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Remote Nodes for Telecommunication

Selecting the ideal air conditioning system

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With major emphasis on telecommunication through privatization, in order to achieve the ambitious plan of increased tele-density of 15 by the year 2010, Telecommunication Remote Nodes, or Base Station Controllers (BSC) or Base Transceiver Stations (BTS) are coming up like mushrooms all over India – both for GSM technology for mobile services as well as for CDMA technology for fixed line services with-limited-mobility. Finding the right HVAC solution for these shelters has assumed a high priority. The cover page shows a typical external view of a Telecom Remote Node.

Air Conditioning Needs of Shelters

2000 + HPAC units of 2 ton net sensible cooling capacity are installed in India (Photo courtesy of Liebert /Hiross)

The unit is externally mounted for convenient access.

These shelters, typically 3.7m x 2.5m x 2.8m high, normally house the switching racks (a major heat dissipation source), distribution panels, fire alarm panels, SMPS (Switch Mode Power Supply) panels and batteries. Reliable air conditioning is essential to remove the equipment heat for proper functioning of the telecom equipment. All these shelters are unmanned and operate round-theclock, round-the-year. They do not have any provision for fresh air intake but fresh air ingress while opening the door during any inspection provides adequate ventilation for the inspecting person. Thus, the air conditioners need to operate with SHF (Sensible Heat Factor) almost equal to unity.

The switches housed in a BTS shelter can withstand a wide variation of temperature and relative humidity, but their life reduces drastically if exposed to a high temperature for long periods. Please refer (**Figure 1**).

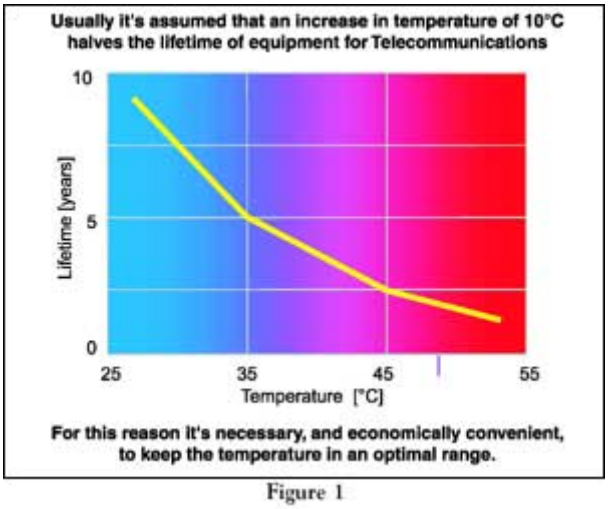

Figure 1

Typically, a temperature of 27°C with 45 to 50% RH is considered ideal for maximum life of switches and optimum energy consumption of air conditioners.

Peak cooling load normally varies from 5kW to 8kW (1.4ton to 2.2ton) depending on the type of switches and the size and location of shelters. To ensure uninterrupted operation,a 100% standby AC unit is installed in each shelter to maximize system "up–time" –targeted for 99.9999% as an international standard at present

Issues Involved in the Design of Special ACs

HPAC (High Performance Air Conditioners or Precision Air Conditioners, as they are commonly called) units should be capable of meeting some stringent needs associated with these shelters, some of which are highlighted below:

1. Since BTS shelters are required to be located in convenient as well as remote locations, all over India, so as to reach all potential subscribers, design criteria for the air conditioners needs to be carefully addressed. Firstly, the day and night temperatures vary widely during the year from location to location – from sub zero to over 45°C.
2. The wide variation of ambient temperature poses a problem of variation in the condensing temperature of the air cooled AC unit from location to location, from season to season and from morning to evening and night. A standard comfort air conditioner without a device to control condensing temperature against changing ambient temperature will result in unstable operation and compressor life may drastically reduce.
3. Further, steady electric power is often not available in all remote locations in India. Thus, any intermittent interruptions of AC power are liable to build up a high temperature in the shelters, damage the switches and interrupt telecom services in respective areas. Even a standby AC unit will not come to the rescue. (Unless a standby DG set is available, which will mean a major increase in project cost).

