

Home Theater HVAC Design

OPTIMIZED HVAC DESIGN IS CRITICAL FOR VIEWER COMFORT

Goals for Home Theater HVAC Design

- Quiet by Design:
 - 1) Duct work must be designed with very low air velocity.
 - 2) Duct work must be internally lined to quiet air noise and eliminates sound leakage in and out of the room.
 - 3) Where possible employ multiple turns in the duct to control sound leakage and equipment noise.
 - 4) Use equipment with a low operating sound pressure with variable speed motors to eliminate abrupt start and stop.
- Independent system:
 - 1) A dedicated system can respond quickly to demand.
 - 2) Does not share duct work eliminating sound leakage.
 - 3) Low operating cost when not in use.
 - 4) System can automatically shift from heat or cooling without affecting other areas of the residence.
 - 5) System will need the ability to operate cooling during low ambient outdoor conditions based on occupancy.
- Indoor Air Quality
 - 1) Introduce fresh air to room and have 4-6 air changes per hour
 - 2) Consider using a heat recovery ventilator to balance fresh air with exhausting air and reclaim heat.
 - 3) Size system properly to take on additional load during extreme outdoor ambient conditions.
- System and Design
 - 1) Integrate HVAC design with sound design parameters
 - 2) Integrate functional design with aesthetic design

Achieving the Home Theater HVAC Goals

1. **Sizing the correct unit:** Conventional methods such as BTU's per square foot are not applicable for home theater load calculations. A home theater should be sized based on occupancy and heat loads from other sources such as lighting and equipment. Also consider what the additional load may be for introducing a fresh air source.
2. **Choosing the correct equipment:** Once the heat and cooling loads have been calculated, consider the equipment that is right for the job. A separate heating and cooling system is required since there are often cooling demands (max occupancy) during low ambient outdoor temperatures, when normal home HVAC systems are in heating mode. There are some very good residential zoning systems but they will not keep the home theater regulated properly and quietly like a dedicated system. Variable speed indoor blowers, using logic that allows the air flow to be tailored to the demand on the system, use a soft start ramp up of the blower to eliminate sudden starts and stops. It is better to slightly over size the air handler and use slower fan speeds to create a quiet stable air flow. Due to the wide variation in load conditions, multiple speed compressors or even better, the use of variable refrigerant volume units is highly recommended. Heat pumps using the technology mentioned above are used quite often, since they provide a soft heat for the rare occasion when heating is required and can operate in much lower outdoor conditions than their predecessors. More importantly, a heat pump eliminates the sound of fossil fuel furnace.
3. **Site survey and existing equipment:** If the home theater is being installed as a renovation to an existing home, then a site survey is essential. Most residential duct work is not insulated since it is in a conditioned space. It is best if the existing duct work, that services rooms other than the theater, can be moved or relocated outside the theater room. If this is not possible then it must be wrapped with R9 duct wrap. A site survey will alert you to others mechanical issues such as insulating water pipes, checking the water pipes are secured properly to eliminate "creaking". Since a home theater is a permanent fixture with a relatively high cost per square foot, it is essential to establish that all mechanicals, isolated by the home theater build out, must be in excellent condition or better yet relocated to an accessible area of the home if service or periodic maintenance is required. Finally the site survey should yield the location of the new dedicated home theater HVAC equipment and the duct work required to quietly flow the correct amount of air given the required capacities.
4. **Duct work design:** The existing duct work will require modification as described above but what about the new duct work? The new duct work design attached to the dedicated equipment must account for sound leakage (in and out of the theater space) since it is inevitably a conduit to the outside of the theater room. The supply duct work design must be large enough to be heavily lined, maintain a low velocity at maximum volume output and have adequate CFM distribution throughout the theater to prevent drafts and hot spots. (CFM: cubic feet per minute.) The return duct work has the same requirements as the supply duct but with larger volume to slow the air velocity and incorporate enough bends to prevent noise intrusion while insuring the air handler is not "choked off" from receiving an adequate amount of air. The introduction of bends and elbows are usually required (rather than eliminated in a traditional system) to help reduce the sound from entering or leaving the space (noise intrusion). The air moving

equipment must be matched to the additional static pressure created by the design of “quiet duct work”. The duct work, the large return registers and the supply registers must be integrated into the aesthetic design of the room with out compromising the functionality of creating “quiet duct work”. The positioning of the registers is essential to how the sound reacts in the theater space requiring detail design specifications to ensure proper integration with regard to sound design.

5. **Indoor air quality: IAQ is extremely important in HT HVAC design. Oxygen** deprived people do not have a good entertainment experience. IAQ standards call for at least four air exchanges per hour. With the high density of people at max occupancy of most home theaters, it is suggested six exchanges per hour. Bringing in outdoor fresh air should be introduced into the return side of the duct work design so the air can be filtered and conditioned prior to entering the room. A bird screen and a weighted back draft damper are required at minimum. The best design is to integrate a heat recovery unit with the dedicated theater HVAC system. A heat recovery ventilator (HRV) reclaims energy that is normally lost through air exchange, and can have its own reheat unit to further temper the incoming air during extremely cold outdoor ambient conditions. A HRV actively exhausts air while introducing outdoor fresh air that has been tempered by the leaving exhaust air. An HRV will filter the air, i.e. actively exchange air even when the HVAC system is not calling or active. When designing and sizing an HRV for home theater, the unit can be sized to exchange air in other parts of the home as well, provided, a positive air pressure is maintained in the home theater by proper air balance of the supply and exhaust.
6. **Controlling the system:** It is recommended that the control of the system be performed by a digital thermostat with a very small dead band of $\pm 1F$ and have auto system changeover from heat to cool. Thermostat placement must be considered with regard to supply duct work vs. return duct work and still integrate with the aesthetics and sound requirements. Many times, the control is integrated with a whole house controller on a touch pad. This is fine provided it works well with the chosen equipment. Most manufacturers of “high end” HVAC equipment require the use of a thermostat specifically designed for their equipment. In this case form should follow function.

Conclusion

To create the ultimate entertainment experience, the design of home theater heating, ventilation, air conditioning system with its unique set of requirements, must be strictly followed. A quiet efficient system is critical. The HVAC design is an important starting point of the home theater design process. It must be integrated with sound design requirements and may be seen but never heard.