CECD1-XX-22 Fan Power

IECC: C403.8.1, TABLE C403.8.1(1), TABLE C403.8.1(2), TABLE C403.8.1(3), TABLE C403.8.1(4), C403.8.1.1, C403.8.1.2, C403.8.2, C403.8.3, C403.8.4, C403.8.5, TABLE C403.8.5, C403.8.6, C403.8.6.1, TABLE C403.8.6.1

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2024 International Energy Conservation Code [CE Project]

Revise as follows:

C403.8.1 Allowable Fan horsepower. ~~For each fan system serving an occupied space or other enclosed space that includes one or more fans or fan arrays with fan electrical input power greater than 1 kW, fan system electrical input power determined per Section C403.8.1.2 at the fan system design airflow shall not be greater than the limit is calculated in accordance with Section C403.8.1.1. This section does not apply to fans service heat rejection equipment.~~ Each HVAC system having a total fan system motor nameplate horsepower exceeding 5 hp (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.

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

C403.8.2 Motor nameplate horsepower. For each fan, the fan brake horsepower (bhp) shall be indicated on the construction documents and the selected motor shall be not larger than the first available motor size greater than the following: 1. For fans less than 6 bhp (4476 W), 1.5 times the fan brake horsepower.

TABLE C403.8.1(1)
FAN POWER LIMITATION

	LIMIT	CONSTANT VOLUME	VARIABLE VOLUME
Option 1: Fan system motor name plate hp	Allowable nameplate motor hp	hp ≤ CFMs × 0.0011	hp ≤ CFMs × 0.0015
Option 2: Fan system bhp	Allowable fan system bhp	bhp ≤ CFMs × 0.00094 + *A*	bhp ≤ CFMs × 0.0013 + *A*

For SI: 1 bhp = 735.5 W, 1 hp = 745.5 W, 1 cfm = 0.4719 L/s.
where:
CFM_S = The maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute.
hp = The maximum combined motor nameplate horsepower.
bhp = The maximum combined fan brake horsepower.
A = Sum of [*PD* × CFM_D / 4131].
where:
PD = Each applicable pressure drop adjustment from Table C403.8.1(2) in. w.c.
CFM_D = The design airflow through each applicable device from Table C403.8.1(2) in cubic feet per minute.

TABLE C403.8.1(2)
FAN POWER LIMITATION PRESSURE DROP ADJUSTMENT

DEVICE	ADJUSTMENT
Credits	
Return air 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 inch w.c. (2.15 inches w.c. for laboratory and vivarium systems)
Return and exhaust airflow control devices	0.5 inch w.c.

Exhaust filters, scrubbers or other exhaust treatment	The pressure drop of device calculated at fan system design condition
Particulate filtration credit: MERV 9 thru 12	0.5 inch w.c.
Particulate filtration credit: MERV 13 thru 15	0.9 inch w.c.
Particulate filtration credit: MERV 16 and greater and electronically enhanced filters	Pressure drop calculated at 2 times the 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 × energy recovery effectiveness - 0.5) inch w.c.
Coil runaround loop	0.6 inch w.c. for each airstream.
Evaporative humidifier/cooler in series with another cooling coil	Pressure drop of device at fan system design conditions.
Sound attenuation section (fans serving spaces with design background noise goals below NC35)	0.15 inch w.c.
Exhaust system serving fume hoods	0.35 inch w.c.
Laboratory and vivarium exhaust systems in high-rise buildings	0.25 inch w.c./100 feet of vertical duct exceeding 75 feet.
Deductions	
Systems without central cooling device	- 0.6 inch w.c.
Systems without central heating device	- 0.3 inch w.c.
Systems with central electric resistance heat	- 0.2 inch w.c

For SI: 1 inch w.c. = 249 Pa, 1 inch = 25.4 mm, 1 foot = 304.8 mm.
w.c. = Water Column, NC = Noise Criterion

For fans 6 bhp (4476 W) and larger, 1.3 times the fan brake horsepower.

Exceptions:

1. Fans equipped with electronic speed control devices to vary the fan airflow as a function of load.
2. Fans with a fan nameplate electrical input power of less than 0.89 kW.
3. Systems complying with Section C403.8.1 fan system motor nameplate hp (Option 1).
4. Fans with motor nameplate horsepower less than 1 hp (746 W)

TABLE C403.8.1(1) SUPPLY FAN POWER ALLOWANCES (W/CFM)

