DENVER AMENDMENT PROPOSAL FORM
FOR PROPOSALS TO THE 2019 DENVER BUILDING CODE AMENDMENTS AND THE 2021 INTERNATIONAL CODES

2021 CODE DEVELOPMENT CYCLE

1) Name: **John Arent** **Date:** **5/28/2022**
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2) One proposal per this document is to be provided with clear and concise information.

Is a separate graphic file provided ("X" to answer): ___ Yes or _x__ No

3) Highlight the code and acronym that applies to the proposal

Acronym	Code Name	Acronym	Code Name
DBC-AP	Denver Building Code–Administrative Provisions	**IPC**	International Plumbing Code
IBC	International Building Code	**IRC**	International Residential Code
IECC	International Energy Conservation Code	**IFGC**	International Fuel Gas Code
IEBC	International Existing Building Code	**IMC**	International Mechanical Code
IFC	International Fire Code	**DGC**	Denver Green Code

Please provide all the following items in your amendment proposal.

Code Sections/Tables/Figures Proposed for Revision:
Instructions: If the proposal is for a new section, indicate (new), otherwise enter applicable code section.

C403.8.1

Table C403.8.1 is modified by removing the nameplate horsepower compliance option as a prescriptive option. The fan brake horsepower totals are revised lower, and dependent on the supply airflow for system.

C403.8 Fans and fan controls. Fans in HVAC systems shall comply with **Sections C403.8.1** through **C403.8.6.1**.

C403.8.1 Allowable fan horsepower. Each HVAC system having a total fan system ~~motor nameplate~~ brake horsepower exceeding ~~5~~1 bhp ~~(~~0.75 kW ~~3.7 kW)~~ at fan system design conditions shall not exceed the allowable *fan system motor nameplate hp* (Option 1) or *fan system bhp* (Option 2) shown in **Table C403.8.1(1)**. This includes supply fans, exhaust fans, return/relief fans, and fan-powered terminal units associated with systems providing heating or cooling capability. Single-zone variable air volume systems shall comply with the constant volume fan power limitation. Systems that provide continuous ventilation while occupied must meet the requirements of Option 2 in Table C403.8.1(1).

Exceptions:
1. Hospital, vivarium and laboratory systems that utilize flow control devices on exhaust or return to maintain space pressure relationships necessary for occupant health and safety or environmental control shall be permitted to use variable volume fan power limitation.
2. Individual exhaust fans with motor nameplate horsepower of 1 hp (0.746 kW) or less are exempt from the allowable fan horsepower requirement.

3. Replacement of existing HVAC equipment with new equipment on an existing building, if no ductwork is altered, shall meet the requirements of Table C403.8.1(2) .

TABLE C403.8.1(1)
FAN POWER LIMITATION

	LIMIT	**Supply Airflow**	**CONSTANT VOLUME**	**VARIABLE VOLUME**
Option 1: Fan system motor nameplate hp	Allowable nameplate motor hp	Not Supported	HP < CFMs x 0.00088	~~Not Supported~~ HP < CFMs x 0.0014
Option 2: Fan system bhp, includes dedicated ventilation	Allowable fan system bhp	< 2000 ≥2,000 and <10,000 > 10.000	bhp < CFM x 0.00075 + A	bhp < 0.00089 + A bhp < 0.00102 + A bhp < 0.0013 + A

TABLE C403.8.1(2)
FAN POWER LIMITATION,
EXISTING BUILDINGS, NO ALTERED DUCTWORK

	Limit	**Constant Volume**	**Variable Volume**
Option 1: Fan system motor nameplate hp	**Allowable nameplate motor hp**	**hp < CFMs x 0.0011**	**hp < CFMs x 0.0015**
Option 2: Fan system bhp	**Allowable fan system bhp**	**bhp < CFMs x 0.00094 + A**	**bhp < CFM x 0.0013 + A**

Supporting Information:
All proposals must include a written explanation and justification as to how they address physical, environmental, and/or customary characteristics that are specific to the City and County of Denver. The following questions must be answered for a proposal to be considered.

- Purpose: What does your proposal achieve?
- Reason: Why is your proposal necessary?
- Substantiation: Why is your proposal valid? (i.e. technical justification)

Purpose: this proposal revises the fan power allowance for systems that provide heating, cooling and ventilation. Through reduction in statis pressure of ductwork, fan systems can achieve significant energy savings. This is especially important for smaller systems with constant volume fans, that currently do not have requirements for fan power. A related recommended change is to remove the fan power adjustment for systems with modest amounts of filtration (MERV 8- MERV 11) and reduce the fan power pressure drop credit for MERV 13 filtration.

Reason: High fan power in light commercial systems that continuously provide ventilation can result in annual fan energy use as high as cooling energy use. While the requirements for fan energy are somewhat design dependent, it is normally feasible to design for lower system fan power with careful duct design and sizing. The energy savings benefits are greatest for systems that are continuously operating to provide ventilation. Units that provide cooling and heating but no ventilation, such as units used with a dedicated outside air system, will see less of an impact from improved fan energy requirements.