Though technology is advancing internationally at a high pace, with appropriate solutions found for air conditioning for such critical applications, many telecom operators, in the early days of privatization of telecom services, chose to go in for standard room ACs or split ACs, carried away by the apparently cheaper prices of these products, compared to the ideal products, internationally eveloped for this specific purpose, or being compelled by their own budget constraints, despite knowledge of better solutions.

Essential Features for HPACs

High SHF. Firstly, let us consider the high SHF typical of these shelters. Due to no occupancy and no positive fresh air injection, the latent heat component is almost negligible, resulting in near unity SHF for such remote nodes. Thus, the dehumidified air quantity required will be much higher than what is available in a comfort air conditioner of equivalent total capacity, since the latter is normally designed with SHF of approximately 0.7.

Bigger evaporator coil and evaporator fan. Thus, in order to remove the high sensible load effectively, both the evaporator fan and the evaporator coil need to be substantially oversized (often more than 100%), in comparison to comfort air conditioners. This definitely increases the first cost of the air conditioners, compared to room ACs or split ACs for comfort application. Please refer (**Figure 2**).

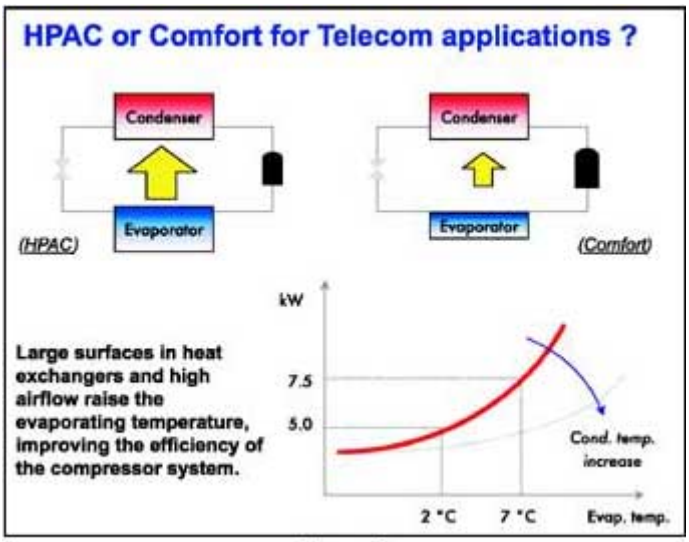

Figure 2

High EER. With the necessity of a bigger evaporator coil to remove the high sensible load, precision ACs operate at a much higher suction temperature (often 6° to 7°C more compared to a comfort AC), thereby improving EER (Energy Efficiency Ratio) substantially. Even the compressor size is often smaller in comparison. Generally, the energy saving achieved with HPAC units is about 25%.

Reliabilty. Reliability is a very important criterion for the AC in these remote nodes since failure of air conditioning causes nonavailability of telecom service to a large number of subscribers. High priority is assigned during design and testing of HPAC units to achieve a MTBF (Mean Time Between Failures) of 4 to 4.5 years compared to 0.5 to 1 year for comfort ACs.

Sensible cooling capacity. Assume the capacity requirement of an air conditioner in a shelter is 5kW, and two(one standby) 5kW capacity (under operating parameters)

room ACs or split ACs have been installed in this shelter. Each unit will actually deliver sensible cooling capacity of 3.5 kW considering 0.7 SHF. Thus, both units will need to work to remove the sensible load. Naturally, failure of one unit will make the other unit inadequate to meet the load demand. So, to attempt a comparable solution with comfort ACs, it may require a third unit, as standby, (space for which may not be readily available) or oversizing the units to deliver the peak net sensible cooling load. Please refer (**Figure 3**).

