Good News
From the Doctor

Understanding Temperature and Altitude Corrections

The most common influences on air density are the effects of temperature other than 70°F and barometric pressures other than 29.92 caused by elevations above sea level.

Ratings found in fan performance tables and curves are based on standard air. Standard air is defined as clean, dry air with a density of 0.075 pounds per cubic foot, with the barometric pressure at sea level of 29.92 inches of mercury and a temperature of 70°F. Selecting a fan to operate at conditions other then standard air requires adjustment to both static pressure and brake horsepower. The volume of air will not be effected in a given system because a fan will move the same amount of air regardless of the air density. In other words, if a fan will move 3,000 cfm at 70°F it will also move 3,000 cfm at 250°F. Since 250°F air weighs only 34% of 70°F air, the fan will require less bhp but also create less pressure than specified.

When a fan is specified for a given cfm and static pressure (Ps) at conditions other than standard, the correction factors (shown in table) must be applied in order to select the proper size fan, fan speed and bhp to meet the new condition.

The best way to understand how the correction factors are used is to work out several examples. Let's look at an example using a specification for a fan to operate at 600°F at sea level. This example will clearly show that the fan must be selected to handle a much greater static pressure than specified.

Example #1: A 20" centrifugal fan (20" BISW) is required to deliver 5,000 cfm at 3.0 inches static pressure. Elevation is 0 (sea level). Temperature is 600°F.

1. Using the chart, the correction factor is 2.00.
2. Multiply the specified operating static pressure by the correction factor to determine the standard air density equivalent static pressure. (Corrected static pressure = 3.0 x 2.00 = 6". The fan must be selected for 6 inches of static pressure.)
3. Based upon our performance table for a 20" BISW fan at 5,000 cfm at 6 inches wg, 2,018 frpm is needed to produce the required performance. (This now requires a Class II fan. Before the correction was made, it would have appeared to be a Class I selection.)
4. The bhp from the performance chart is 6.76.
5. What is the operating bhp at 600°F?

Since the horsepower shown in the performance chart refers to standard air density, this should be corrected to reflect actual bhp at the lighter operating air. Operating bhp =

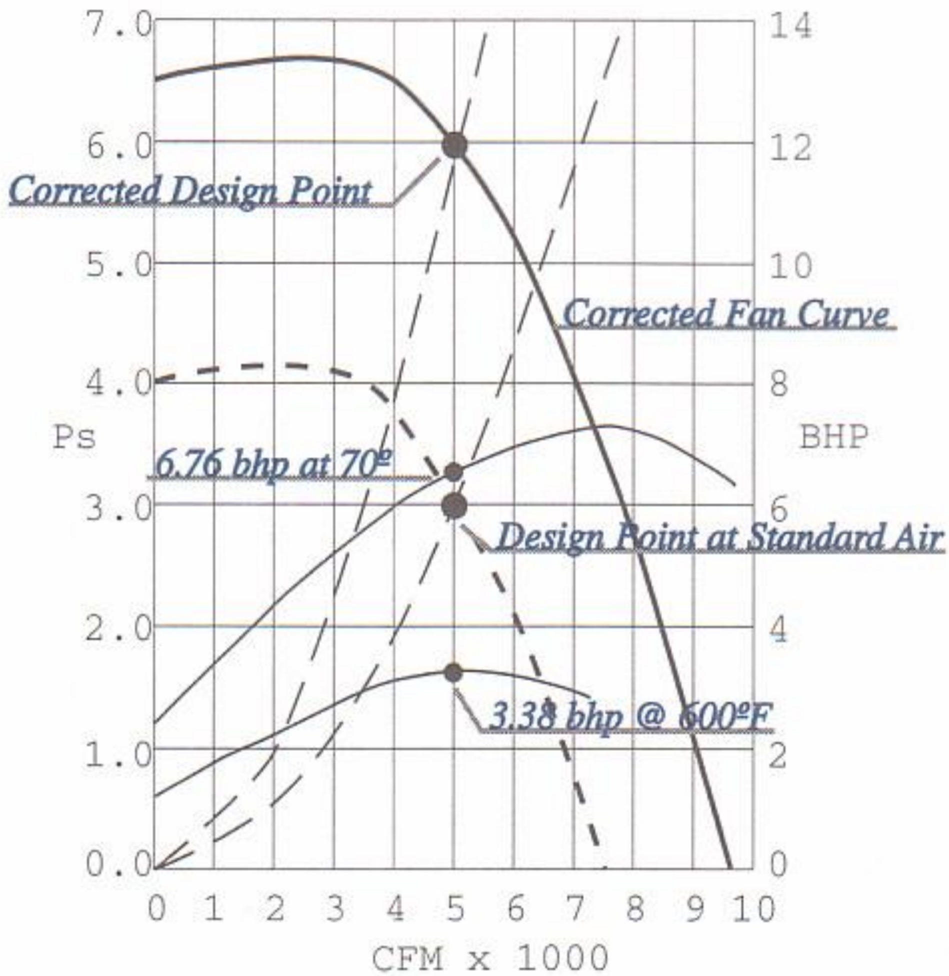
standard bhp ÷ 2.00 or 6.76 ÷ 2.00 = 3.38 bhp.

