WAC 51-11C-4038 Section C403.8—Fan and fan controls.

C403.8 Fan and fan controls. Fans in HVAC systems shall comply with Sections C403.8.1 through C403.8.5.1.

The airflow requirements of Section C403.8.5.1 shall apply to all fan motors. Low capacity ventilation fans shall also comply with Section C403.8.4.

C403.8.1

Fan System. Each *fan system* that includes at least one fan or fan array with *fan electrical input power* ≥ 1 kW, moving air into, out of, or between conditioned spaces or circulating air for the purpose of conditioning air within a space shall comply with Sections C403.8.1.1 through C403.8.1.2.

C403.8.1.1 Determining fan power budget. For each *fan system*, the *fan system electrical input power* (Fan $kW_{design,system}$) determined in accordance with Section C403.8.1.2 at the *fan system airflow* shall not exceed Fan kW_{budget}. Calculate fan power budget (Fan kW_{budget}) for each *fan system* as follows:

1. Determine the *fan system airflow* and choose the appropriate table(s) for fan power allowance.

1.1. For *single-cabinet fan systems*, use the *fan system airflow* and the power allowances in both Table C403.8.1.1(1) and Table C403.8.1.1(2).

1.2. For *supply-only fan systems*, use the *fan system airflow* and power allowances in Table C403.8.1.1(1).

1.3. For *relief fan systems*, use the design relief airflow and the power allowances in Table C403.8.1.1(2).

1.4. For exhaust, return and transfer *fan systems*, use the *fan system airflow* and the power allowances in Table C403.8.1.1(2).

1.5. For complex 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, use supply airflow at the *fan system* design conditions, and the power allowances in Table C403.8.1.1(1). For the return/exhaust airflow, use return/exhaust airflow at the *fan system* design conditions, and the power allowances in Table C403.8.1.1(2).

2. 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 that component in accordance with Equation 4-11:

(Equation 4-11)

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

Where:

FPA_{adj}	=	The corrected fan power allowance for the component in W/cfm.
Q_{comp}	=	The airflow through component in cfm.
Q_{sys}	=	The *fan system airflow* in cfm.

FPA_{comp} = The fan power allowance of the component from Table C403.8.1.1(1) or Table C403.8.1.1(2).

3. Multiply the *fan system airflow* by the sum of the fan power allowances for the *fan system*.

4. Divide by 1,000 to convert to Fan kW_{budget}.

5. For building sites at elevations greater than 3,000 feet, multiply Fan kW_{budget} by 0.896.

Table C403.8.1.1(1)
Supply Fan Power Allowances (W/CFM)

Airflow	Multi-Zone VAV Systems[a] ≤ 5,000 cfm	Multi-Zone VAV Systems[a] > 5,000 and ≤ 10,000 cfm	Multi-Zone VAV Systems[a] > 10,000 cfm	All Other *Fan Systems* ≤ 5,000 cfm	All Other *Fan Systems* > 5,000 and ≤ 10,000 cfm	All Other *Fan Systems* > 10,000 cfm
Supply system base allowance for AHU serving spaces ≤ 6 floors away	0.395	0.453	0.413	0.232	0.256	0.236
Supply system base allowance for AHU serving spaces > 6 floors away	0.508	0.548	0.501	0.349	0.356	0.325
MERV 13 to MERV 16 Filter upstream of thermal conditioning equipment (two-times the clean filter pressure drop)[b]	0.136	0.114	0.105	0.139	0.120	0.107
MERV 13 to MERV 16 Final filter downstream of thermal conditioning equipment (two-times the clean filter pressure drop)[b]	0.225	0.188	0.176	0.231	0.197	0.177
Filtration allowance for > MERV 16 or HEPA Filter (two-times the clean filter pressure drop)[b]	0.335	0.280	0.265	0.342	0.292	0.264
Central hydronic heating coil allowance	0.046	0.048	0.052	0.046	0.050	0.054
Electric heat allowance	0.046	0.038	0.035	0.046	0.040	0.036
Gas heat allowance	0.069	0.057	0.070	0.058	0.060	0.072

