower of 5 hp or less or with a fan system electrical input power of 4.1 kW or less.
3. Embedded fans that are part of equipment listed under Section 110.2 (Mandatory Requirements for Space Conditioning Equipment)
4. Embedded fans included in equipment bearing a third-party-certified seal for air or energy performance of the equipment package.
5. Ceiling fans, i.e., nonportable devices suspended from a ceiling or overhead structure for circulating air via the rotation of fan blades.
6. Fans used for moving gases at temperatures above 482°F.
7. Fans used for operation in explosive atmospheres.
8. Reversible fans used for tunnel ventilation.
9. Fans outside the scope of AMCA 208.
10. Fans that are intended to only operate during emergency conditions.

Standards

ANSI/AMCA Standard 208-2018- Calculation of the Fan Energy Index: https://www.amca.org/publications-and-standards/standards/ansi/amca-standard-208-18-calculation-of-the-fan-energy-index.html

Reference Appendices

Learn more about FEI:

- https://www.amca.org/advocate/energy-efficiency/about-fan-energy-index/
- https://www.online.colostate.edu/brochures/amca/fan-energy-index-brief/
- http://www.nxtbook.com/nxtbooks/ashrae/ashraejournal_amca_2018fall_v2/index.php#/1

Proposal Summary

2022 California Energy Code (Title 24, Part 6)

Air Distribution – Expand Duct Leakage Testing

Updated: Thursday, October 31, 2019

Prepared by: Benny Zank, Energy Solutions

Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on November 5, 2019. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by November 19, 2019.

Measure Description

New prescriptive duct leakage requirements for nonresidential buildings that utilize VAV supply-air systems running through ceiling-plenum returns, toilet exhaust systems, and general exhaust systems. In all three cases, ductwork will be required to meet Sealing Class A. VAV supply-air duct systems will be required to not exceed leakage rates of 4 percent upstream, plus 4 percent downstream of the VAV boxes. Exhaust duct systems will be required to not exceed leakage rates of 6 percent. Testing requirements will be based on either ANSI/ASHRAE Standard 215-2018: Method of Test to Determine Leakage of Operating HVAC Air Distribution Systems or the SMACNA System Air Leakage Test (SALT) Manual for VAV supply-air systems and ASTM E1554, SMACNA SALT Manual, or SMACNA Air Duct Leakage Test (DALT) Manual for exhaust systems.

Draft Code Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2019 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions). Sections or tables of the proposed code for which exact change are not yet specified are highlighted in yellow.

Standards

SECTION 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

Section 140.4 (l) Air Distribution System Duct Leakage Sealing. Duct systems shall be sealed in accordance with 1 or 2 below:

1. Systems serving high-rise residential buildings, hotel/motel buildings and nonresidential buildings other than healthcare facilities, the duct system shall be sealed to a leakage rate not to exceed 6 percent of the

nominal air handler airflow rate as confirmed through field verification and diagnostic testing, in accordance with the applicable procedures in Reference Nonresidential Appendices NA1 and NA2. if the criteria in Subsections A, B and C below are met:

A. The duct system provides conditioned air to an occupiable space for a constant volume, single zone, space-conditioning system; and
B. The space conditioning system serves less than 5,000 square feet of conditioned floor area; and
C. The combined surface area of the ducts located in the following spaces is more than 25 percent of the total surface area of the entire duct system:
   i. Outdoors; or
   ii. In a space directly under a roof that
      a. Has a U-factor greater than the U-factor of the ceiling, or if the roof does not meet the requirements of Section 140.3(a)1B, or
      b. Has fixed vents or openings to the outside or unconditioned spaces; or
   iii. In an unconditioned crawlspace; or
   iv. In other unconditioned spaces.

2. ~~Duct systems serving healthcare facilities shall be sealed in accordance with the California Mechanical Code.~~ For all VAV supply-air systems with ceiling plenum returns serving hotel/motel buildings and nonresidential buildings, the ductwork shall be sealed to conform with Sealing Class A. The air distribution system shall be sealed to a leakage rate not to exceed 4 percent of the design air handler flowrate upstream of the VAV box, and 4 percent of the design airflow rate downstream of the VAV box. The leakage rates shall be confirmed through field verification and diagnostic testing, in accordance with the applicable procedures in Reference Nonresidential Appendices NA1 and NA2.
3. For toilet exhaust systems, and general exhaust systems serving hotel/motel buildings and nonresidential buildings, the ductwork shall be sealed to conform with Sealing Class A. The air distribution system shall be sealed to a leakage rate not to exceed 6 percent of the design air handler airflow. The leakage rates shall be confirmed through field verification and diagnostic testing, in accordance with the applicable procedures in Reference Nonresidential Appendices NA1 and NA2.