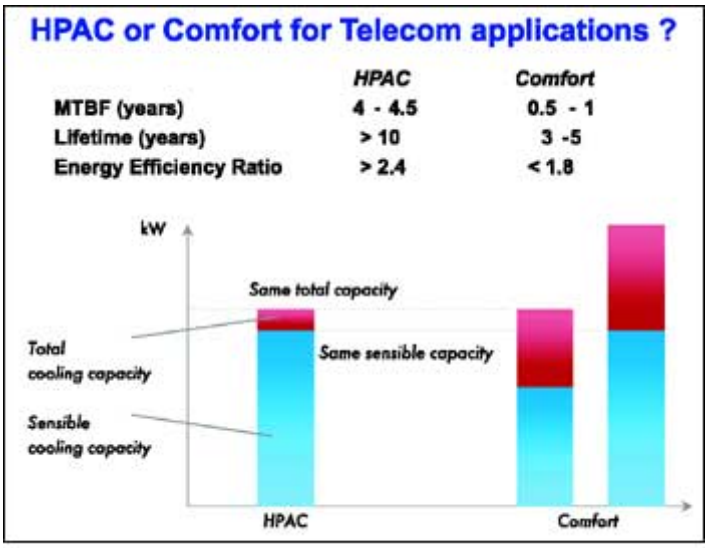

Figure 3

Round-the-clock operation. It is common knowledge that standard units are created for human comfort and are normally required to run 8 to 10 hours a day, either in an office or in a residence. Thus, for a heavy-duty application for round-the-clock, round the- year operation, the life of a standard comfort AC will be drastically reduced, thereby requiring one or two replacements in a 10 year period. HPAC units, being designed for such heavy duty, work satisfactorily beyond 10 years without any need to replace them.

Condensing temperature control. To avoid unstable operation of compressors due to wide variation of ambient temperatures, between day and night and between seasons, each HPAC unit is provided with a 'Variex' – an automatic speed control mechanism that adjusts the condenser fan speed through a microprocessor control, acting on a signal from the ambient temperature sensor. This helps maintain the condensing temperature within an acceptable range to avoid compressor hunting. Standard units with unmanned operation in BTS shelters have been found to fail repeatedly in areas where seasonal variations are wide.

Ease of installation and servicing. Since the remote nodes are unmanned, the configuration of HPAC units is such that the unit is fixed from the outside with only three

openings in the wall for supply air grille, return air grille and passage of wires. Please refer (**Figure 4**).

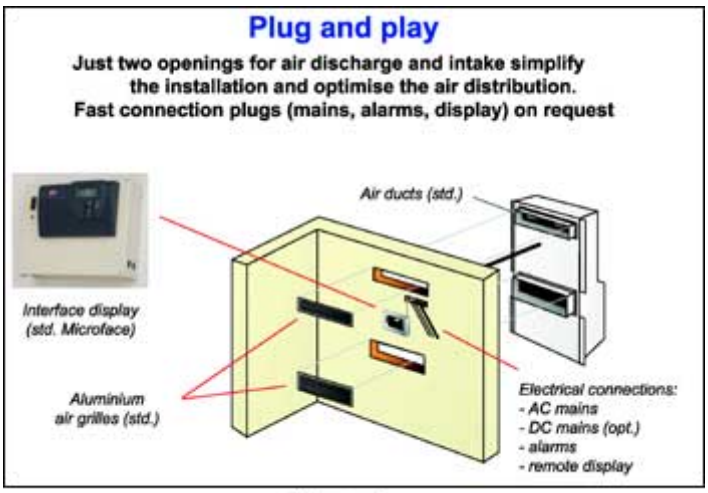

Figure 4

Servicing is done from the outside without need to enter the shelter. The unit casing is fixed with anti-vandalism special screws that require special keys to open them.

Emergency Cooling for Increased eased Switch Life and High MTBF

As mentioned earlier, irrespective of the reliability and quality of the air conditioner, unstable electric power at remote locations, causing frequent stoppage of the AC units for short or long durations, is likely to cause temperature build-up in the shelters. A temperature gradient above 0.5°C/ minute limits the life and drastically reduces the MTBF of the HT equipment. HPAC units made by leading manufacturers have a feature of "Emergency and Free Cooling" (EFC), which specifically addresses this problem. Please refer (**Figure 5**).