Airflow	Multi-Zone VAV Systems[a] ≤ 5,000 cfm	Multi-Zone VAV Systems[a] > 5,000 and ≤ 10,000 cfm	Multi-Zone VAV Systems[a] > 10,000 cfm	All Other *Fan Systems* ≤ 5,000 cfm	All Other *Fan Systems* > 5,000 and ≤ 10,000 cfm	All Other *Fan Systems* > 10,000 cfm
Hydronic/DX cooling coil or heat pump coil (wet) allowance[c]	0.135	0.114	0.105	0.139	0.120	0.107
Solid or liquid desiccant system allowance	0.157	0.132	0.123	0.163	0.139	0.124
Reheat coil for dehumidification allowance	0.045	0.038	0.035	0.046	0.040	0.036
Allowance for evaporative humidifier/ cooler in series with a cooling coil. Value shown is allowed W/cfm per 1.0 inches of water gauge (in.w.g.). Determine pressure loss (in.w.g.) at 400 fpm or maximum velocity allowed by the manufacturer, whichever is less[d]	0.224	0.188	0.176	0.231	0.197	0.177
Allowance for 100% Outdoor air system[e]	0.000	0.000	0.000	0.070	0.100	0.107
Energy recovery allowance for 0.50 ≤ ERR <0.55[f]	0.135	0.114	0.105	0.139	0.120	0.107
Energy recovery allowance for 0.55 ≤ ERR <0.60[f]	0.160	0.134	0.124	0.165	0.141	0.126
Energy recovery allowance for 0.60 ≤ ERR <0.65[f]	0.184	0.155	0.144	0.190	0.163	0.146
Energy recovery allowance for 0.65 ≤ ERR <0.70[f]	0.208	0.175	0.163	0.215	0.184	0.165
Energy recovery allowance for 0.70 ≤ ERR <0.75[f]	0.232	0.196	0.183	0.240	0.205	0.184
Energy recovery allowance for 0.75 ≤ ERR <0.80[f]	0.257	0.216	0.202	0.264	0.226	0.203

Airflow	Multi-Zone VAV Systems[a] ≤ 5,000 cfm	Multi-Zone VAV Systems[a] > 5,000 and ≤ 10,000 cfm	Multi-Zone VAV Systems[a] > 10,000 cfm	All Other *Fan Systems* ≤ 5,000 cfm	All Other *Fan Systems* > 5,000 and ≤ 10,000 cfm	All Other *Fan Systems* > 10,000 cfm
Energy recovery allowance for ERR ≥ 0.80[f]	0.281	0.236	0.222	0.289	0.247	0.222
Coil runaround loop	0.135	0.114	0.105	0.139	0.120	0.107
Allowance for Gas phase filtration required by code or accredited standard. Value shown is allowed W/cfm per 1.0 in. wg air pressure drop[d]	0.224	0.188	0.176	0.231	0.197	0.177
Economizer damper return	0.045	0.038	0.035	0.046	0.040	0.036
Air blender allowance	0.045	0.038	0.035	0.046	0.040	0.036
Sound attenuation section [fans serving spaces with design background noise goals below NC35]	0.034	0.029	0.026	0.035	0.030	0.027
Deduction for systems that feed a terminal unit with a fan with electrical input power < 1kW	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100
Low-turndown single-zone VAV fan systems[g]	0.000	0.000	0.000	0.070	0.100	0.089

[a] See definition of FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV).
[b] Filter fan power allowance can only be counted once per fan system, except fan systems in health care facilities, which can claim one of the MERV 13 to 16 filter allowances and the HEPA filter allowance if both are included in the *fan system*.
[c] Health care facilities can claim this fan power allowance twice per *fan system* where coil design leaving air temperature is less than 44ºF.
[d] Power allowance requires further calculation by multiplying the actual inches of water gauge (in.w.g.) of the device/component by the w/cfm in Table C403.8.1(1).
[e] The 100% outdoor air system must serve 3 or more HVAC zones and airflow during noneconomizer operating periods must comply with Section C403.2.2.1.
[f] Enthalpy Recovery Ratio (ERR) calculated per ANSI/ASHRAE 84-2020.
[g] 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.