SECTION 141.0 – ADDITIONS, ALTERATIONS, AND REPAIRS TO EXISTING NONRESIDENTIAL, HIGH-RISE RESIDENTIAL, AND HOTEL/MOTEL BUILDINGS, TO EXISTING OUTDOOR LIGHTING, AND TO INTERNALLY AND EXTERNALLY ILLUMINATED SIGNS

141.0(b)2D Altered Duct Systems. When new or replacement space-conditioning system ducts are installed to serve an existing building, the new ducts shall meet the requirements of Section 120.4. If the space conditioning system meets the criteria of Section 140.4(l)~~1~~, The duct system shall be sealed as confirmed through field verification and diagnostic testing in accordance with the procedures for duct sealing of an existing duct system as specified in Reference Nonresidential Appendix NA2, to meet one of the following requirements:

Reference Appendices

NA1.9.1 Duct Leakage Verification by the Acceptance Test Technician

Under this alternative procedure, when the Certificate of Compliance indicates that field verification and diagnostic testing of duct leakage is required as a condition for compliance with Title 24, Part 6 a certified ATT may perform the duct leakage verification to satisfy the condition of compliance, at the discretion of the enforcement agency. Systems verified under this procedure are not eligible for sampling.

NA2.1.1 Purpose and Scope

1. NA2.1 contains procedures for field verification and diagnostic testing for air leakage ~~in single zone, constant volume, nonresidential air distribution systems serving zones with 5000 ft² of conditioned floor area or less~~ as required by Standards section 140.4(l)~~1~~.

2. NA2.1 procedures are applicable to new space conditioning systems in newly constructed buildings and to new or altered space conditioning systems in existing buildings.

3. NA2.1 procedures shall be used by installers, HERS Raters, and others who perform field verification of air distribution systems as required by Standards Section 140.4(l)~~1~~.

4. Table NA2.1-1 provides a summary of the duct leakage verification and diagnostic test protocols included in Section NA2.1, and the compliance criteria.

NA2.1.4.2 Diagnostic Duct Leakage

Diagnostic duct leakage measurement shall be used by installers and HERS Raters to verify that duct leakage meets the compliance criteria for sealed duct systems for which field verification and diagnostic testing is required. Table NA2.1-1 summarizes the leakage criteria and the diagnostic test procedures that shall be used to demonstrate compliance.

Table NA2.1-1 – Duct Leakage Verification and Diagnostic Test Protocols and Compliance Criteria

Case	User and Application	Leakage Compliance Criteria, (% of Nominal Air Handler Airflow)	Procedure(s)
Sealed and tested new duct systems, defined by Standards section 140.4(l)1	Installer Testing HERS Rater Testing	6%	NA2.1.4.2.1
Sealed and tested new duct systems, defined by Standards section 140.4(l)2	TBD	4% upstream of VAV boxes & 4% downstream of VAV boxes	NA2.1.4.2.5 or NA2.1.4.2.6
Sealed and tested new duct systems, defined by Standards section 140.4(l)3	TBD	6%	NA2.1.4.2.1 or NA2.1.4.2.7
Sealed and tested altered existing duct systems, defined by Standards section 140.4(l)1	Installer Testing HERS Rater Testing	15%	NA2.1.4.2.1
Sealed and tested altered existing duct systems, defined by Standards section 140.4(l)2	TBD	xx	NA2.1.4.2.5 or NA2.1.4.2.6
Sealed and tested altered existing duct systems, defined by Standards section 140.4(l)3	TBD	xx	NA2.1.4.2.1 or NA2.1.4.2.7
Sealed and tested altered existing duct systems	Installer Testing and Inspection HERS Rater Testing and Verification	Fails Leakage Test but All Accessible Ducts are Sealed Inspection and Smoke Test with 100% Verification	NA2.1.4.2.2 NA2.1.4.2.3 NA2.1.4.2.4

NA2.1.4.2.1 Diagnostic Duct Leakage from Fan Pressurization of Ducts

The objective of this procedure is for an installer to determine and a HERS Rater to verify the leakage of a new or altered duct system. The duct leakage shall be determined by pressurizing the entire duct system ducts to 25 Pa (0.1 inches water) with respect to outside. The following procedure shall be used for the fan pressurization tests:

(a) Verify that the air handler, supply and return plenums and all the connectors, transition pieces, duct boots, and registers are installed, and ensure the following locations have been sealed:

1. Connections to plenums and other connections to the air-handling unit.

2. Refrigerant line and other penetrations into the air-handling unit.

3. Air handler access door or panel (do not use permanent sealing material, metal tape is acceptable).

The entire duct system including the air- handler shall be included in the test.

(b) For newly installed or altered ducts, verify that cloth backed rubber adhesive duct tape has not been used.

(c) Temporarily seal all the supply registers and return grilles, except for one large centrally located return grille or the air handler cabinet access door or panel. Verify that all outside air dampers and/or economizers are sealed prior to pressurizing the system.

(d) Attach the fan flowmeter device to the duct system at the unsealed return grille or the air handler cabinet access door or panel.

(e) Install a static pressure probe at a supply register located close to the air handler, or at the supply plenum.

(f) Adjust the fan flowmeter to produce a positive 25 Pa (0.1 inches water) pressure at the supply register or the supply plenum with respect to the outside or with respect to the building space with the entry door open to the outside.

(g) Record the flow through the flowmeter, this is the duct leakage flow at 25 Pa (0.1 inches water).