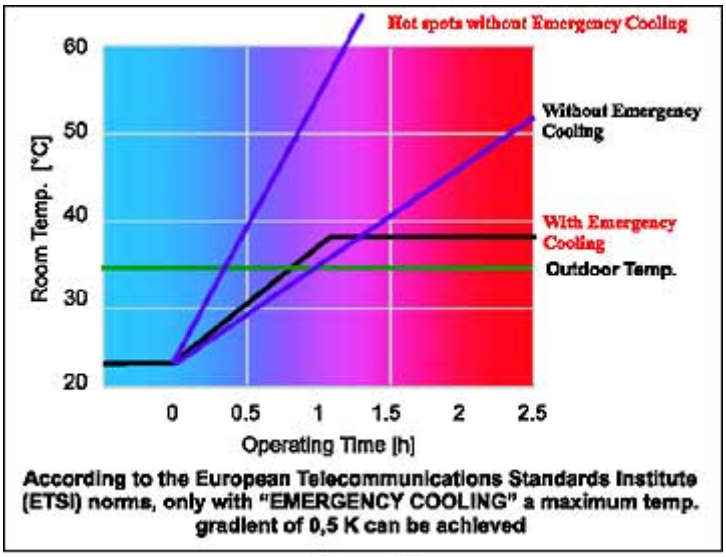

Figure 5

Units provided with EFC features have a DC fan drive for the evaporator, which draws power from the battery within the BTS shelter. In addition, there is a modulating damper mechanism, which draws and exhausts the required quantity of outside air (duly filtered) on command from the microprocessor. Depending on the ambient temperature at the time of failure of the AC supply and the duration of non-availability of power, the microprocessor starts opening the damper slowly to minimize the temperature gradient from the design inside temperature to about 5°C above the ambient temperature with the damper in a fully opened position. Please refer (**Figure 6**).

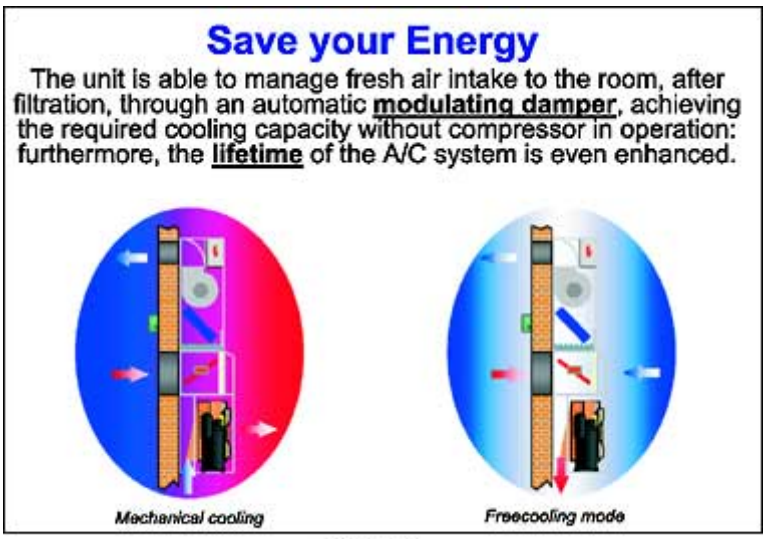

Figure 6

This saves the switches from rapid heat build-up and thermal shock. Most switches can normally sustain up to 55° C for 48 to 72 hours, which is adequate time to restore the main power and normal cooling.

Naturally, for cooler ambients, the margin available is much higher. It has to be noted, that, even with AC power available, the evaporator fan for units provided with EFC is driven by a DC fan powered by the battery. In another version, an inverter is used to convert the battery power to AC, which powers the AC evaporator fan.

The “free cooling” option of a modulating damper also ensures a major saving in the energy bill, in locations where the ambient temperature goes much lower than the inside design temperature. This is achieved by circulating cool outside air in the required proportion, through the modulating damper, on command from the microprocessor, when the compressor remains off for long durations in the year.