Multi-Zone VAV Fan System Airflow (cfm)[a]	All Other Fan Systems Airflow (cfm)					
Air system Component	<5,000	5,000 to <10,000	≥10,000	<5,000	5,000 to <10,000	≥10,000
W/cfm						
Supply System Base Allowance for each fan system	0.413	0.472	0.480	0.243	0.267	0.248
Particle filtration (select all that apply)						
Filter not higher than MERV 12	0.094	0.079	0.073	0.097	0.084	0.075
MERV 13 to MERV 16 filter	0.210	0.177	0.165	0.217	0.185	0.168
HEPA filter	0.347	0.292	0.277	0.357	0.304	0.278
Heating (select all that apply)						
Hydronic heating coil (central)	0.047	0.050	0.055	0.049	0.053	0.057
Electric heat	0.047	0.050	0.055	0.049	0.042	0.038
Gas or oil furnace <90% Et or <90% AFUE	0.071	0.060	0.073	0.061	0.063	0.075
Gas or oil furnace ≥ 90% Et or ≥90% AFUE	0.117	0.099	0.092	0.122	0.104	0.094
Cooling and dehumidification (select all that apply)						
Hydronic/DX cooling coil, or heat pump coil (wet) [Healthcare facilities can select twice]	0.141	0.118	0.110	0.146	0.125	0.112
Fluid economizer coil	0.141	0.118	0.110	0.146	0.125	0.112
Desiccant system-solid or liquid	0.164	0.138	0.128	0.170	0.145	0.131
Hot gas reheat coil	0.047	0.040	0.037	0.049	0.042	0.038
Series energy recovery	0.141	0.118	0.110	0.146	0.125	0.112
Evaporative humidifier/cooler in series with a cooling coil. Value shown is allowed W/cfm per 1.0 in. wg. Determine pressure loss (in. wg.) at the lesser of 400 fpm or maximum velocity allowed by the manufacturer. [Calculation required[b]]	0.233	0.196	0.184	0.241	0.205	0.186
Energy recovery						
Enthalpy Recovery Ratio ≥0.50 and <0.55	0.141	0.118	0.110	0.146	0.125	0.112
Enthalpy Recovery Ratio ≥0.55 and <0.60	0.166	0.140	0.130	0.172	0.147	0.133
Enthalpy Recovery Ratio ≥0.60 and <0.65	0.191	0.161	0.151	0.198	0.169	0.153
Enthalpy Recovery Ratio ≥0.65 and <0.70	0.217	0.182	0.171	0.224	0.191	0.173
Enthalpy Recovery Ratio ≥0.70 and <0.75	0.242	0.204	0.191	0.250	0.213	0.193
Enthalpy Recovery Ratio ≥0.75 and <0.80	0.267	0.225	0.212	0.276	0.235	0.213
Enthalpy Recovery Ratio ≥0.80	0.292	0.246	0.232	0.301	0.257	0.234
Run-around liquid or refrigerant coils	0.141	0.118	0.110	0.146	0.125	0.112
Gas-phase filtration						
Gas-phase filtration	0.233	0.196	0.184	0.241	0.205	0.186
Other						
Economizer return damper	0.049	0.042	0.038	0.049	0.043	0.039
100% Outdoor air system[c]	0.000	0.000	0.000	0.073	0.104	0.112
Low-turndown single-zone VAV fan systems[d]	0.000	0.000	0.000	0.073	0.104	0.094
Air blender	0.047	0.040	0.037	0.049	0.042	0.038
Sound attenuation section [fans serving spaces with design background noise goals below NC35]	0.035	0.030	0.027	0.036	0.032	0.029
Deducation for systems that feed a terminal unit or fan coil with a fan with electrical input power <1kW	-0.500	-0.500	-0.500	-0.100	-0.100	-0.100

a. See section C408.3.1.1 for requirements for a Multi-Zone VAV system.

b. Power allowances require further calculation. Multiply the actual pressure drop of the device or component by the fan power allowance in Table C403.8.1(2).

c. The 100 percent outdoor air system must serve 3 or more HVAC zones.

d. A low-turndown single-zone VAV fan system must be capable of and configured to reduce airflow to 50 percent of design airflow and use no more than 30 percent of the design wattage at that airflow. No more than 10 percent of the design load served by the equipment shall have fixed loads.

e. The deduction of 0.500 W/cfm is a default value for multizone VAV fan systems. If the terminal unit or fan coil manufacturer can demonstrate that the share of the unit's fan power required to move the fan system's air is less than 0.500 W/cfm, that value may be used. The W/cfm shall be calculated by dividing the power required to operate the terminal unit's fan at fan system design conditions by the airflow of the terminal unit at those conditions.

