was wondering if anyone had experience modeling DX systems in their proposed systems. I received a USGBC comment that the actual airflow had to be modeled, auto-sizing was not allowed. My baseline system was already modeled correctly with both the cooling and heating systems oversized by 15% and 25% per Appendix G. My main question is how does Appendix G account for the fact that the fan airflows for constant volume DX systems, like packaged and split heat pumps, is set at 350-400 cfm/ton for them to work properly. My baseline system is a packaged DX system, and even with the 15% and 25% oversizing of the equipment, the baseline system is still below 350 cfm/ton. Yet, I must model my actual airflow rate of my equipment, which will increase my fan power and thus increase energy over the baseline becuase i'm using a real world piece of equipment that does not operate or dehumidify properly below 350 cfm/ton. Is Appendix G pentalizing me for using a DX system (by requiring me to model the actual airflow), when it does not require "real-world" airflows in the baseline DX system?

Any guidance on the matter would be appreciated!

Mail This

[http://www.leeduser.com/sites/default/files/imagecache/forum_responder/pictures/picture-5288.jpg**Barbara McCrary**](http://www.leeduser.com/users/barbaram) Mechanical Engineer, PE, LEED AP BD&C, HHB Engineers, P.C., Prattville, AL Oct 18 2010 LEEDuser Member 686 Thumbs Up

13

[Vote up!](http://www.leeduser.com/vote/comment/7326/1/Thumbs%20Up/thumbsup/3823a3c452d3eef56886e31214a115d3)

Let me correct myself, App G makes you both oversize equipment capacities in baseline AND size air flow rates based on a 20F supply air to room temp difference. So still not a "real-world" cfm based on the [heat pump](http://www.leeduser.com/glossary/14#term4821) capacity!

Mail This

[**Michael Tillou**](http://www.leeduser.com/users/mtillou) Director of Energy Services, Cannon Design Oct 18 2010 Guest 229 Thumbs Up

12

[Vote up!](http://www.leeduser.com/vote/comment/7327/1/Thumbs%20Up/thumbsup/60110e9377a98dfa53979640289da011)

Barbara,  
Appendix G is not penalizing you as you describe.

If your baseline DX systems work out to less than 350 CFM/ton than the baseline supply air CFM has not been calculated correctly. Based on a 20F design delta T, required by Appendix G, the supply air CFM should be approx. 555.5 SCFM/ton which is higher than the 350/400 CFM/ton you describe. I would confirm that you are performing the sizing runs correctly.  
The proper method for doing a sizing run for an Appendix G baseline energy model is:  
1. Set all internal load and envelope parameters to the baseline conditions.  
2. Set design day criteria to the required ASHRAE conditions specified in Appendix G. Remember that programs like eQUEST require the creation of special heating and cooling design days otherwise the peak heating and cooling is based on the weather file.  
3. Simulate the model and find the peak heating and cooling loads for each system.  
4. Increase the peak heating loads by 25% and the peak cooling loads by 15%.  
5. Calulate the supply air flow rate for each system using a 20F delta-T.  
6. Enter in the calculated heating and cooling capacities and the supply air flow rates for each baseline system.  
7. Simulate the final baseline HVAC energy model.

If your energy modeling program is not doing this correctly you may have to do it manually to get the correct answers.

Mail This

[http://www.leeduser.com/sites/default/files/imagecache/forum_responder/pictures/picture-5288.jpg**Barbara McCrary**](http://www.leeduser.com/users/barbaram) Mechanical Engineer, PE, LEED AP BD&C, HHB Engineers, P.C., Prattville, AL Oct 18 2010 LEEDuser Member 686 Thumbs Up

11

[Vote up!](http://www.leeduser.com/vote/comment/7328/1/Thumbs%20Up/thumbsup/bebbe5e9a31bdf2458f43bfd9827ebb8)

Michael, thanks for your quick reply. I also just performed the calc you did and you are right, a 20F delta T works out to 555 cfm/ton. I'm using Trane Trace and will double check what it is doing, because it is calculating less than 350 cfm/ton on the baseline system.

