Proposal Summary

2022 California Energy Code (Title 24, Part 6)

Air Distribution – Expand Duct Leakage Testing

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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 March 12, 2020. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com.

Measure Description

During the first utility-sponsored stakeholder meeting, which was held on November 5, 2019, the Statewide CASE Team presented an potential code change proposal to require leakage testing of entire air distribution systems. As of January 1, 2020, the California Mechanical Code (CMC) requires substantial changes to Title 24, Part 4 controlling duct leakage[i]. Both testing and allowed level of leakage for all ducted systems are established by Section 603.10.1 of the CMC. The section states, "Representative sections totaling not less than 10 percent of the total installed duct area shall be tested." If the 10 percent fails to meet the requirements, 40 percent shall be tested. If the 40 percent fails, 100 percent needs to be tested. The duct work must meet Leakage Class 6. The Statewide CASE Team is developing clarifying language in the reference appendices of Title 24, Part 6, detailing how the testing is to be executed, as well as compliance documentation.

The Statewide CASE Team is also proposing mandatory requirements of Seal Class A for all ductwork and VAV box leakage certification by ASHRAE 130 or field testing by the SMACNA System Air Leakage Test Manuals[ii]. This proposal aligns with the sealing requirements in ASHRAE 90.1.

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 100.1 – DEFINITIONS AND RULES OF CONSTRUCTION

DUCT SYSTEM is all the ducts, duct fittings (including but not limited to spin-ins, taps, or other branch connections), plenums, access doors, access panels, accessories, and fans when assembled to form a continuous passageway for the distribution of air.

SECTION 120.4 – REQUIREMENTS FOR AIR DISTRIBUTION SYSTEM DUCTS AND PLENUMS

Nonresidential, high-rise residential, and hotel/motel buildings shall comply with the applicable requirements of Sections 120.4(a) through 120.4(f).

~~**EXCEPTION to Section 120.4:** Systems serving healthcare facilities shall comply with the applicable requirements of the California Mechanical Code.~~

(a)**CMC Compliance.** All air distribution system ducts and plenums, including, but not limited to, building cavities, mechanical closets, air-handler boxes and support platforms used as ducts or plenums, shall meet the requirements of the CMC Sections 601.0, 602.0, 603.0, 604.0, 605.0, and ANSI/SMACNA-006-2006 HVAC Duct Construction Standards Metal and Flexible 3rd Edition, incorporated herein by reference. Connections of metal ducts and the inner core of flexible ducts shall be mechanically fastened. Openings shall be sealed with mastic, tape, aerosol sealant, or other duct-closure system that meets the applicable requirements of UL 181, UL 181A, or UL 181B. If mastic or tape is used to seal openings greater than 1/4 inch, the combination of mastic and either mesh or tape shall be used.

All ducts systems not covered by 140.4(l)1 shall comply with the leakage requirements in the California Mechanical Code Section 603.10.1. Leakage rates shall be confirmed through field verification and diagnostic testing, in accordance with the applicable procedures in Reference Nonresidential Appendices NA1 and NA2.

Portions of supply-air and return-air ducts conveying heated or cooled air located in one or more of the following spaces shall be insulated to a minimum installed level of R-8:

1. Outdoors; or
2. In a space between the roof and an insulated ceiling; or
3. In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces; or
4. In an unconditioned crawlspace; or
5. In other unconditioned spaces.

Portions of supply-air ducts that are not in one of these spaces, including ducts buried in concrete slab, shall be insulated to a minimum installed level of R-4.2 or be enclosed in directly conditioned space.

(b) **Duct and Plenum Materials.**

1. Factory-fabricated duct systems.

D. All connections shall be sealed, including but not limited to spin-ins, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. All duct pressure class ratings shall be designated in the design documents. Joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

2. Field-fabricated duct systems.

D. All connections shall be sealed, including but not limited to spin-ins, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. All duct pressure class ratings shall be designated in the design documents. Joints and seams of duct systems and their components

shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

(g) Air Distribution Accessories

Single duct air terminal units shall not exceed the leakage allowances specified in the Table 120.4-A and dual duct air terminal units shall not exceed the leakage allowances specified in Table 120.4-B. Single and dual duct terminal units shall either be third party certified at the discretion of the Energy Commission to ASHRAE 130 or their leakage determined through field verification and diagnostic testing, in accordance with the applicable procedures in Reference Nonresidential Appendices NA2.

Table 120.4-A: Single Duct Air Terminal Unit Leakage Requirements (All Casing and Appurtenance Leakages are Additive)

Damper Leakage Tested at 1" Differential Pressure Casing and Downstream Appurtenances Leakage Tested at 0.5" Differential Pressure							
Inlet Size	AHRI Nominal Rating (CFM)	Damper Max Leakage (CFM)	Casing Max Leakage (CFM)	Appurtenances			
				Max.	Water Coil Max. Leakage Per Additional Row (CFM)	Electric Heater Max. Leakage (CFM)	Multiple Outlet Plenum Max. Leakage (CFM)
4"	150	8	4	2	2	6	4
5"	250	8	4	2	2	6	4
6"	400	8	4	2	2	6	4
7"	550	14	7	3	2	8	6
8"	700	14	7	3	2	8	6
9"	900	22	11	4	6	10	8
10"	1100	22	11	4	6	10	8
12"	1600	32	16	8	12	10	8
14"	2100	42	21	10	15	12	12
16"	2800	56	28	12	18	12	15

16”x24”	5350	107	53	15	21	15	26

Table 120.4-B: Dual Duct Air Terminal Unit Leakage Requiements

Damper Leakage Tested at 6” Differential Pressure Casing Leakage Tested at 1” Differential Pressure (casing leakage determined by largest inlet size)			
Inlet Size	AHRI Nominal Rating (CFM)	Maximum Leakage per Damper (CFM)	Casing Maximum Leakage (CFM)
4”	150	12	6
5”	250	12	6
6”	400	12	6
7”	550	21	11
8”	700	21	11
9”	900	33	17
10”	1100	33	17
12”	1600	48	24
14”	2100	63	32
16”	2800	84	42

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 ft^2 of conditioned floor area or less~~ as required by Standards section 140.4(l)1 and 120.4(a).

