

# AIR CONDITIONING AND REFRIGERATION Journal

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## Air Conditioning of Multiplexes

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Over the past 5 years, India has seen a major revolution in the entertainment industry. The young generation today, believes in working hard, earning well and spending lavishly on recreation. Having all the entertainment facilities such as food courts, shopping malls, super markets, restaurants, theatres, video games parlour, bowling alley and discotheque under one roof is becoming common. A Multiplex is a building complex which provides all these facilities. In a tropical country like India, comfort air conditioning of entertainment centres is inevitable. The first fully air-conditioned Multiplex in India was launched in Ahmedabad four years ago, and after that another five or six Multiplexes have sprouted in Ahmedabad alone. Throughout the country more than a 100 Multiplexes are under construction or already complete and more than 500 are at various stages of planning.

### System Design and Selection

Designing the HVAC system for a Multiplex is a complex task as the design must satisfy a specific set of requirements which are unique to each area. The inside design conditions

like temperature & RH, noise level, ventilation or fresh air level and flexibility in operation play a vital role in selecting the high and low side equipment.

The different areas in a Multiplex can be broadly classified from the design point of view into critical, semi-critical and non-critical areas as shown in **Table 1**.

<b>Critical Areas (<math>22 \pm 2^{\circ}\text{C}</math>)</b>	<b>Semi-Critical Areas (<math>24 \pm 2^{\circ}\text{C}</math>)</b>	<b>Non-Critical Areas (<math>26 \pm 2^{\circ}\text{C}</math>)</b>
Theatres & Projector Rooms	Food Court, Restaurants, Entertainment and Shopping Areas	Atrium, Lobbies and Passages

## Theatres

Theatres generally have large volumes and ventilation air requirements, resulting in large cooling loads with a high latent heat load and large air quantities along with a very critical noise level to be maintained (25 db). Requirements also vary, depending on the popularity of the movie running in the theatre, its show time and the holiday season. One has to keep in mind, not to exceed air velocities in ducts above 1000 FPM and also the location of supply air and return air outlets. Generally, it is recommended that supply air be introduced from the top through diffusers and return air be collected from the bottom, below the seats to maintain the desired air flow pattern.



Planning for return air is very critical and should be coordinated with the architects and structural consultants at a very early stage of design. It is also advisable, to install double-skin AHUs with a VFD drive and chilled water control (3-way or 2-way valves) for economical operation of the plant. Automation including CO<sub>2</sub> sensors to modulate the fresh air quantity, should also be planned to reduce operating costs.

Sheet metal air ducts should not be located near sound boxes (behind the screens) to avoid noise interference.

The location of AHU rooms is also important and should be planned at an early stage of building design. Ideally the location should be at a substantial distance from the

auditorium, preferably with ducted supply air and return air. In case AHU rooms are very close to the auditoriums, sound attenuators should be provided to reduce noise transfer from the AHU room. Vibration isolators should be used below the AHU and at fan outlets to avoid transfer of vibrations to the duct feeding the auditorium or theatre. It is further recommended that flexible connections be used between the main ducts and supply air diffusers to eliminate transfer of any vibration or noise.

## Projector Room (Bio Box)

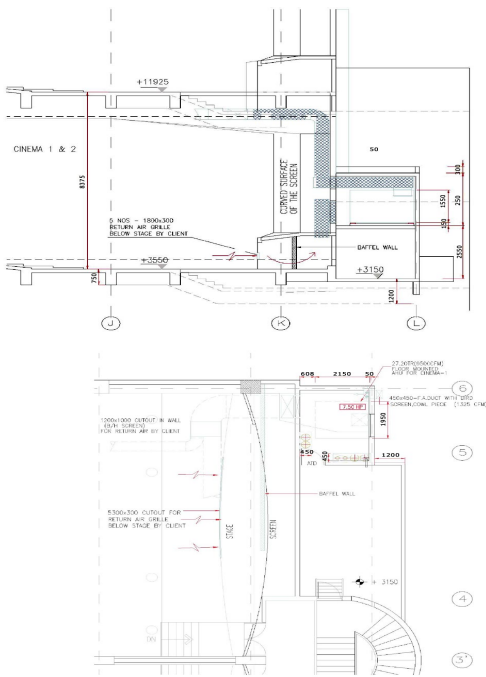


Figure 1 : Return air arrangement below the stage. AHU behind sound box with buffer wall to isolate sound

### [Click to view clear picture](#)

This is the heart of any theatre and besides maintaining proper temperature, relative humidity and noise level, it is essential to design an excellent air distribution system due to the high heat generated by the projector lamps.

A 100 per cent stand-by ventilation unit is recommended for the projection area. Capacity of the ventilation unit should depend on the specification of the projector manufacturer and may vary from manufacture to manufacturer. Automation of projector ventilation system is a must and it should start 15 – 20 minutes before the projector starts and stop 15 – 20 minutes after projection stops, ensuring removal of all heat from the machine. Condensation of any kind on the Xenon bulbs of a projection machine can lead to damage of bulbs, which are very expensive.