Table C403.8.1.1(2)
Exhaust, Return, Relief, Transfer Fan Power Allowances (W/CFM)

Airflow	Multi-Zone VAV Systems[a] ≤ 5,000 cfm	Multi-Zone VAV Systems[a] > 5,000 and ≤ 10,000 cfm	Multi-Zone VAV Systems[a] > 10,000 cfm	All Other *Fan Systems* ≤ 5,000 cfm	All Other *Fan Systems* > 5,000 and ≤ 10,000 cfm	All Other *Fan Systems* > 10,000 cfm
Exhaust system base allowance	0.221	0.246	0.236	0.186	0.184	0.190
Filter (any MERV value)[b]	0.046	0.041	0.036	0.046	0.041	0.035

Airflow	Multi-Zone VAV Systems[a] ≤ 5,000 cfm	Multi-Zone VAV Systems[a] > 5,000 and ≤ 10,000 cfm	Multi-Zone VAV Systems[a] > 10,000 cfm	All Other *Fan Systems* ≤ 5,000 cfm	All Other *Fan Systems* > 5,000 and ≤ 10,000 cfm	All Other *Fan Systems* > 10,000 cfm
Energy recovery allowance for 0.50 ≤ ERR <0.55[c]	0.139	0.120	0.107	0.139	0.123	0.109
Energy recovery allowance for 0.55 ≤ ERR <0.60[c]	0.165	0.142	0.126	0.165	0.144	0.128
Energy recovery allowance for 0.60 ≤ ERR <0.65[c]	0.190	0.163	0.146	0.191	0.166	0.148
Energy recovery allowance for 0.65 ≤ ERR <0.70[c]	0.215	0.184	0.165	0.216	0.188	0.167
Energy recovery allowance for 0.70 ≤ ERR <0.75[c]	0.240	0.206	0.184	0.241	0.209	0.186
Energy recovery allowance for 0.75 ≤ ERR <0.80[c]	0.265	0.227	0.203	0.266	0.231	0.205
Energy recovery allowance for ERR ≥ 0.80[c]	0.289	0.248	0.222	0.291	0.252	0.225
Coil runaround loop	0.139	0.120	0.107	0.139	0.123	0.109
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	0.116	0.100	0.089	0.116	0.102	0.091
Return and/or exhaust airflow control devices	0.116	0.100	0.089	0.116	0.102	0.091
Laboratory and vivarium exhaust systems in high-rise buildings for vertical duct exceeding 75 ft. Value shown is allowed W/cfm per 0.25 in. wg for each 100 feet exceeding 75 feet[d]	0.058	0.051	0.045	0.058	0.052	0.046

Airflow	Multi-Zone VAV Systems[a] ≤ 5,000 cfm	Multi-Zone VAV Systems[a] > 5,000 and ≤ 10,000 cfm	Multi-Zone VAV Systems[a] > 10,000 cfm	All Other *Fan Systems* ≤ 5,000 cfm	All Other *Fan Systems* > 5,000 and ≤ 10,000 cfm	All Other *Fan Systems* > 10,000 cfm
Biosafety cabinet. Value shown is allowed W/cfm per 1.0 in. wg air pressure drop[d]	0.231	0.198	0.177	0.232	0.202	0.179
Exhaust filters, scrubbers, or other exhaust treatment required by code or standard. Value shown is allowed W/cfm per 1.0 in. wg air pressure drop[d]	0.231	0.198	0.177	0.232	0.202	0.179
Health care facility allowance[e]	0.231	0.198	0.177	0.232	0.202	0.179
Sound attenuation section [Fans serving spaces with design background noise goals below NC35.]	0.035	0.030	0.027	0.035	0.031	0.028

[a] See definition of FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV) to be classified as a Multi-Zone VAV System.
[b] Filter pressure loss can only be counted once per fan system.
[c] Enthalpy Recovery Ratio (ERR) calculated per ANSI/ASHRAE 84-2020.
[d] Power allowance requires further calculation, multiplying the actual pressure drop (in. wg) of the device/component by the W/cfm in the Table C403.8.1(2).
[e] This allowance can only be taken for health care facilities.