Important: We now know the operating bhp. However, what motor horsepower should be specified for this fan?

AIR DENSITY CORRECTION FACTORS

Air Temp. °F	Elevation (Feet Above Sea Level)															
	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	13000	14000	15000
0	0.87	0.90	0.94	0.97	1.01	1.05	1.08	1.13	1.17	1.22	1.26	1.31	1.37	1.43	1.48	1.54
50	0.96	1.00	1.04	1.08	1.11	1.15	1.20	1.24	1.30	1.34	1.40	1.45	1.51	1.57	1.63	1.70
70	1.00	1.04	1.08	1.12	1.16	1.22	1.25	1.30	1.35	1.40	1.45	1.51	1.57	1.64	1.70	1.77
100	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.37	1.42	1.48	1.54	1.60	1.66	1.74	1.80	1.88
150	1.15	1.19	1.24	1.30	1.33	1.38	1.44	1.49	1.55	1.61	1.67	1.74	1.81	1.89	1.96	2.04
200	1.25	1.29	1.34	1.40	1.44	1.50	1.56	1.61	1.68	1.75	1.81	1.89	1.96	2.05	2.13	2.21
250	1.34	1.39	1.44	1.50	1.55	1.61	1.67	1.74	1.80	1.88	1.95	2.02	2.10	2.20	2.28	2.37
300	1.43	1.49	1.54	1.60	1.66	1.72	1.79	1.86	1.93	2.01	2.08	2.16	2.25	2.35	2.43	2.53
350	1.53	1.58	1.64	1.71	1.77	1.84	1.91	1.98	2.06	2.14	2.22	2.31	2.40	2.51	2.60	2.71
400	1.62	1.68	1.75	1.81	1.88	1.94	2.03	2.09	2.19	2.27	2.37	2.46	2.54	2.66	2.75	2.87
500	1.81	1.88	1.95	2.02	2.10	2.18	2.26	2.35	2.44	2.54	2.63	2.73	2.84	2.97	3.08	3.20
600	2.00	2.07	2.15	2.23	2.31	2.40	2.50	2.59	2.69	2.84	2.91	3.02	3.14	3.28	3.40	3.54
700	2.19	2.27	2.35	2.44	2.53	2.63	2.73	2.83	2.94	3.07	3.17	3.31	3.44	3.59	3.72	3.88
800	2.38	2.48	2.57	2.67	2.76	2.86	2.98	3.09	3.21	3.33	3.45	3.59	3.74	3.90	4.05	4.21
900	2.56	2.66	2.76	2.87	2.97	3.07	3.20	3.33	3.46	3.58	3.71	3.87	4.02	4.20	4.35	4.53
1000	2.76	2.87	2.99	3.09	3.20	3.31	3.45	3.59	3.73	3.86	4.00	4.17	4.33	4.53	4.69	4.89

Note: It's acceptable to interpolate when exact temperatures or elevations are not shown in chart.



Example 1: The fan curve represents the fans operation at both the corrected and specified conditions. Curves are plotted at standard air.

If a fan is selected to operate at high temperatures, the motor must be of sufficient horsepower to handle the increased load at any lower operating temperature where the air is denser. Assume the air entering the fan at start up is 70°F, therefore no correction should be made. The starting bhp remains at 6.76 and the 7 1/2 hp motor is required.
Note: bhp corrections are most commonly used for altitude corrections (see next example) or when the starting and operating temperatures are the same.
Example #2: A fan used at 6,000-ft. elevation of exhaust 100°F air from an attic space. A 30" roof fan (GB-300) is required to move 10,400 cfm at 0.25 inch static pressure.

1. Using the chart, the correction factor is 1.32.
2. Multiply the specified operating static pressure by the correction factor to determine the standard air density equivalent static pressure (Corrected static pressure = 0.25" x 1.32 =

0.33” static pressure. The fan must be selected for 0.33” static pressure.)
3. Based upon our performance table for a 30” roof fan (GB-300), 698 frpm is needed to produce the required performance.
4. The bhp from the performance chart is 2.40.
5. What is the operating bhp at 6,000-ft. elevation and 100°F air?