(h) Divide the duct leakage flow by the nominal air handler airflow determined by the procedure in Section NA2.1.4.1 and convert to a percentage. If the duct leakage flow percentage is equal to or less than the target compliance criterion from Table NA2.1-1, the system passes.

NA2.1.4.2.2 Sealing of All Accessible Leaks

For altered existing duct systems that are unable to pass the leakage test in Section NA2.1.4.2.1, the objective of this test is to verify that all accessible leaks are sealed. The following procedure shall be used:

(a) Complete the leakage test specified in Section NA2.1.4.2.1.

(b) Seal all accessible ducts.

(c) After sealing is complete, again use the procedure in NA2.1.4.2.1 to measure the leakage after duct sealing.

(d) Complete the Smoke Test as specified in NA2.1.4.2.3.

(e) Complete the Visual Inspection as specified in NA2.1.4.2.4.

All duct systems that fail to pass the leakage test specified in Section NA2.1.4.2.1 shall be tested and inspected by a HERS Rater to verify that all accessible ducts have been sealed and damaged ducts have been replaced. Compliance with HERS verification requirements shall not utilize group sampling procedures when the installer used the Sealing of All Accessible Leaks procedure in Section NA2.1.4.2.2.

NA2.1.4.2.3 Smoke-Test of Accessible-Duct Sealing

For altered existing ducts that fail the leakage tests, the objective of the smoke test is to confirm that all accessible leaks have been sealed. The following procedure shall be used:

(a) Inject either theatrical or other non-toxic smoke into a fan pressurization device that is maintaining a duct pressure difference of 25 Pa (0.1 inches water) relative to the duct surroundings, with all grilles and registers in the duct system sealed.

(b) Visually inspect all accessible portions of the duct system during smoke injection.

(c) The system shall pass the test if one of the following conditions is met:

1. No visible smoke exits the accessible portions of the duct system.

2. Smoke only emanates from the furnace cabinet which is gasketed and sealed by the manufacturer and no visible smoke exits from the accessible portions of the duct system.

NA2.1.4.2.4 Visual Inspection of Accessible Duct Sealing

For altered existing duct systems that are unable to pass the leakage test in Section NA2.1.4.2.1, the objective of this inspection in conjunction with the smoke test (Section NA2.1.4.2.3) is to confirm that all accessible leaks have been sealed. Visually inspect to verify that the following locations have been sealed:

(a) Connections to plenums and other connections to the air-handling unit.

(b) Refrigerant line and other penetrations into the air-handling unit.

(c) Air handler access door or panel (do not use permanent sealing material, metal tape is acceptable).

(d) Register boots sealed to surrounding material.

(e) Connections between lengths of duct, as well as connections to takeoffs, wyes, tees, and splitter boxes

NA2.1.4.2.5 Diagnostic Duct System Leakage from Fan Pressurization of Ducts

(a) The system shall be prepared according to SMACNA System Air Leakage Testing Manual Chapter 5.1 Pre-test Activities.

(b) 100% of the duct work shall be tested according to SMACNA System Air Leakage Testing Manual Chapter 5.2 General Procedures.

(c) >20% or three of each accessory/equipment type, whichever is greater, shall be tested according to SMACNA System Air Leakage Testing Manual Chapter 5.3 “Isolated Item Test (IIT)” For Inline Accessories and Equipment.

NA2.1.4.2.6 Diagnostic Duct System Leakage of Operating HVAC Air Distribution System

(a) Ductwork shall be leak tested according to the California Mechanical Code Section 603.10.1 during the construction process

(b) When the system is fully constructed and operational, it shall be tested according to ANSI/ASHRAE Standard 215-2018: Method of Test to Determine Leakage of Operating HVAC Air Distribution Systems.

NA2.1.4.2.7 Diagnostic Exhaust System Leakage from Fan Pressurization of Ducts

(a) The system shall be prepared according to SMACNA System Air Leakage Testing Manual Chapter 5.1 Pre-test Activities.

(b) 100% of the duct work shall be tested according to SMACNA System Air Leakage Testing Manual Chapter 5.2 General Procedures.

The SMACNA Air Duct Leakage Test Manual is also being considered for exhaust systems.

NA7.5.3 Air Distribution Systems

NA7.5.3.2 Functional Testing

Step 1: Perform duct leakage test as specified by Reference Nonresidential Appendix NA2 to verify the duct leakage conforms to the requirements of Standards §140.4(l)~~1~~ and §141.0(b)2D.

Step 2: Obtain HERS Rater field verification as specified in Reference Nonresidential Appendix NA1. Or at the discretion of the enforcement agency, field verification may be satisfied by the ATT as specified in Reference Nonresidential Appendix NA1.9.

References:

California Mechanical Code: http://epubs.iapmo.org/2019/CMC/mobile/index.html#p=164

ANSI/ASHRAE Standard 215-2018:
https://webstore.ansi.org/standards/ashrae/ansiashraestandard2152018

SMACNA System Air Leakage Test Manual:
https://www.smacna.org/news/latest/archives/2019/10/31/for-public-review-smacna-system-air-leakage-test-standard

SMACNA Air Duct Leakage Test Manual: https://www.smacna.org/store/product/hvac-air-duct-leakage-test-manual