C403.8.1.2 Determining *Fan System Electrical Input Power* (Fan $kW_{design,system}$). *Fan* $kW_{design,system}$ is the sum of *Fan* kW_{design} for each fan or fan array included in the *fan system*. If variable speed drives are used, their efficiency losses shall be included. Fan input power shall be calculated with two-times the clean filter pressure drop. The *Fan* kW_{design} 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* kW_{design} in Table C403.8.1.2 for one or more of the fans. This method cannot be used for *complex fan systems*.

2. Use the *Fan* kW_{design} 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 C.F.R. Part 430, 10 C.F.R. Part 431, ANSI/AMCA 208, ANSI/AMCA S210, AHRI 430, AHRI 440, or ISO 5801.

3. Use the *Fan* kW_{design} 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. Determine the *Fan* kW_{design} by using the maximum electrical input power provided on the motor nameplate.

Table C403.8.1.2

Default Values for Fan kW_{design} Based on Motor Nameplate HP[a,b]

Motor Nameplate HP	Default *Fan* kW_{design} with variable speed drive (Fan kW_{design})	Default *Fan* kW_{design} without variable speed drive (Fan kW_{design})
<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	12.4	12.0
≥15 and <20	16.5	16.0
≥20 and <25	20.5	19.9
≥25 and <30	24.5	23.7
≥30 and <40	32.7	31.7
≥40 and <50	40.7	39.4
≥50 and <60	48.5	47.1
≥60 and <75	60.4	58.8
≥75 and ≤100	80.4	78.1

[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.

C403.8.2 Motor nameplate horsepower. For each fan, the selected fan motor shall be no larger than the first available motor size greater than the brake horsepower (bhp). The fan brake horsepower (bhp) shall be indicated on the design documents to allow for compliance verification by the *code official*.

EXCEPTIONS:
1. For fans less than 6 bhp (4476 W), where the first available motor larger than the brake horsepower has a nameplate rating within 50 percent of the bhp, selection of the next larger nameplate motor size is allowed.
2. For fans 6 bhp (4476 W) and larger, where the first available motor larger than the bhp has a nameplate rating within 30 percent of the bhp, selection of the next larger nameplate motor size is allowed.
3. For fans used only in *approved* life safety applications such as smoke evacuation.
4. Fans with motor nameplate horsepower less than 1 hp or fans with a fan motor nameplate electrical input power of less than 0.89 kW.
5. Fans equipped with electronic speed control devices to vary the fan airflow as a function of load.

C403.8.3 Fan efficiency. Each fan and *fan array* shall have a *fan energy index (FEI)* of not less than 1.00 at the design point of operation, as determined in accordance with AMCA 208 by an *approved*, independent testing laboratory and labeled by the manufacturer. Each fan and *fan array* used for a variable-air volume system shall have an *FEI* of not less than 0.95 at the design point of operation as determined in accordance with AMCA 208 by an *approved*, independent testing laboratory and labeled by the manufacturer. The *FEI* for *fan arrays* shall be calculated in accordance with AMCA 208 Annex C.

EXCEPTION: The following fans are not required to have a fan energy index:
1. Fans that are not *embedded pans* with motor nameplate horsepower of less than 1.0 hp (0.75 kW) or with a nameplate electrical input power of less than 0.89 kW.
2. *Embedded fans* that have a motor nameplate horsepower of 5 hp (3.7 kW) or less or with a fan system electrical input power of 4.1 kW or less.
3. Multiple fans operated in series or parallel as the functional equivalent of a single fan that have a combined motor nameplate horsepower of 5 hp (3.7 kW) or less or with a fan system electrical input power of 4.1 kW or less.
4. Fans that are part of equipment covered under Section C403.3.2.
5. Fans included in an equipment package certified by an *approved agency* for air or energy performance.
6. *Ceiling fans*.
7. Fans used for moving gases at temperatures above 425°F (250°C).
8. Fans used for operation in explosive atmospheres.
9. Reversible fans used for tunnel ventilation.
10. Fans that are intended to operate only during emergency conditions.
11. Fans outside the scope of AMCA 208.