Mail This

[http://www.leeduser.com/sites/default/files/imagecache/forum_responder/pictures/picture-5288.jpg**Barbara McCrary**](http://www.leeduser.com/users/barbaram) Mechanical Engineer, PE, LEED AP BD&C, HHB Engineers, P.C., Prattville, AL Oct 18 2010 LEEDuser Member 686 Thumbs Up

11

[Vote up!](http://www.leeduser.com/vote/comment/7330/1/Thumbs%20Up/thumbsup/d352ce32e5586ddfab3476461b122238)

Michael - actually, correct me if i'm wrong. Did you use the formula Q=1.08\*CFM\*DeltaT to come up with 555 cfm/ton? The Delta T in this formula is the different in entering air and leaving air across the coil, which will not be 20 if you have untempered outside air mixing with your return air. So by assuming a 20 different in supply air and room air temperature, it doesn't automatically mean you will have 555 cfm/ton. For high outside air quantities it can be much lower. So i guess i'm back to my original question on setting cfm/ton on DX equipment to 350. My Trane Trace sensible capacites on my coils (which is seems to be setting my airflows), do seems a bit off, so i'm still going to have to take a look at them.

Mail This

[**Michael Tillou**](http://www.leeduser.com/users/mtillou) Director of Energy Services, Cannon Design Oct 19 2010 Guest 229 Thumbs Up

12

[Vote up!](http://www.leeduser.com/vote/comment/7371/1/Thumbs%20Up/thumbsup/968d6dbb21bc16f8379ff671857f0c1d)

I did. That formula applies to any sensible load whether its a load on a coil or a load in a space. Appendix G assumes that ventilation loads are handled by the system prior to calculating the baseline supply airflow rate. That is why it specifically says you use a supply air temperature to room air temperature delta-T of 20F, it assumes a 55F SAT and a 75F room temp setpoint. So you are correct that if you add in the ventilation load the CFM/ton of a specific unit would be less than the 555 CFM/ton I mention.

The baseline does not assume you are using a "real world" piece of equipment.

[**Nina N**](http://www.leeduser.com/users/nettynina) [](http://www.leeduser.com/users/nettynina)

Jan 15 2010

Guest

20 Thumbs Up

**Baseline Fan Power Calculation (kW/CFM)**

20

[Vote up!](http://www.leeduser.com/vote/comment/852/1/Thumbs%20Up/thumbsup/b9ef7ba70bcd03057e4f455ffca16ec5)

What is the best way to calculate fan power (kW/CFM) as per section G3.1.2.9 of ASHRAE 90.1-2007? This is always a question we get asked from LEED reviewers and have gotten many different interpretations on how to calculate it. Also what is the best documentation to provide to the LEED reviewers regarding this issue?

Mail This

[**Shillpa Singh**](http://www.leeduser.com/users/ssingh) Senior Sustainability Manager, YR&G Jan 21 2010 LEEDuser Member 1364 Thumbs Up

16

[Vote up!](http://www.leeduser.com/vote/comment/900/1/Thumbs%20Up/thumbsup/407f4a326ff8d8b4fdc68a982cee58f0)

Yes, it is true that LEED reviews are coming back with comments on calculations for baseline fan power. The best approach is to run the calculations as requiried by ASHRAE 90.1 2007 G 3.1.2.9 and submit these backup calculations as supporting documents. Ensure to include both the fan brake horsepower and the total fan power. Use the fan supply volumes for each [AHU](http://www.leeduser.com/glossary/14#term4654). The supply CFM should be used to calculate the TOTAL fan power, and that fan power should then be broken up into supply, exhaust, return, etc.

