



Air Conditioning for Domestic Airport Terminals

Representative view of a domestic airport terminal

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Finally making up for lost time, India's airports are being upgraded and modernized at a fast rate, with the help of the private sector. The Airports Authority of India (AAI) currently owns 127 airports including 16 with international services, 79 domestic airports and 27 civil enclaves in military airfields. However, only about 60 of these have worthwhile, regular, scheduled services, which is totally inadequate for a country of 1.1 billion people.

However, things are beginning to change. Two totally new green-field airports have started operations, one at Bangalore and the other at Hyderabad. The existing airports at Mumbai and Delhi are being upgraded substantially to meet the increasing traffic demand. Kolkata and

Chennai airports are being modernized and the HVAC contracts for these have just been awarded.

Beyond these major airports, AAI is also developing and upgrading 35 selected non-metro airports ranging from large ones like Ahmedabad, Amritsar and Trivandrum to small ones at Dinapur and Dehradun. The airside work will be carried out by AAI, while landside developments are being left to private companies.

This article deals with the design features of the HVAC works at more than a dozen, non-metro domestic airports and highlights various facets of the HVAC system. The author has been involved in the design and installation work in all these airports.

The total chiller capacity, including

working and standby of some of the airports is shown in *Table 1*.

Specific Design Features of the Building

The main concourse areas, which include the arrival and departure halls, ticket counters and baggage claim, are all double height areas with imported insulated sandwich-panel roofing. With good aesthetics and a powder coated finish, the panel gives both a good appearance and acts as an excellent insulation barrier. As such, no false ceiling or boxing has been

About the Author

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Airport	Modular Expansion (ME) or Greenfield Project (G)	Total Chiller Capacity TR	Working TR	Standby TR
Ahmedabad	G	3415	2770	645
Amritsar	ME	1800	1200	600
Aurangabad	G	1200	900	300
Dehradun	G	246	164	82
Jaipur	ME	1500	1000	500
Khajuraho	G	900	600	300
Madurai	G	1200	900	300
Mangalore	G	1200	900	300
Nagpur	ME	1200	900	300
Pune	ME	780	780	NIL
Trivandrum	G	1800	1200	600
Varanasi	G	1500	1000	500

used in these high-ceiling areas. These areas are also spacious with large spans. This posed a challenge to carry out equitable air distribution. The manner in which this was achieved is explained later in this article.

The panel-type roof could not be used for fresh air intake or exhaust openings. Therefore a solution needed to be found to circumvent this design feature of the building.

In some of the installations, it was necessary to run exposed ducts. Spiral GSS or SS ducting was used for this purpose and the ducting needed to be neatly supported through hangers which had the requisite strength and were aesthetically acceptable.

Inside Design Conditions and Fresh Air Considerations

The terminal building, except the plant rooms and other utility areas such as the electrical rooms and toilets, are air conditioned at comfort level at the following conditions:

- Main concourse 23 ±1°C, RH 55 ±5%
- Office areas 24 ±1°C, RH around 60%

Fresh air/outside air flow rate is critical, these being public areas with large volumes of human traffic.

In some of the airports, minimum fresh air at rates calculated on the basis of ASHRAE Standard 62N have been specified by the consultants (see Table 2). In these cases, outside air is taken from the exterior side walls of the terminal building through fan/filter units and ducted up to individual air handlers in the mixing box of the AHU.

Sr. No.	Area Description	Fresh Air Quantity
1.	Concourse area	0.25 l/s per m ²
2.	Office area	2.5 l/s per m ²
3.	Duty-free shopping and other areas	1.0 l/s per m ²
4.	Restaurant, cafés, etc.	2.5 l/s per m ²

Table 2 : Fresh Air Quantity.

In other airports, the consultants have opted to go in for an ozone system in which a controlled amount of ozone is let into the supply air stream, thus reducing the outside air intake in such systems.

The ozone generator is installed on a frame inside the supply air ducts and the controlled ozone mixes with the supply air

stream. The regulation of the ozone is maintained by an auto VOC sensor installed in the occupied zone/return air duct. The ozone is now available to oxidise any organic or volatile pollutants in the space. Thus the fresh air requirement is considerably reduced.

In those cases where ozone has been used, the rate of fresh air has been taken on the basis of 5 CFM per person. The number of persons in the given space has been specified and is used to calculate the fresh air required.

Outdoor air volumes and carbon dioxide levels are constantly monitored and controlled amounts of ozone are injected in the supply air stream to maintain indoor air quality.

Centralized Chilled Water System

All the airports have centralized, water-cooled, chilled water plants. The chillers are housed in a plant room remote from the terminal building, in a utilities block. The utility block also houses DG sets, transformers and main electrical rooms required for the airport building.

Water chilling units (screw chillers or centrifugal chillers) with R134a as refrigerant, work in conjunction with condenser water pumps, constant-flow primary chilled water pumps and variable flow secondary chilled water pumps. Energy efficient screw chillers (up to 300 TR each) and centrifugal chillers for requirements of above 400 TR each have been specified. The IKW/TR not exceeding 0.68 has been selected, underlining the importance of optimum energy efficiency. Typical chilled water in/out temperatures are 12.2/6.6°C. with fouling factors of 0.001°F.ft².hr/BTU for condenser and 0.005°F.ft².hr/BTU for evaporator.

