AboveAir Technologies

Design Note: High Latent Load Design - Exercise Studios and Gym Spaces

Designing Exercise Studios and Gym Spaces (Spin Classes for example) present unique challenges. Such spaces experience varying occupancy loads and accompanying ventilation requirements. Using commonly applied design guidelines often leads to space humidity control issues and unhappy occupants. The common mistake is failure to consider the latent load during the design phase. While ASHRAE 62.1 prescribes a minimum outdoor airflow rate for air quality, it does not address humidity control. This must be considered during the design phase of the project and equipment must be sized to control both sensible and latent load.

We present the following examples to illustrate this in a hypothetical fitness studio. The American College of Sports Medicine recommends a space design temperature of 68°F-72°F for fitness spaces; AboveAir recommends designing around 72°F to fall within this temperature range while minimizing your equipment size and energy consumption.

Case 1: A Fitness Studio, 55°F DB/54°F WB Supply Air

Consider a fitness studio dedicated to a spin class. The 1,000 ft² studio is outfitted with 12 stationary bikes and a 50" LED TV. We assume 100 W for the TV and 0.9 W/ft² for lighting. Each occupant contributes 710 BTUh sensible and 1,090 BTUh latent while engaged in high effort exercise. We are ignoring any envelope loads for this example. The loads are summarized in the table below:

	Sensible (BTUh)	Latent (BTUh)
People	8,520	13,080
Equipment	341	-
Lighting	3,069	-
Total	11,930	13,080

Our space design condition is 72°F DB/50% RH and we assume a typical comfort cooling supply air temperature of 55°F DB/54°F WB. For latent load calculation, the corresponding conditions are 58.6 grains/lb and 60.7 grains/lb, respectively. Based on these conditions, we calculate the airflow required to meet both the sensible and latent loads (rounded to the nearest 10 CFM).

Sensible Design	CFM=11,930/(1.08*(72-55))	650 CFM
Latent Design	CFM=13,080/(0.68*(58.6-60.7))	N/A

From these numbers, we can immediately see that we are going to lose control of the space's humidity because our space design condition is dryer than our supply air. *We will never control the latent load.* If you have been asked to redesign a fitness room that feels like a sauna, you are aware that this is a common issue. The latent load will not be satisified and will reach an equilibrium far greater than the design condition.

Case 2: A Fitness Studio, 50°F DB/49°F WB Supply Air

In this case, we will assume that the HVAC system is designed with a colder supply air temperature; we will use 50°F DB/49°F WB supply air which is a reasonable design air condition for medium temperature HVAC equipment. Our space design condition remains 72°F DB / 50% RH. The humidity ratios for our latent load calculations are 58.6 grains/lb for the space and 50.0 grains/lb for the supply air. Based on these conditions, we calculate the required airflows again (rounded to the nearest 10 CFM).

Sensible Design	CFM=11,930/(1.08*(72-50))	500 CFM
Latent Design	CFM=13,080/(0.68*(58.6-50.0))	2,240 CFM

By using cooler, dryer air we are able to meet the design condition of 72°F DB / 50% RH. We also note that the space must be designed around the airflow required to meet the latent load; if the unit is designed to meet the sensible load only then we will still lose control of the space's humidity.

Design recommendations

- Use 50°F for the leaving air temperature off of the cooling coil to maximize dehumidification. This lower leaving air temperature minimizes the required airflow to meet the space sensible and latent loads while remaining in the range of medium temperature HVAC unit design.
- Dehumidification requires reheat. Always specify hot gas reheat in DX units; hot gas reheat uses waste heat from the refrigeration cycle to reheat the air when you do not need sensible cooling.
- Make sure you check the airflow required to meet both the space's latent and sensible loads. When a space has a high latent load, the airflow required to meet the sensible load may not be adequate to dehumidify the space.
- Applications with outdoor air percentages greater than 20% should utilize our HPOA control sequences. The MC-3000/4000P Primary control may be selected if your desire a stand-alone unit that will control the space directly while the MC-3000/4000V VAV sequence may be selected if you would prefer to feed multiple VAV boxes to control your space.
- If your outdoor air percentage is lower, we recommend one of our MC-2000 control sequences. The MC-2000RH sequence provides temperature and humidity control. For extra energy savings, consider the MC-2000SZ control sequence. The single zone VAV sequence will allow airflow to be reduced to meet the load requirements of your space and its varying occupancy.

For more information or assistance in selecting the right product for your application, contact sales@aboveair.com or visit http://www.aboveair.com.