A compelling reason for improving distribution system performance is the resiliency of the measure. For most buildings, the duct system will remain in place unaltered after (rooftop) cooling and heating equipment is replaced.

With decentralized, packaged HVAC systems, there are few opportunities for code improvement. In addition to federal preemption, nearly all system features and control options that can be specified are already required by code. Fans and associated distribution systems present a good opportunity for energy reduction.

Substantiation: Recent code proposals are under consideration by California and ASHRAE 90.1. Methods of improving fan power include: (1) reduction of required fan power through distribution system improvements, (2) improved fan system selection with the Fan Energy Index, and (3) expanded duct leakage testing requirements. Of these submeasures, NORESCO is proposing the fan power limit revision move forward as a priority for Denver IECC Amendments.

This is a summary rationale of a similar measure proposed for the CA 2022 Title 24 Building Energy Efficiency Standards. A similar measure is being discussed by the ASHRAE 90.1 mechanical subcommittee.

Title 24 Proposal Excerpt: Fan Power Budget

The fan power budget submeasure would update the current methodology used to calculate prescriptive fan power limitations for fan systems. The submeasure would expand the current scope from all space conditioning fan systems ≥ 5 nameplate HP to ≥ 1 kW (which is roughly 1 nameplate HP). The submeasure would create new, clear definitions for fan systems as the fan power budget would apply separately to supply fan systems and to return/relief/exhaust fan systems. Each fan system would be allocated a fan power budget (kW) as function of the airflow (cfm), system type, and components in the fan system. The fan power budget submeasure would apply to new construction, alterations and additions. As a prescriptive measure it would require changes to the Alternative Calculation Method (ACM) Reference Manual and the compliance software. It should be noted there is a similar proposal being proposed for consideration as an addendum to American Society of Heating, Refrigerating and Air-Conditioning Engineers Standard 90.1-2019 (ASHRAE 90.1-2019). At the time the Final CASE Report was posted for public review, the proposal is being discussed within the ASHRAE 90.1 mechanical subcommittee.

The table excerpt from Energy Solutions (2020) shows the reduction in static pressure typically needed to meet the proposed fan limits established in the 2022 Title 24 Standards (under 45-day language review).

Table 31: Modeled Duct External Static Pressure Values for Large Office Prototype

HVAC Type	System Type	Calculated Airflow (cfm)	Standard Design (2019) Target ESP (in. wg)	Proposed Design (2022) Target ESP (in. wg)	2022 Design Layout ESP (in. wg)
Mixed-Air Design	VAV Supply	18,375	2.25	1.78	1.76
	VAV Return	18,375	1.5	1.21	0.46
100% Outside Air Design	CAV Supply	7,765	1.25	1.23 [a]	1.2
	CAV Return	7,765	1	0.84	0.45

Source: Statewide CASE Team

a. In the case of the 100 percent outside air CAV fan system, an extra 0.5 inches of pressure is allocated under the reference pressure tables. See Table 128.

The approach taken here is to return fan power requirements but retain the basic structure of the 90.1 / IECC tables. The California approach is much more involved, with requirements disaggregated into individual fans and system components.

Bibliography and Access to Materials (as needed when substantiating material is associated with the amendment proposal):

2 Worth, Chad et. al. 2020. “Air Distribution: High Performance Ducts and Fan Systems”. 2022-NR-HVAC2-F | Nonresidential HVAC, IOU Codes and Standards Team Final CASE Report, September 2020.

Glazer, J. Development of Maximum Technically Achievable Energy
Targets for Commercial Buildings – Ultra-Low Energy Use Building Set. ASHRAE 1651-RP. December 2015

Stein, J. 2014-2016. Guidance to California Title 24 update included a review of fan power requirements against project data from several dozen projects.

Other Regulations Proposed to be Affected

***For proposals to delete content from the 2019 Denver Green Code in conjunction with adding it to other mandatory Denver codes and/or regulations, only.**

Please identify which other mandatory codes or regulations are suggested to be updated (if any) to accept relocated content.

Referenced Standards :

List any new referenced standards that are proposed to be referenced in the code.

ASHRAE 90.1 Mechanical Subcomittee proceedings
Title 24-2022 Building Energy Efficiency Standards, May 2021 (45-day Language Review Draft).

Impact:

How will this proposal impact cost and restrictiveness of code? (”X” answer for each item below)

There could be a slight increase in construction and design, due to improved duct design and layour.

Cost of construction:	_x__ Increase	___ Decrease	___ No Impact
Cost of design:	_x_ Increase	___ Decrease	_x_ No Impact
Restrictiveness:	___ Increase	___ Decrease	_x_ No Impact