AAI has also included for factory witness testing of chillers as per ARI and ARI/Eurovent certification for the chillers. All chillers have microprocessor control panels and BMS compatibility to monitor and control the efficient operation of the chillers.

Low noise FRP cooling towers have been specified and are located either on the plant room roof or adjoining the utilities block. The location of the plant room being remote from the terminal building, the noise factor poses no threat to the occupants of the airport building.

Chilled water to the terminal building is pumped from the plant room through MS insulated pipes, which are either buried in earth with suitable treatment over the insulation or are run through RCC/masonry tunnels carrying other utility services as well, such as electrical power, control and communication cables.

Winter Heating

For some of the airports in the northern parts of the country, for e.g. Varanasi and Dehradun, winter heating has been provided. Hot water at 50°C is produced with an electrical hot water generator located in the plant room and circulated through pumps to the coils of the AHUs.

The hot water generator capacities range from 200kW to 400 kW, depending on the area of the terminal being heated. The piping is a two-pipe system and the same cooling coil in summer acts as a heating coil in winter. Change-over valves are installed to switch over from cooling mode to heating mode once winter sets in.

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Air Handling System

Double skin air handling units comprising centrifugal fan, cooling coil and filter sections have been provided for distributing cool and dehumidified air to the various spaces in the terminal building. Air handling units for major areas have Variable Frequency Drives (VFDs) as an energy saving device, besides two-way control valves on the chilled water lines. The AHUs have 18G stainless steel drain pans. Pre-filters having efficiency of 90% down to 10 micron with synthetic non-woven media in an aluminium frame have been specified.

Typically, the number of air handling units depends upon the type of area and volume being air conditioned. AHU zoning has been done based on the usage of the area. AHU capacities and TR vary widely across airport installations ranging from AHU sizes of 4000 CMH for VIP rooms / office areas to 80000 CMH each for open concourse areas. Typical air handling unit zones are Visitor's Concourse, Check in, Departure Concourse, Baggage Claim, Arrival Lounge, VIP Lounges, Air Side Corridor, Rotundas and internal office areas.

Air Distribution

Most of the airports being constructed have concourse areas with double heights. Typically, true ceiling levels are 7m upwards. While carrying out the heat load calculations, stratification has been taken into account due to the high ceiling and the TR and AHU capacities have been calculated on the basis of occupied zone loads.

Mainly, the following types of air distribution patterns have been followed:

1. Cool air is supplied through supply air ducting at around 4m level with air being distributed through jet diffusers/nozzles. Jet nozzles help the air to be supplied with larger throw and velocity in the spacious arrival and departure halls. Return air is taken back through grills and return air ducts back to the AHU room. The return air ducting is either at 4m level where ceiling slab is available, or at 7m truss level.

2. The second type of arrangement uses a low pressure floor plenum approach. In this arrangement, cool air from the main AHU is ducted to an under-floor duct trench. The distributed trench ducting has vertical sheet-steel risers from which cool air is thrown into the space through grills or jet nozzles. The return air



Supply air ducting with jet nozzles help with longer air throw at a reduced noise level

is collected through grills on the AHU room walls at a higher level. In the above manner, much of the internal heat from people, lights and computers is allowed to stratify, which reduces the space cooling load.

3. The entry-exit curtain wall of the concourse of most of the terminal buildings has significant glazing. This adds considerable cooling load requirement in the perimeter zones. To take care of the additional heat generated, several perimeter standalone AC units have been specified with short ductwork and several air outlets which sweep cool air over the perimeter glazing to make these areas more comfortable. Many of these units have been masked to hide the utilities such as piping, ducts, electrical switches, etc.

Water Treatment

Though there is a shortage of water in almost all parts of the country, the air conditioning systems provided at all airports have water-cooled chillers. In almost all cases, the water needs to be treated for its hardness and conventional water softening plants using resins and brine have been specified to bring the hardness level down to less than 10 ppm. In some cases a sand-filter bed has also been specified to provide soft, filtered water for the AC plant.

Building Management Systems

All the airport terminal buildings have a Building Management System (BMS) using DDC controllers. The role of the BMS is to reduce energy costs by monitoring and controlling various parameters through the following applications:

1. Time scheduling
2. Duty cycling
3. Chiller sequencing
4. Demand limiting
5. Chilled water reset
6. VFD and temperature control on AHUs

The main HVAC equipments under the BMS are chillers, pumps, cooling tower fans, AHUs, filters, etc. Typical I/O points considered for monitoring and control are on/off of all the major equipment. The BMS system also helps in optimal operation of the HVAC system. The maintenance, in terms of mandatory maintenance schedules, can also be optimized using the BMS system.

Conclusion

The new aviation policy has certainly taken the right steps in improving the airport infrastructure in the country. Modern, state-of-the-art facilities, including energy-efficient air conditioning, have been introduced in many of the new airports that are now being built. This will greatly enhance comfort for the air traveller.

Consultants

Some of the HVAC consultants involved with the airport projects covered in this article are:

- Gupta Consultants, New Delhi for Jaipur, Varanasi & Mangalore
- Kothari & Associates, Ahmedabad for Trivandrum & Dehradun
- Span Consultants, New Delhi for Khajuraho
- Refrisynth, Pune for Aurangabad