



Reducing Unmet Loads Using HAP 4.4

Introduction

When running HAP energy simulations under certain conditions unmet loads may sometimes occur.

This document will identify some of the causes of unmet loads and provide a process you may follow to identify and reduce or eliminate unmet loads.

Unmet loads in HAP are generated when the configured system (or plant) equipment capacity is smaller than the load imposed on the equipment. Unmet load hours in HAP can be checked by running the unmet loads report for the air system (when the plant is integral to the air system such as with DX equipment), for the plant (chiller or boiler plants) or in the LEED-NC EAc1 Report, as indicated in Figure 1.

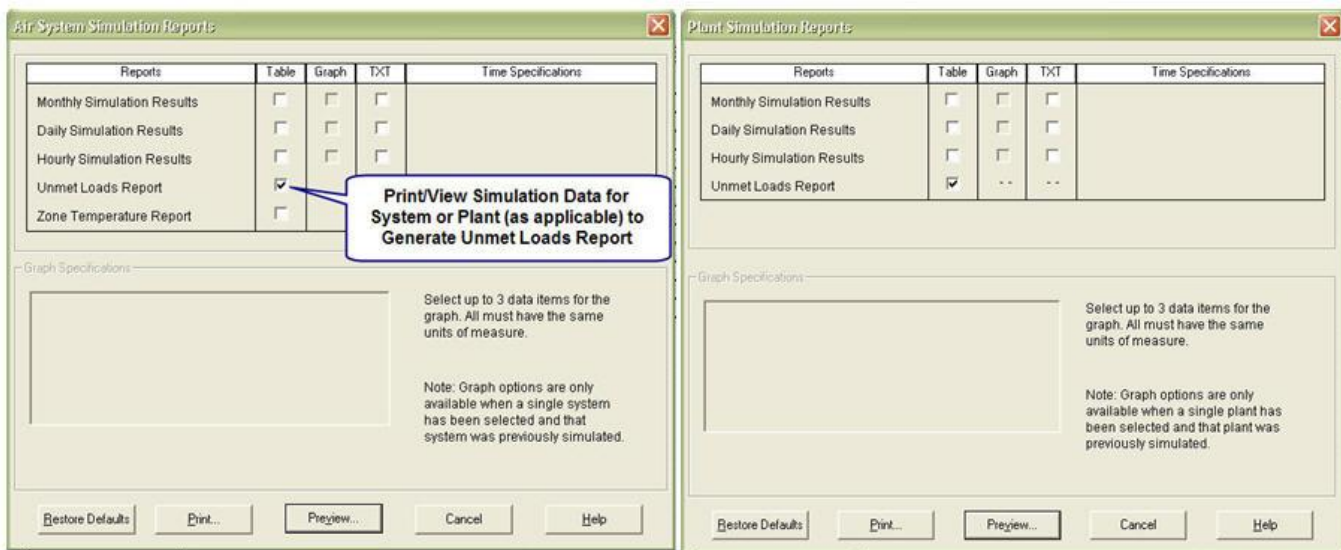


Figure 1 – Selecting Unmet Loads Reports

Eliminating unmet loads is especially important on LEED projects. According to ASHRAE 90.1-2004, Appendix G, “unmet loads for the proposed design or baseline building designs shall not exceed 300 (of the 8,760 hours simulated), and unmet load hours for the proposed design shall not exceed the number of unmet load hours for the baseline building design by more than 50.”

If you have excessive unmet load hours on a LEED report, this procedure will assist you in reducing or eliminating them. Before we look at specifics we will discuss some of the possible causes of unmet loads.



Reducing Unmet Loads Using HAP 4.4

General Information

Simulation Program Name and Version **Hourly Analysis Program v4.41**
 Simulation Weather File Name **Austin, Texas (TMY)**
 Total Conditioned Floor Area **26,304** ft²
 Total Floor Area **26,304** ft²

Building Designations

Proposed Building **Proposed Building**
 Baseline - 0 degrees **[B000] Baseline Building**
 Baseline - 90 degrees **[B090] Baseline Building**
 Baseline - 180 degrees **[B180] Baseline Building**
 Baseline - 270 degrees **[B270] Baseline Building**

Window-to-Wall Ratios

	Proposed Design	Baseline
Window to Wall Ratio	18 %	18 %
Gross Wall Area (ft ²)	13,571	13,571
Vertical Window Area (ft ²)	2,485	2,443

Unmet Loads Indicated on LEED EAc1 Report

Advisory Messages

	Proposed Building	Baseline Building (0 deg. rotation)	Difference
Number of hours heating loads not met	0	0	0
Number of hours cooling loads not met	34	2	+32

Figure 2 – Unmet Loads on the LEED Summary Report

What Causes Unmet Loads and How Do I Reduce or Eliminate Them?