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)	Installer Testing HERS Rater Testing	6% of Nominal Air Handler Airflow	NA2.1.4.2.1
All remaining sealed and tested new duct systems	TBD	Leakage Class 6	NA2.1.4.2.5
Sealed and tested altered existing duct systems, defined by Standards section 140.4(l)	Installer Testing HERS Rater Testing	15%	NA2.1.4.2.1

NA2.1.4.2.5 Diagnostic Duct Leakage from Fan Pressurization of Ducts

The objective of this procedure is for an installer to determine and an XX to verify the leakage of a new duct system. In the case of CAV supply-air systems, 10% of the duct work shall be tested. In the case of VAV supply-air systems, 10% of ductwork upstream of VAV air valves and 10% of ductwork downstream of VAV air valves shall be tested. In the case of systems that employ VAV diffusers, test in the same manner as a CAV system. For exhaust fan systems, 10% of the systems, or at least one system, whichever is greater, shall be tested in its entirety.

Sections of ductwork to be tested for compliance purposes shall be selected jointly by the building owner or building owner's representative and the testing professional. All ductwork that will become inaccessible shall be tested. The sections to be tested shall be selected from all the ductwork prior to being covered up, by random sampling to meet the above percentages of the total duct surface area for the entire building. At least 25% of the testing shall be performed before 50% of the ductwork (by surface area) has been installed, and at least 40% of the testing shall be performed once at least 90% of the ductwork (by surface area) has been installed:

(a) Select test pressure equal to the lowest pressure class of any component or ductwork section of the assembly being tested
    a. When testing downstream of VAV air valves, test at 25 Pa (0.1 i.w.c.)

b. When testing downstream of CAV terminal boxes or branch balancing dampers, test at 50% of the upstream pressure class

(b) When testing 10% of ductwork downstream of VAV air valves, section selection shall be representative of the downstream sections found in the building (e.g. similar type and number of diffusers, similar design flow, similar total duct length)

(c) Calculate maximum permitted leakage according to 603.10.1 of the California Mechanical Code:

a. Maximum permitted leakage is calculated according to the following equation:

$$L_{max} = CL * P^{0.65}$$

Where:

L_{max} = maximum permitted leakage, (cfm/min)/100 ft^2 of duct surface area

CL = six, duct leakage class (cfm/min)/100 ft^2 duct surface area at 1 inch water column

P = test pressure, equal to the design duct pressure class rating, inch water column

b. The total leakage flow (cfm) at the pressure conditions specified in a. shall be equal to the sum of the leakage flows from all the sections being tested.

c. The total leakage flow shall be less than the product of the allowable percentage leakage multiplied by the design flow through the section being tested.

d. For VAV supply systems, the leakage calculation shall be performed separately for sections upstream and downstream of VAV air valves.

e. For CAV supply systems with terminal boxes (e.g. with reheat coils), the leakage calculation shall be performed separately for sections upstream and downstream of the terminal boxes.

(d) Connect blower and flow meter to duct or equipment section and temporarily seal open ends of ductwork or equipment

(e) Prevent over pressurizing by starting with the test apparatus inlet damper closed or VFD set to low delivery. Carefully pressurize.

(f) Read flow meter and compare to allowed leakage from c. If it meets the allowed rate continue, otherwise:

a. Inspect for sensible leaks

b. Smoke test can be used to identify actual leaks. Soap solution can be applied if necessary:

i. 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.

ii. Visually inspect all accessible portions of the duct system during smoke injection.

iii. 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.

c. Depressurize and repair leaks. If test pressure could not be reached and significant leak sites were not detected, consider smaller sections or larger test bigger apparatus.

d. Allow seals to cure and retest.

(g) Complete test report and obtain witness signature, if required.

(h) Remove temporary plugs and seals

(i) For terminal units whose leakage is not certified, at least 20% of the units, or three units, whichever is greater, shall be tested according to the following procedure:

a. Note: it is acceptable to test a VAV box plus downstream ductwork and diffusers simultaneously rather than separately.
b. Note: for stand-alone testing leakage of VAV boxes, if the air valve is located at the entry of the box, the measured leakage shall be added to the leakage downstream of the VAV air valve. If the air valve is located at the exit of the box, the measured leakage shall be added to the leakage upstream of the VAV air valve, and testing shall be performed at a pressure equal to the pressure of the upstream ductwork,
c. Assemble a portion of duct suitable for installation of the terminal unit.
d. Test the duct to determine its leakage according to the procedure in (c), (d), (e), (f), and (g).
e. Install the terminal united to be tested into the duct.
f. Verify that the product is installed in accordance with the plans and specifications, local codes and manufacturer's instructions. This shall be witnessed and approved.
g. Retest the duct/terminal unit assembly according to the procedure in (c), (d), (e), (f), and (g).
h. Document the leakage for duct/terminal unit assembly
i. Where the tested 20 percent fail to the requirements in Table 120.4-A or 120.4-B, then 40 percent of the terminal units shall be tested. Where the tested 40 percent fail to meet the requirements in Table 120.4-A or 120.4-B then 100 percent of the terminal units shall be tested.

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