The Microprocessor Controller

The heart of the HPAC unit is its microprocessor, providing intelligent control. Out of immense capability of the continuouslyupdated controller, the following features are worth special mention:

1.Stand by and rotation. In case of failure, an alarm signal is generated, and the back-up unit automatically starts. The rotation of the stand-by unit occurs every 24 hours, allowing a homogeneous wear of the system components.

2. Cascade mode. The units respond automatically to load demand with maximum saving in energy. With two units in a shelter with low ambient, first, one unit works on FC (free cooling) mode; then the second unit also comes on FC mode with a rise in ambient temperature; with further rise in
ambient, one unit runs in DX mode and the other on FC mode. In the unlikely event of a sudden increase in load (like door kept open for longer-than-normal), even the second unit comes to help by running in DX mode. Please refer (**Figure 7**).

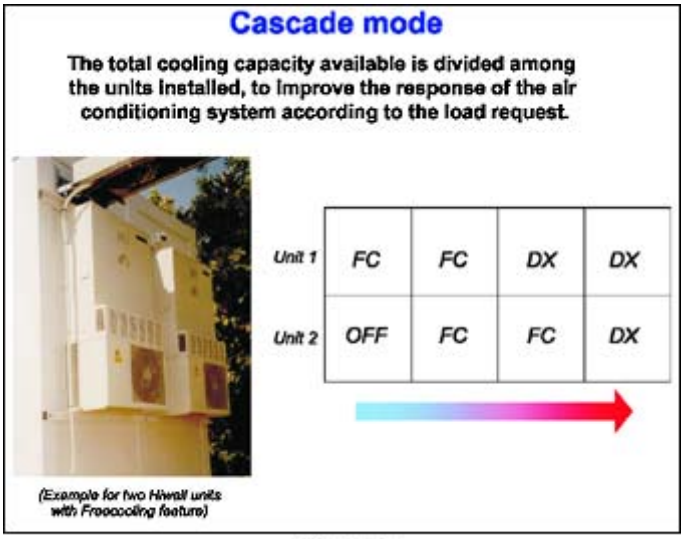

Figure 7

3. Emergency and free cooling. Operation as already explained above.

4. New SMS feature. With an interface the HPAC units can be equipped with digital "Short Message Manager" to send a message of self diagnosis like 'filter dirty', 'compressor failure' to designated GSM900-1800 mobile phones, thereby reducing dependence on human factors.

5. Latest "auto test – self commissioning" feature. A complete automated cycle runs the evaporator fan, compressor, dampers and heaters for a pre-decided duration, and prompts simplified start-up measurements. No skilled person with electronics knowledge is required to commission the units any more, at convenient and remote locations, but an average technician (available anywhere in India) can do the job correctly.

Quality Assurance / Certifications

To fulfill the international regulations and to build up customer confidence for ensuring quality and reliability of such critical products, leading manufacturers get their products certified by reputed agencies. Apart from quality certification from Lloyd Register Quality Assurance, EMC certification for conformity to regulations regarding electro-magnetic interference, CE certification etc., HPAC products for critical applications like telecom remote nodes, also need to be Eurovent certified. This guarantees the operating technical parameters like total cooling capacity, sensible cooling capacity, power consumption, sound pressure level, water pressure drop in case of chilled water units, etc. as claimed by the manufacturers in their catalogs and technical documentation.

The units are tested in independent laboratories by random sample testing and test data compared with manufacturer's data. In case of failure, the manufacturer has to rerate not only the specific product, but also all other products in the basic group, or else, withdraw the product from the market. Eurovent certification needs to be renewed every year and successful companies are listed yearly in an official Eurovent Directory. All details are also available on the Eurovent website. HPAC unit manufacturers, who are Eurovent certified are Hiross, Airdale, Qualitair, Ciat ,RC Condizionatori and Uniflair.