You can get unmet loads for several different reasons:

1. Simulation Weather Is More Extreme Than Design Weather. There are two sets of weather data used in HAP, the ASHRAE 0.4% design weather (for performing design load calculations) and the 8,760 hr simulation weather (for performing energy simulations and operating cost calculations). The definition of summer and winter design value is that these values are exceeded for a certain number of hours per year. For example, the 1% summer value is exceeded almost 90 hours (0.01 x 8,760) in a typical year. Because of this and the way the simulation weather is compiled, there are a number of hours where the simulation weather is warmer or colder than the design conditions.

HAP uses the 0.4% design weather to perform the sizing of components. When running a simulation however, HAP uses the simulation weather dataset. Unless you use a capacity over-sizing factor for the equipment or plant, the sizing of the equipment or plant may be slightly undersized for a few hours each year resulting in unmet loads.

One possible solution is to use a small over-sizing factor when selecting plant equipment if unmet hours cannot be eliminated by the other methods discussed in this document.

2. Pull-down (or warm-up) Loads May Require Starting The Fan/Thermostat Occupied Schedule Earlier. If you have a hot weekend or a long weekend when equipment is shutdown or in night setback or setup, the Monday morning pull-down load may be substantial. This can also happen when you have a fractional schedule assigned that allows a significant amount of internal heat gains such as lights, electric equipment and people to be present during the unoccupied periods. Even a small amount (such as 10-20%) of internal loads can saturate the building with heat and if the building is well-insulated, like most buildings are today, this heat cannot escape and must be removed by the HVAC equipment the next day at the onset of the occupied period as determined by the fan-thermostat schedule.



Reducing Unmet Loads Using HAP 4.4

There is a simple, fast check that you can perform to determine how much effect, if any, the pull-down (or warm-up) loads are contributing to the unmet loads problem. To do this set the unoccupied thermostat setpoints the same as the occupied setpoints to eliminate any setback or setup then re-run the simulation calculations. Any resulting change in unmet loads is due to the pull-down or warm-up effects.

Once you have determined the magnitude of the pull-down or warm-up loads go back and set the thermostat setpoints correctly again. Starting the system earlier will allow the system more time to remove the residual heat buildup from the night before prior to the additional internal loads coming online. You might also consider using a small oversizing factor such as 5-10% to help reduce the pull-down loads faster.

Another solution might be to start the thermostat occupied period one or two or even three hours earlier than when the lights and other internal loads come on. You will have to experiment with this to see the effects. Also be sure that fractional schedules for all internal loads are realistic and accurate, including the day type assignments. That is you make sure you do not have internal loads scheduled on during the unoccupied periods if they are not supposed to be. Doing so will result in a lot of residual heat buildup during the unoccupied time periods exacerbating the pulldown problem.

3. Lack of Low-Temperature Operation. If you are using packaged DX equipment and have not configured an airside economizer, you may generate unmet cooling loads if the building requires cooling when it is cool outside (like with most commercial buildings). If you are not using an airside economizer you will need to specify low-ambient control which allows mechanical cooling to operate down to a lower ambient temperature. The screenshot below shows this input. With no airside economizer, and no low-ambient control configured, there is no way to cool the building and HAP will typically report unmet load hours on cooling.