TABLE C403.8.1(2) EXHAUST, RETURN, RELIEF, TRANSFER FAN SYSTEM POWER ALLOWANCES (W/CFM)

Mult-Zone VAV Fan System airflow[a] (cfm)			All Other Fan Systems Airflow (cfm)			
Air System Component	<5,000	5,000 TO <10,000	≥10,000	<5,000	5,000 to <10,000	≥10,000
W/cfm						
Exhaust, Return, Relief, and Transfer System Base Allowance for each *fan system*	0.231	0.256	0.248	0.194	0.192	0.200
Particle filtration						
Filter (any MERV value)[b]	0.049	0.042	0.038	0.049	0.043	0.039
Energy recovery						
Enthalpy Recovery Ratio ≥ 0.50 and <0.55	0.146	0.125	0.112	0.146	0.128	0.114
Enthalpy Recovery Ratio ≥0.55 and <0.60	0.173	0.148	0.133	0.173	0.150	0.135
Enthalpy Recovery Ratio≥0.60 and <0.65	0.199	0.170	0.153	0.199	0.173	0.155
Enthalpy Recovery Ratio ≥0.65 and <0.70	0.225	0.192	0.173	0.226	0.196	0.176
Enthalpy Recovery Ratio ≥0.70 and <0.75	0.250	0.214	0.193	0.252	0.218	0.196
Enthalpy Recovery Ratio ≥0.75 and <0.80	0.276	0.236	0.213	0.277	0.240	0.216
Enthalpy Recovery Ratio ≥0.8	0.302	0.258	0.234	0.303	0.263	0.236
Run-around liquid or refrigerant coils	0.146	0.125	0.112	0.146	0.128	0.114
Special exhaust and return system requirements (select all that apply)						
Return or exhaust systems required to be fully ducted by code or accreditation standards	0.122	0.105	0.094	0.122	0.107	0.096
Return and/or exhaust airflow control devices required by code or accreditation standards to maintain pressure relationships between spaces	0.122	0.105	0.094	0.122	0.107	0.096
Laboratory and vivarium exhaust systems in high-rise buildings for vertical duct exceeding 75 feet. Value shown is allowed W/cfm per 0.25 inch wg for each 100 feet exceeding 75 feet. [Calculation required[c]]	0.061	0.053	0.047	0.061	0.054	0.048
Exhaust system serving fume hoods	0.085	0.074	0.066	0.085	0.075	0.067
Biosafety cabinet. Value shown is allowed W/cfm per 1.0 inch wg air pressure drop [Calculation required[c]]	0.241	0.206	0.186	0.242	0.210	0.188
Exhaust filters, scrubbers, or other exhaust treatment required by code or standard. Value shown is allowed W/cfm per 1.0 inch wg air pressure drop. [Calculation required[c]]	0.241	0.206	0.186	0.242	0.210	0.188
Other						
Sound attenuation section (fans serving spaces with design background noise goals below NC35)	0.036	0.032	0.029	0.036	0.032	0.029

a. See Section C408.3.1.1 for requirements for a Multi-Zone VAV System.

b. Particle filter pressure loss can only be counted once per fan system.

c. Power allowances require further calculation. Multiply the actual pressure drop of the device or component by the fan power allowance in Table C403.8.1(2).

~~TABLE C403.8.1(3) FAN POWER LIMIT ALTITUDE CORRECTION FACTOR~~

~~Altitude (ft)~~	~~Correction factor~~
~~<3,000~~	~~1.000~~
~~≥3,000 and <4,000~~	~~0.896~~
~~≥4,000 and <5,000~~	~~0.864~~
~~≥5,000 and <6,000~~	~~0.832~~
~~≥6,000~~	~~0.801~~

TABLE C403.8.1(4) DEFAULT VALUES FOR FAN ELECTRICAL INPUT POWER BASED ON MOTOR NAMEPLATE HP[a,b]

Motor Nameplate Horsepower	Variable-Speed Drive (kW)	Without Variable-Speed Drive (kW)
<1	0.96	0.89
≥1 and <1.5	1.38	1.29
≥1.5 and <2	1.84	1.72
≥2 and <3	2.73	2.57
≥3 and <5	4.38	4.17
≥5 and <7.5	6.43	6.15
≥7.5 and <10	8.46	8.13
≥10 and <15	12.47	12.03
≥15 and <20	16.55	16.04
≥20 and <25	20.58	19.92
≥25 and <30	24.59	23.77
≥30 and <40	32.74	31.70
≥40 and <50	40.71	39.46
≥50 and <60	48.50	47.10
≥60 and <75	60.45	58.87
≥75 and <100	80.40	78.17

a. This table cannot be used for Motor Nameplate Horsepower values greater than 100.

b. This table is to be used only with motors with a service factor ≤1.15. If the service factor is not provided, this table may not be used.

C403.8.1.1 Determining Fan Power Limit. The maximum allowed fan system electrical input power, shall be determined in accordance with the following steps 1 through 5:

1. The fan system's classification shall be determined. A fan system is considered to be multizone VAV where it meets the following requirements; fan systems that do not meet the following requirements shall be classified as other fans:

   1.1 The fan system shall serve three or more HVAC zones and airflow to each shall be individually controlled based on heating, cooling and/or ventilation requirements.