It is important that the HVAC design engineer interacts with the projection machine supplier, prior to finalization of the system design for this area. Many projection machines require chilled water cooling in the form of a plate-type secondary heat exchanger. Normally, they require water at 13°C to 15°C with the cooling load not exceeding 3 ton. A dedicated water cooler could also be considered in case auditoriums are being cooled by a DX type system or there are constraints for running chilled water lines to the area. However, the noise of such a cooler may cause serious problems so it requires planning at an early stage.

The side walls of the projector room which are common for 3 to 5 theatres is not available for running air conditioning ducts or exhaust ducts or chilled water lines as they will have rollers and movie film space and therefore this area becomes critical. It is always recommended to plan for dedicated AHUs / exhaust units for each projector room so that transfer of sound from one theatre to another is avoided. The exhaust from the projection system can be connected to the main duct through flexible ducts to isolate vibrations. Precision air conditioners can be considered for this critical room as the equipment costs several crores to the owners.

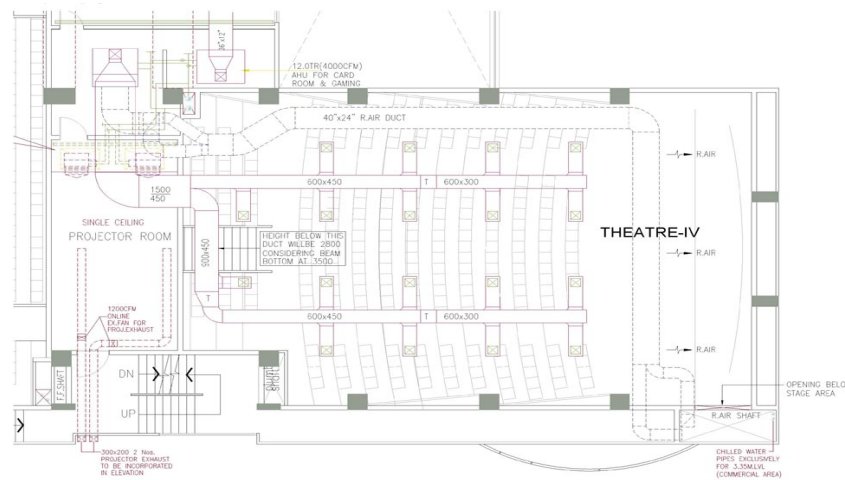


Figure 2 : Return air below the stage with AHU on opposite end

## Food court

This is another area of a Multiplex with large occupancies. Food courts are generally, not separated physically from the public areas. Here, it is important to maintain the right airflow direction to avoid food odours leaking to atriums and subsequently to all the other areas of the building. Also, proper ventilation air quantity should be planned so as to provide for air exhaust from the kitchen. The cooking areas should always be maintained at negative pressures.

An efficient kitchen ventilation system must be planned along with a suitable hood and filters to collect the contaminated, oily, exhaust air from the kitchen. Normally food courts

are on the ground or first floor level of the building and hence the layout of fresh air and exhaust ducts leading to the terraces should be well coordinated with the building structure. Also the exhaust from the food court should be located, keeping in mind the wind direction to avoid its direct entry to the fresh air inlet of theatre AHUs.



Proper planning of fumes coming out of the popcorn machine should be ensured. The soda-fountain machines control room also requires a dedicated air conditioning system and must be designed with proper space planning.

## Recreation Area

This another popular part of any Multiplex building with high sensible loads resulting in large air quantities. The critical point here is the noise contamination which can be avoided by planning a separate air distribution system for the area.

The location of supply air outlets should depend on the equipment loads and occupied areas to ensure comfortable and consistent inside conditions.

## Atrium / Public areas

This is a non-critical but important area of any Multiplex, where the occupancy is mainly in transit. The occupancy level will vary depending on the show timings. Here, the design conditions can be kept slightly higher, say 26°C and 60% RH with less ventilation air to reduce the overall cooling load. Planning should be such that the air distribution should be in the occupied areas only and attic spaces should be ventilated properly. The HVAC designer must take care of the smoke evacuation system from the atrium areas along with pressurization of stairwells and lift shafts and integrate these requirements with the fire detection systems.