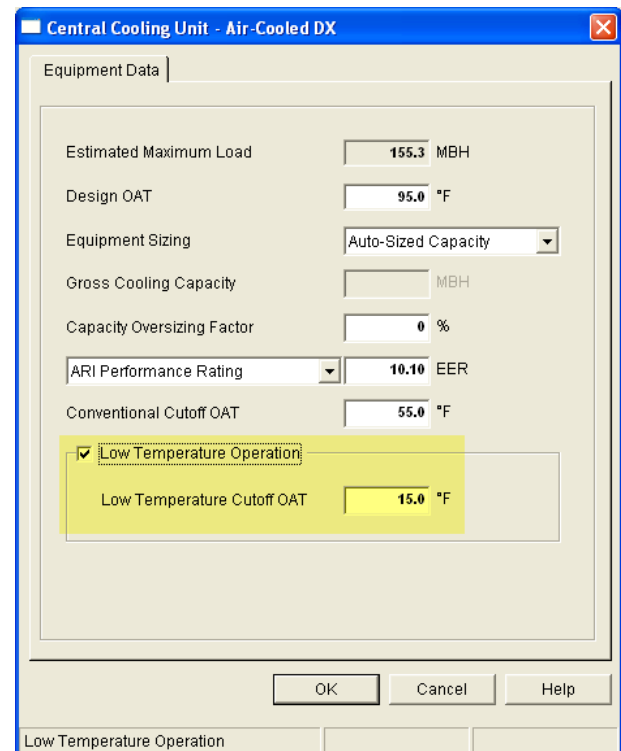


Figure 3. Selecting Low Temperature Operation



Reducing Unmet Loads Using HAP 4.4

4. Improper DX Equipment Modeling. When specifying DX equipment performance you need to observe the following rules:

- Specify the Design OAT (or Design EWT for water-cooled equipment) at the expected peak design condition, or if peak loads have already been calculated - specify the actual peak temperature reported.
- If you specify the gross capacity directly (not use auto-sizing), specify equipment capacity corresponding to that Design OAT or Design EWT, whichever is appropriate.

If you leave the Design OAT or Design EWT at the standard default value (typically an ARI or ISO/ARI value), then your gross capacity corresponds to that temperature, and at warmer temperatures you will have less cooling capacity available and that may result in unmet loads. A deviation of a few degrees (e.g., actual peak of 97 F vs the ARI standard value of 95 F) may not make much difference, however a difference of 5, 10 or 15 degrees often results in unmet loads.

5. WSHP Equipment Configuration Not Correct. Accepting the default values for cooling design EWT and heating design EWT can sometimes generate unmet load hours. Accepting the default design EWT for WSHPs is more likely to cause unmet load problems than with other types of equipment. The following example illustrates why this can occur.

Example: Suppose you are designing a WSHP system and have a WSHP loop with setpoints of maximum 95 F and minimum of 55 F, as shown in Figure 4.

When specifying equipment performance, assuming you accept the defaults:

Cooling Design EWT = 86 F

Heating Design EWT = 68 F

And you also specify auto-sizing with 15% capacity oversizing for cooling and 25% for heating, as shown in Figure 5.

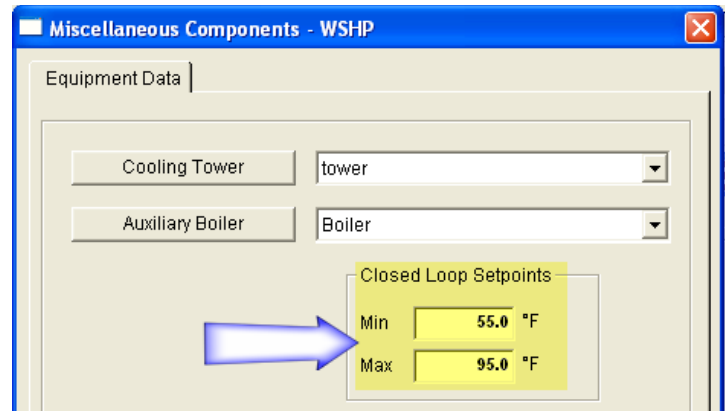


Figure 4. WSHP Loop Setpoints

Assuming one of the zones has a peak cooling load of 60 MBH and you set a 15% capacity oversizing factor this means you will get 69 MBH (60 x 1.15) cooling capacity at 86 F EWT. Now, because your upper loop setpoint is 95 F, the WSHP will spend most of its cooling duty operating hours at 95 F, not 86 F. At the warmer EWT of 95 F EWT you have about 65.4 MBH capacity or about 5% less capacity than at 86 F EWT. So instead of having a 15% safety factor, you essentially have only a 9% safety factor. This smaller safety factor increases the risk of unmet hours, especially for times like pulldown or on unusually hot days.

A similar situation exists for heating. Suppose you have a peak heating load of 50 MBH with a 25% capacity oversizing factor. This means you will get 62.5 MBH (50 x 1.25) heating capacity at 68 F EWT. Now because your lower loop setpoint is 55 F, the WSHP will spend most of its heating duty operating hours at 55 F, not 68 F. At the colder EWT of 55 F you have about 58.3 MBH capacity, or about 7% less than at 68 F. So instead of having a 25% safety factor, you essentially have a 17% safety factor. Again, the smaller safety factor increases the risk of unmet hours, especially for warmup hours or for unusually cold days. The solution is to make sure you specify your Design EWT values equal to the setpoints of your system, 95 F for cooling and 55 F for heating.