Since the horsepower selected refers to standard air density, this should be corrected to reflect actual bhp at the lighter operating air. Operating bhp = standard bhp ÷ 1.32 or 2.40 ÷ 1.32 = 1.82 bhp.

In this example, we can use the corrected bhp because the fan is located at a given elevation and will not be turned on until the attic temperature reaches 100°F. The result is a 2 hp motor can be specified in lieu of a 3 hp.

Communicate Your Corrections

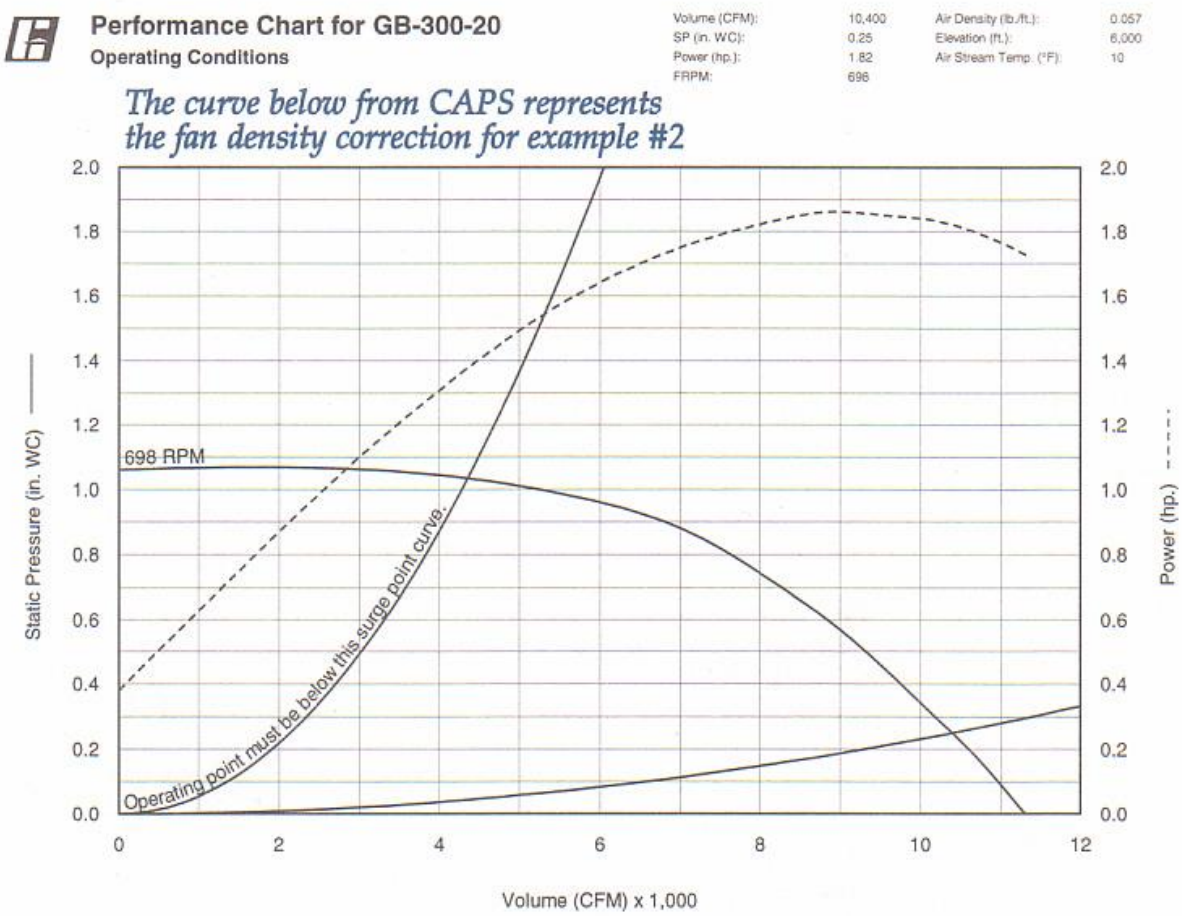
When a specified fan appears on the fan schedule, it’s important to determine if the specifier has already made the required corrections for temperature and altitude. Avoid confusion by specifying at what temperature or altitude (or both) the static pressure was calculated.

For example: 5,000 cfm at 600°F and 6 inches static pressure at 600°F (or 3” Ps at 70°F).

Electronic fan selection programs, such as Greenheck CAPs are excellent tools to solve both the selection and specifying problems.

CAPs prompts the user to enter the air stream temperature, the startup temperature, and the altitude. The fan with the corrected conditions is then automatically selected.

Using CAPs will also guard against making selections for fan types or models that are not appropriate for the condition. This is especially important for selections at extreme temperatures that require special considerations for materials, motors, bearings, drives and speed derate factors.



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