Refer to ASHRAE 90.1 2007 Users’ Manual Page G-28 for more explanation of ASHRAE requirements. Below is an example from the User’s Manual:

The supply air volume for an 80,000 ft² medical office building is 120,000 cfm, as determined by the simulation program using a 20 ºF temperature difference between space temperature and supply air temperature as required by § G3.1.2.8. The baseline building HVAC system is system 5 (packaged [VAV](http://www.leeduser.com/glossary/14#term4931) with a gas furnace). What is the baseline building peak fan power?  
A  
Using the equation from Table G3.1.2.9, the brake horsepower for the baseline fan  
system is 136.5 hp as calculated below:  
bhp = 0.0013 × CFMS + A  
bhp = 0.0013 × 120000 + 0  
bhp = 156  
Lookup Table 10.8 for the next size greater than 156 bhp using the enclosed motor at  
1800 rpm, the fan motor efficiency is 95%, therefore, the fan power is 122,501 W, as  
calculated below:  
Pfan = bhp × 746 / Fan Motor Efficiency  
Pfan = 156 × 746 / 0.95  
Pfan = 122,501 Watts

Hope this is helpful.

Mail This

[**Jean Marais**](http://www.leeduser.com/users/maraisjean) b.i.g. Bechtold DesignBuilder Expert Jan 25 2010 LEEDuser Member 5667 Thumbs Up

17

[Vote up!](http://www.leeduser.com/vote/comment/918/1/Thumbs%20Up/thumbsup/fc85e32c279bd4783df3e2520b39b6c1)

Thank you for the explanation. Pitty there's no ASHRAE forum as good as this LEEDuser.

I had assumed that, although not explicitly stated, exhaust fans should be handled just like supply fans and the respective powers calculated the same way. Seems I was wrong.

2 issues still bother me...

1) If I design a out door air only system that has an exhaust fan half the size of the supply fan and ASHRAE 90.1-2007 says...

"If return or relief fans are specified in the proposed design, the baseline building design shall also be modeled with fans serving the same functions and sized for the baseline system supply fan air quantity less the minimum outdoor air, or 90% of the supply fan air quantity, whichever is larger."

...then it forces me to seriously oversize my exhaust fans for the baseline case (as the 90% rule would apply, since I have no recirculation).

2) As the proceedure includes a factor for conditioned spaces, it assumes that there's a cooling or heating coil in my Air Handling Unit, which their may not be. It also thereby excludes pure extraction / exhaust fans. What happens when I have 6 (not all nessesarily the same size) in-room recirculation fancoils per zone and say 20 zones with them, do I do this calculation possibly 6 x 20 times?

Mail This

[http://www.leeduser.com/sites/default/files/imagecache/forum_responder/pictures/picture-3483.jpg**Christopher Schaffner**](http://www.leeduser.com/users/chris_3) Principal & Founder, The Green Engineer, LLP Jan 28 2010 LEEDuser Expert 5687 Thumbs Up

16

[Vote up!](http://www.leeduser.com/vote/comment/959/1/Thumbs%20Up/thumbsup/7105b7f80609214549840d3eb6787dc6)

I'm diving in the deep end here - pretty good conversation already.

The key for getting the fan power consumption for both the proposed case and the baseline case close to accurate is to make sure that all the air movement taking place in the building (whether OA or re-circulation) is being accounted for in some way. There are several ways to do that. Keeping it simple and following the ASHRAE 90.1-2007, G3.1.2.9 and examples from the ASHRAE user’s manual works best.

What Shilpa has stated below is the method we use most of the time to calculate fan power consumption for our baseline cases and it works with the reviewers.

For the 2 issues stated below by Jean, here are our thoughts:

1) In my world the "goesintos" have to equal the "goesoutofs". If the OA system has exhaust fan just half the size of supply fan, then I would think that excess air would be exhausting through some other fan system in the design (toilet fans, etc.). The design fan power calculations should take account of this. For the baseline case, 90% rule would hold true as stated in AHSRAE 90.1-2007

With some exceptions (schedule differences, heat recovery in Baseline, etc.), it’s OK to consolidate fan types in the Baseline. The requirement is simply that the fans serve the same functions. Consolidating fans by function makes it much more straight forward to apply the ASHRAE rules.

The key to the fan power calcs is that they give TOTAL Fan Power. You basically just need to distribute that power appropriately to account for when it’s in use.