Reducing Unmet Loads Using HAP 4.4

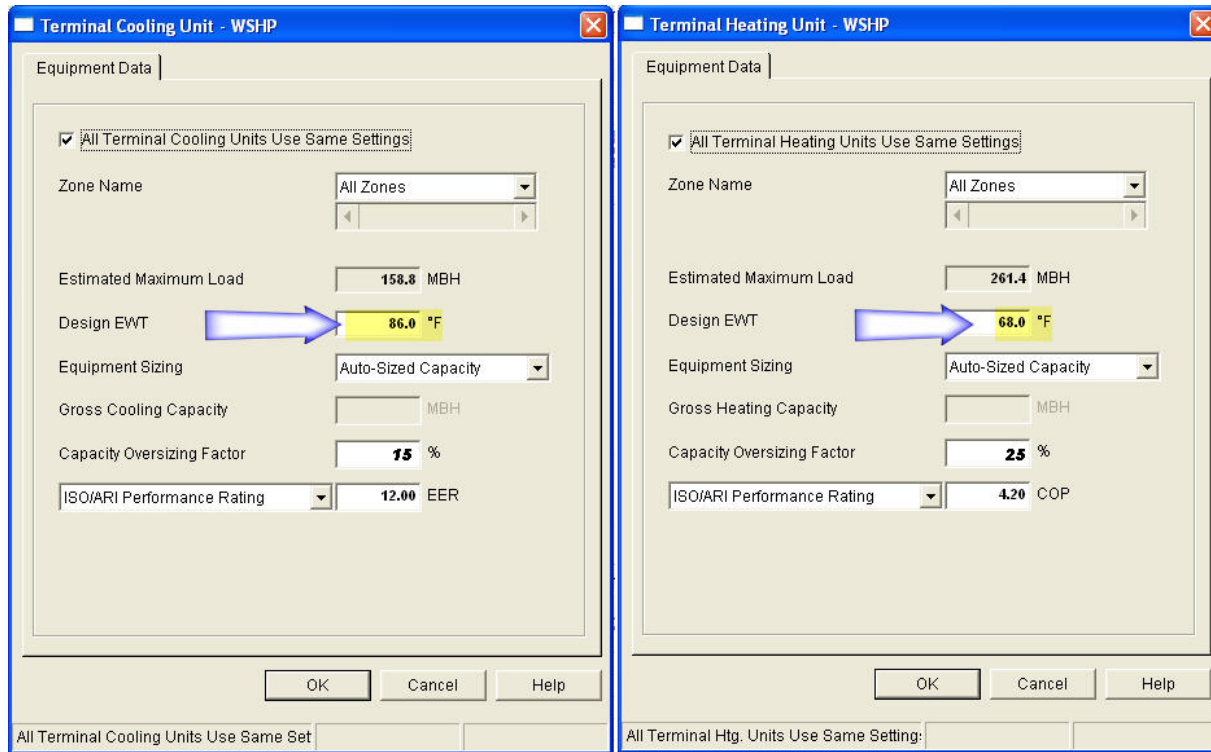


Figure 5. WSHP Cooling and Heating Equipment Inputs

Because of how WSHP systems operate - most operation is near the max loop setpoint or min loop setpoint, any shortage of capacity is magnified - the problem can persist for many, many hours. For equipment like air-cooled DX, you spend a few hours at hot temperatures so any capacity shortage only generates a couple unmet load hours.

Another thing users are sometimes confused about is they think the Design EWT must match the ISO/ARI rating condition if they are specifying EER or COP ratings. **This is NOT true. The user should always input the Design EWT based on their expected operating conditions for the system.** For WSHP systems this means using the loop upper and lower setpoints for cooling and heating respectively. For GWSHP and GSHP systems this means using the max and min source water temperatures for cooling and heating respectively.

Conclusion

It is paramount when analyzing LEED projects to develop the habit of checking the unmet loads report to then conform to the requirements mentioned on page 1 of this e-Help. This discussion on reducing unmet hours provides you with valuable tips on how to reduce unmet hours accordingly. As always, please send us your feedback and comments.