C403.8.4 Low-capacity ventilation fans. Mechanical ventilation system fans with motors less than 1/12 hp (0.062 kW) in capacity shall meet the efficacy requirements of Table C403.8.4 at one or more rating points.

EXCEPTIONS: 1. Where ventilation fans are a component of a listed heating or cooling appliance.
2. Dryer exhaust duct power ventilators and domestic range booster fans that operate intermittently.

Table C403.8.4
Low-Capacity Ventilation Fan Efficacy[a]

Fan Location	Airflow Rate Minimum (cfm)	Minimum Efficacy (cfm/watt)	Airflow Rate Maximum (cfm)
HRV or ERV	Any	1.2 cfm/watt	Any
Range hood	Any	2.8 cfm/watt	Any
In-line fan	Any	3.8 cfm/watt	Any
Bathroom, utility room	10	2.8 cfm/watt	< 90
Bathroom, utility room	90	3.5 cfm/watt	Any

For SI: 1 cfm/ft = 47.82 W.
[a] Airflow shall be tested in accordance with HVI 916 and listed. Efficacy shall be listed or shall be derived from listed power and airflow. Fan efficacy for fully ducted HRV, ERV, balanced and in-line fans shall be determined at a static pressure not less than 0.2 inch w.c. Fan efficacy for ducted range hoods, bathroom, and utility room fans shall be determined at a static pressure not less than 0.1 inch w.c.

C403.8.5 Fan controls. Controls shall be provided for fans in accordance with Section C403.8.5.1 and as required for specific systems provided in Section C403.

C403.8.5.1 Fan airflow control. Each cooling system listed in Table C403.8.5.1 shall be designed to vary the indoor fan airflow as a function of load and shall comply with the following requirements:

1. Direct expansion (DX) and chilled water cooling units that control the capacity of the mechanical cooling directly based on space temperature shall have not fewer than two stages of fan control. Low or minimum speed shall not be greater than 66 percent of full speed. At low or minimum speed, the fan system shall draw not more than 40 percent of the fan power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.

2. Other units including DX cooling units and chilled water units that control the space temperature by modulating the airflow to the space shall have modulating fan control. Minimum speed shall be not greater than 50 percent of full speed. At minimum speed, the fan system shall draw no more than 30 percent of the power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.

3. Units that include an airside economizer in accordance with Section C403.5 shall have not fewer than two speeds of fan control during economizer operation.

EXCEPTIONS: 1. Modulating fan control is not required for chilled water and evaporative cooling units with fan motors of less than 1 hp (0.746 kW) where the units are not used to provide ventilation air and the indoor fan cycles with the load.
2. Where the volume of outdoor air required to comply with the ventilation requirements of the *International Mechanical Code* at low speed exceeds the air that would be delivered at the minimum speed defined in Section C403.8.5, the minimum speed shall be selected to provide the required ventilation air.

Table C403.8.5.1
Fan Control

Cooling System Type	Fan Motor Size	Mechanical Cooling Capacity
DX cooling	Any	≥ 42,000 Btu/h

Cooling System Type	Fan Motor Size	Mechanical Cooling Capacity
Chilled water and evaporative cooling	≥ 1/4 hp	Any

C403.8.6 Large-diameter ceiling fans. Where provided, *large-diameter ceiling fans* shall be tested and labeled in accordance with AMCA 230.

[Statutory Authority: RCW 19.27A.020, 19.27A.025, 19.27A.160 and chapters 19.27A and 19.27 RCW. WSR 22-14-091, 23-12-101, and 23-20-021, § 51-11C-4038, filed 7/1/22, 6/7/23, and 9/25/23, effective 3/15/24. Statutory Authority: RCW 19.27A.020, 19.27A.025, 19.27A.160 and chapter 19.27 RCW. WSR 19-24-040, § 51-11C-4038, filed 11/26/19, effective 7/1/20.]

Reviser's note: The brackets and enclosed material in the text of the above section occurred in the copy filed by the agency.