Precision Testing and Environment Simulation

Naturally, to ensure accurate performance data so as to qualify for Eurovent certification and avoid misleading customers for their critical applications, manufacturers must have high precision test facilities in their own laboratories to carry out the following tests on units for telecom remote nodes -

- Airflow
- Cooling capacity
- Cold start
- Hot start
- Overheating
- Safety test
- Storage
- Water resistance
- Noise
- Continuous running

Climatic chambers are used to simulate :

- Room conditions: **0°C / +60°C**
- Ambient conditions:**–30°C/+60°C**

with automatic data acquisition systems and remote access to testing facilities.

Test for all ETS (European Telecommunications Standards) conditions Additional tests carried out in Official Labs are:

EMC (Electro Magnetic Compatibility) test

IP (Industrial Protection) test, related to motor protection.

Transportation and Vibration test

Continuous Upgrading

The newest development for BTS shelter cooling is the downward air delivery (displacement series), see (**Figure 8**),

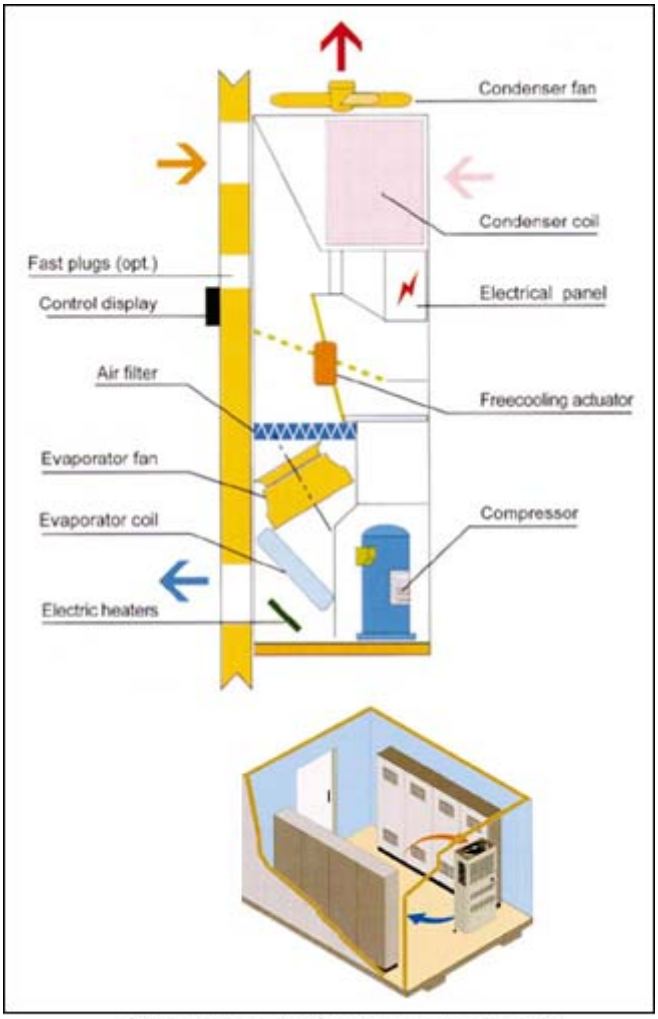

Figure 8 : Notice the supply air discharge from the lower part of the unit

which optimises the air distribution over the telecommunication equipment and reduces the rack core temperature. In other words, it delivers cooling where it is most needed, by the equipment, allowing other parts of the shelter to maintain slightly higher temperatures and increase energy efficiency.

Conclusion

To perfect a solution to any technical problem, it takes major research and development work, based on continuous feedback from the users. Continuous upgrading of products requires adopting the latest technology to meet changing user requirements. Thus, the air conditioners developed and adopted worldwide, as the right solution, technically and commercially, for today's Telecom Remote Nodes, cannot be substituted by comfort air conditioners like room ACs or split ACs using an over-simplistic argument that these are much cheaper. Whereas, in reality, they prove to be much dearer and the user runs the risk of damaging expensive telecom switches and interruption of telecom access to subscribers.