   1.2 The sum of the minimum airflows for each HVAC zone shall be not greater than 40 percent of the fan system design conditions.

   Exception: Hospital, vivarium, and laboratory systems that use flow control devices on exhaust or return to maintain space pressure relationships necessary for occupant health and safety or environmental control shall use the multizone VAV fan power allowances.

2. Determine the fan system airflow and choose the applicable table(s) for fan power allowance.

   2.1 For single-cabinet fan systems, use the fan system airflow and the power allowances in both Table C403.8.1(1) and Table C403.8.1(2).

   2.2 For supply-only fan systems, use the fan system airflow and power allowances in Table C403.8.1(1).

   2.3 For relief fan systems, use the design relief airflow and the power allowances in Table C403.8.1(2).

   2.4 For exhaust, return and transfer fan systems, use the fan system airflow and the power allowances in Table C403.8.1(2).

   2.5 For complex fan systems and DOAS with energy recovery fan systems, separately calculate the fan power allowance for the supply and return/exhaust systems and sum them. For the supply airflow at the fan system design conditions, and the power allowances in Table C403.8.1(1). For the return/exhaust airflow, use return or exhaust airflow at the fan system design conditions, and the power allowances in Table C403.8.1(2).

3. ~~For each fan system determine the components included in the fan system and sum the fan power allowances of those components. All fan systems shall include the System Base Allowance. If, for a given component, only a portion of the fan system airflow passes through the component, calculate the fan power allowance for the com-ponent per equation 4-7:~~

~~(Equation 4-7)~~

$$FPA_{adj} = (Q_{comp} / Q_{sys}) * FPA_{comp}$$

~~FPA_{adj} = The corrected fan power allowance for the component in w/cfm~~
~~Q_{comp} = The airflow through component in cfm~~
~~Qsys = The fan system airflow in cfm~~
~~FPA_{comp} = The fan power allowance of the component from Table C403.8.1(1) or Table C403.8.1(2)~~

4. ~~Multiply the fan system airflow by the sum of the fan power allowances for the fan system, then divide by 1000 to convert to KW.~~

~~(Equation 4-8)~~

$$FPL = (Q_{sys} * FPA_{sum})/1000$$

~~FPL = The fan power limit in KW~~
~~Q_{sys} = The fan system airflow in cflm (L/s)~~
~~FPA_{sum} = The sum of the fan power allowance for the system in W/cfm~~
~~1000 = The conversion from W to kW~~

5. ~~For building sites at elevations greater than 3,000 feet (900 m), multiply the fan power limit by the correction factor from Table C408.3.1(3).~~

~~(Equation 4-9)~~

$$FPL_{alt} = FPL * C_{alt}$$

~~FPL_{alt} = The adjusted fan power limit in KW.~~
~~FPL = The fan power limit in KW calculated in step 4.~~
~~C_{alt} = The altitude correction factor from Table C408.3.1(3)~~

~~**C403.8.1.2 Determining Fan System Electrical Input Power**. **The fan system electrical input power is the sum of the fan electrical input power of each fan or fan array in-cluded in the fan system other than fans with fan electrical input power ≤ 1 kW. If variable speed drives are used their efficiency losses shall be included. Fan system input power shall be calculated with mid-life filter pressure drop, which is the mean of the clean filter pressure drop and design final filter pressure drop. The fan electrical input power for each fan or fan array shall be determined using one of the following methods. There is no requirement to use the same method for all fans in a fan system:**~~

1. ~~**Use the default fan electrical input power in Table C408.3.1(4) for one or more of the fans. This method cannot be used for complex fan systems.**~~
2. ~~**Use the fan electrical input power at fan system design conditions provided by the manufacturer of the fan, fan array, or equipment that includes the fan or fan array, calculated per a test procedure included in 10 CFR Part 430, 10 CFR Part 431, ANSI/AMCA Standard 210, ASHRAE 51 AHRI Standard 430, AHRI Standard 440, or ISO 5801.**~~
3. ~~**Use the fan electrical input power provided by the manufacturer, calculated at fan system design conditions per one of the methods listed in section 5.3 of ANSI/AMCA 208.**~~
4. ~~**Use the fan nameplate electrical input power.**~~

Reason: AHRI is concerned that the most recent 90.1 addendum (ISC) includes corrections that are present in IECC Public Draft 1. The 90.1 ISC also received additional comments. Until this major proposal has been fully vetted and has had issued resolved through the 90.1 process, it is not yet ready to be adopted into code.
AHRI Recommendation: Reintroduce proposal (completely harmonized with 90.1) after the 90.1 addendum has been finalized.

Cost Impact: The code change proposal will decrease the cost of construction.
Changes to Section C403.8.1 as included in the Public Draft 1 would increase the cost of construction. Reverting to the lanuaguage in the 2021 IECC would reduce the cost, by comparison.