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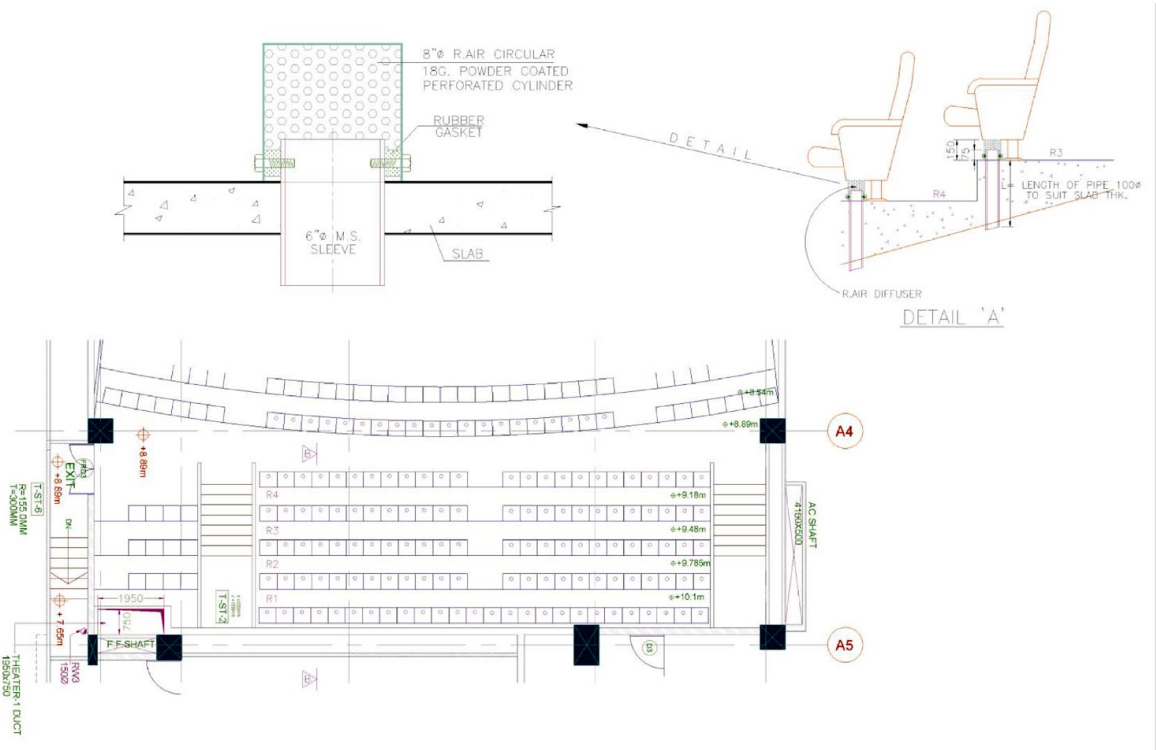


Figure 3 : Collecting return air below the seats

## Chiller / Equipment Selection

Multiplexes, due to their variable requirements, occupancies, operating time and usage, require chiller package modules with multiple circuits for flexibility in operation. For example, a 5-screen Multiplex having a total cooling load of 400 ton can have a requirement of 40 – 50 ton minimum with 300 – 320 ton maximum. The ideal chiller selection can be 160 ton x 2 nos., each with two independent circuits of 80 ton, which can meet any requirement very economically. The use of an energy storage system can be an ideal solution for such applications.

Up to now, in many of the Multiplexes, all the areas in the building were owned by a single owner, so it was advisable to have a single, centralized chilling plant, to enjoy the advantages of different diversities.

But the scenario is changing today and all the parts of a building are not necessarily owned by the same person. The theatre and atrium may belong to one owner, while the food court and restaurants to another. Recreation areas are usually owned by a third person and the shopping malls may be by a fourth owner. In such cases, multiple separate utilities for different areas or one centralized plant with a proper BMS for billing of utilities, can be planned.

The location of chiller plants, cooling towers, and AHUs is very critical and must be well coordinated with the architects and structural consultants and interior designer at the

planning stage, with clear understanding of the supply and return air paths. Also very careful thought should be given to isolation of vibration generated by all the mechanical equipment such as chillers, pumps, AHUs etc. by using vibration isolation mountings below the equipment and flexible connections at the inlet and outlet of equipment to avoid transmission of vibration to the pipes and ducts.

A Multiplex could have more than 3000 occupants on a busy day and therefore the air distribution system should be well designed and separated in a modular way to avoid transfer of fire from one system to another, in case of any emergency. Integration of the fire detection and fire fighting with the HVAC system is very important in a Multiplex building. Use of fire dampers and tripping of AHUs with a detection system should also be planned properly. Many theatres are provided with VESDA type fire detection system and the HVAC designer must ensure its installation with capillary tubes in the return air path for early detection of fire in auditoriums. (VESDA is the name of a company that manufactures a very sensitive fire detector installed in the return air path thus eliminating sensors normally located inside the auditorium)

## **Building Management Systems**

A BMS system plays a vital role in operating such a huge system, having multiple requirements. The BMS can accurately determine the requirements of individual areas on the basis of pre-determined parameters in its memory and accordingly try to maintain them by regulating the controls.

This precise management system saves energy which is not possible by manual controls without BMS.

BMS can be planned not only for the HVAC but also for other utilities like water management, power management, DG management, elevator management and integration with fire, P. A. and security systems. Use of BMS will ensure optimizing energy cost and reducing operation and maintenance cost.