2) For fans which account as part of the process loads, and don't interact with other loads, (for example, garage exhaust fans) we typically perform a simple power consumption calculation, with an assumed usage schedule to estimate the fan’s energy use for a year.

The ASHRAE 90.1 User's Manual backs this approach up.

The 90.1-2004 User's Manual states in Section 6.5.3,  
"Fans that ventilate only, such as garage exhaust fans or equipment room ventilation fans that transfer only unconditioned outdoor air, do not qualify as a fan system in this context.  Fan systems must be part of a system with heating or cooling capability."

The user's manual provides a few additional useful clarifications regarding what constitutes a "fan system". Garage exhaust fans, stairwell pressurization fans, etc. should be modeled as miscellaneous load, with both the CFM and BHP per CFM modeled identically (except the motor efficiency in the proposed case can be modeled as improving upon the requirements of Section 10.4). LEED allows you to model other savings via control strategies, as an exceptional calculation measure ([ECM](http://www.leeduser.com/glossary/14#term4783)).

Regarding the question on fancoils, if we go by the ASHRAE methodology, we would do the calculations for each zone.

As an example, if the baseline system was PZS-AC and the design has 20 thermal zones, then for the baseline case each zone would be served by its own PSZ-AC, and yes, LEED reviewers expect you to size and calculate fan power for each of those PSZ-AC systems. So follow the same the same methodology for the design case.

Also to be noted is that the fan power calculation as described in section G3.1.2.9 is excluding any fan powered [VAV](http://www.leeduser.com/glossary/14#term4931) boxes which assume a fixed power consumption of .35W/cfm for the baseline case.

Mail This

[**Jean Marais**](http://www.leeduser.com/users/maraisjean) b.i.g. Bechtold DesignBuilder Expert Apr 16 2010 LEEDuser Member 5667 Thumbs Up

19

[Vote up!](http://www.leeduser.com/vote/comment/2114/1/Thumbs%20Up/thumbsup/08b69dc1a2d0574ea57ab586f3613932)

Christopher...regarding your following comments:

The 90.1-2004 User's Manual states in Section 6.5.3,  
"Fans that ventilate only, such as garage exhaust fans or equipment room ventilation fans that transfer only unconditioned outdoor air, do not qualify as a fan system in this context. Fan systems must be part of a system with heating or cooling capability."

The user's manual provides a few additional useful clarifications regarding what constitutes a "fan system". Garage exhaust fans, stairwell pressurization fans, etc. should be modeled as miscellaneous load, with both the CFM and BHP per CFM modeled identically (except the motor efficiency in the proposed case can be modeled as improving upon the requirements of Section 10.4). LEED allows you to model other savings via control strategies, as an exceptional calculation measure ([ECM](http://www.leeduser.com/glossary/14#term4783)).

My questions:  
1) WC exhaust only fan, from a "conditioned" WC, i.e. it has a radiator in it. Makeup transfer air flows into WC under door slot. "Fan systems must be part of a system with heating or cooling capability." --- does this mean a 'Ventilation' system or is the word system including my radiator? The space is 'conditioned' by the 90.1 definition. NB: There is no Supply Air in the building...it is naturally ventilated.

Mail This

[http://www.leeduser.com/sites/default/files/imagecache/forum_responder/pictures/picture-3483.jpg**Christopher Schaffner**](http://www.leeduser.com/users/chris_3) Principal & Founder, The Green Engineer, LLP Apr 17 2010 LEEDuser Expert 5687 Thumbs Up

16

[Vote up!](http://www.leeduser.com/vote/comment/2149/1/Thumbs%20Up/thumbsup/a427ab68f01f1abe88789584de0432e6)

Jean:

Re: 4/14 comment - we find the real opportunity for improvement is in air distribution design. If we can oversize ducts, coils and filter banks then we can reduce system static pressure, and therefore fan energy.

Re:4/16 comment - that fan energy must be accounted for somewhere in the model. Even with a "naturally ventilated" building, you are still comparing against a mechanically heated base case. I think your design case includes that fan only - it is the "system".