AIR CONDITIONING AND REFRIGERATION
Journal
The magazine of the Indian Society of Heating, Refrigerating and Air Conditioning Engineers

Issue : January-March 2002

HVAC - Its Relevance to Telecommunications

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Bharat Sanchar Nigam Limited (BSNL) is a Government of India Enterprise that provides telecommunication services throughout India. Electrical engineers of BSNL constitute a professional group having a background of over 25 years of experience in the field of HVAC and are associated with the design and implementation of HVAC systems in all BSNL telecommunication buildings. This article, while giving a historical perspective about the growth of Indian telecommunication highlights salient features relating to HVAC as applicable to telecommunication in the electronic era.

Technological developments in the field of telecommunication in India have been taking place at a rapid pace during the past three decades. This phenomenon however is universal. During the early seventies manual telephone exchanges were functioning throughout the country with Strowger type switching equipment.

As viewed from the HVAC angle Strowger exchanges posed no problems because the contribution of heat by the switching equipment was minimal. Only large capacity telephone exchanges in cities were provided with air conditioning. The basic purpose was human comfort on account of the fact that several maintenance personnel were attending to switching equipment faults in the switch room on a 24 hour basis.

With the introduction of Cross Bar switching technology during the mid seventies, a major transformation took place and manual exchanges were replaced by Automatic Cross Bar type exchanges. Cross Bar type switching generated a considerable amount of heat inside the switching space and hence air conditioning became a compelling necessity, which called for installation of large capacity central air conditioning plants. Even in Cross Bar exchanges the presence of maintenance staff was substantial (e.g. in a 5000 line exchange about 25 to 30 persons were working) thereby the basic criteria for air conditioning was to provide a working environment for maintenance personnel.

In the early eighties major developments took place. For the first time, Electronic exchanges of E-10B switching technology were introduced in the telecom network on an experimental basis. With E-10 B switching equipment, environmental control became mandatory as the equipment functioned only under the controlled environment of temperature, humidity and relatively clean environment. Subsequently, improved versions of E-10 B (OCB type switching equipment) as well as several other high technology equipment viz. Siemens, Ericsson, Modi Alkatel, Fujitsu, GPT and OCB-283, (ITI India), have been introduced in the telecom network on an all India basis.

The department has also developed Electronic switching equipment of CDOT technology indigenously and the same is predominantly used in small exchanges of 20K capacity and below. In major exchanges of 20K lines and above, Electronic switching equipment of imported make / indigeneous make with imported technology are is use.

As on date, Electronic exchanges have practically replaced all old exchanges. Thus the importance of HVAC became more and more prominent. The criteria for environmental control is altogether different and the parameters fixed for inside temperature, humidity and dust control are in accordance with the switching equipment's need as recommended by the manufacturer of such equipment.

HVAC - Design Concepts for Telecommunications

a) Design parameters for environmental control

With the advent of Electronic exchanges, the concept of air conditioning or environmental control (to be more precise) has undergone transformation from human comfort application to the specialised telecom oriented application. Because of a variety of different makes of electronic equipment added to the Indian telecom network the Department of Telecom (now "BSNL") has standardised the parameters for environmental control as under:

Temperature and humidity

The overall recommendations for temperature and humidity are:

- Temperature below the rack of the exchange, wherever bottom feed is stipulated : 20° ± 3°C dry bulb.
- Switch Room temperature : 23° ± 3° C dry bulb.
- Switch Room relative humidity : 45 ± 15% (30 to 60%).

Fresh Air

The system is designed for a maximum of one air change per hour, but normal operation shall be half air change per hour with adjustable dampers.

Air Filtration

The filtration arrangement for fresh air and return air shall be as under :

Fresh air path: EU-2 (coarse filter, efficiency 90% down to 20 microns) and EU-5 (fine filter, efficiency 99.9% down to 5 microns).

Return air through the packaged air conditioner : EU-2 (coarse filter, efficiency 90% down to 20 microns) and EU-3 (filter, having efficiency 95% down to 5 microns).

b) Criteria for selection of equipment for HVAC

The new generation Electronic switches require considerably less switch room floor area as compared to the exchanges of the previous era.

For exchanges of Cross Bar era a 5K capacity exchange warranted installation of a central air conditioning plant because the area coverage of air conditioning space was considerable. But for Electronic exchanges, the switch room size is much smaller. This in turn has facilitated standardisation of air conditioning system modules of 15 ton / 20 ton / 30 ton / 40 ton with a battery of package air conditioning units of 5 / 7 / 10 ton capacities for meeting the requirement of environmental control. BSNL has standardised the technical parameters for packaged air conditioning units and with the help of Indian industry has introduced packaged air conditioning units exclusively developed for telecommunication applications.

Brief specifications of a typical 7 ton packaged air conditioning unit are given in **Table 1**.

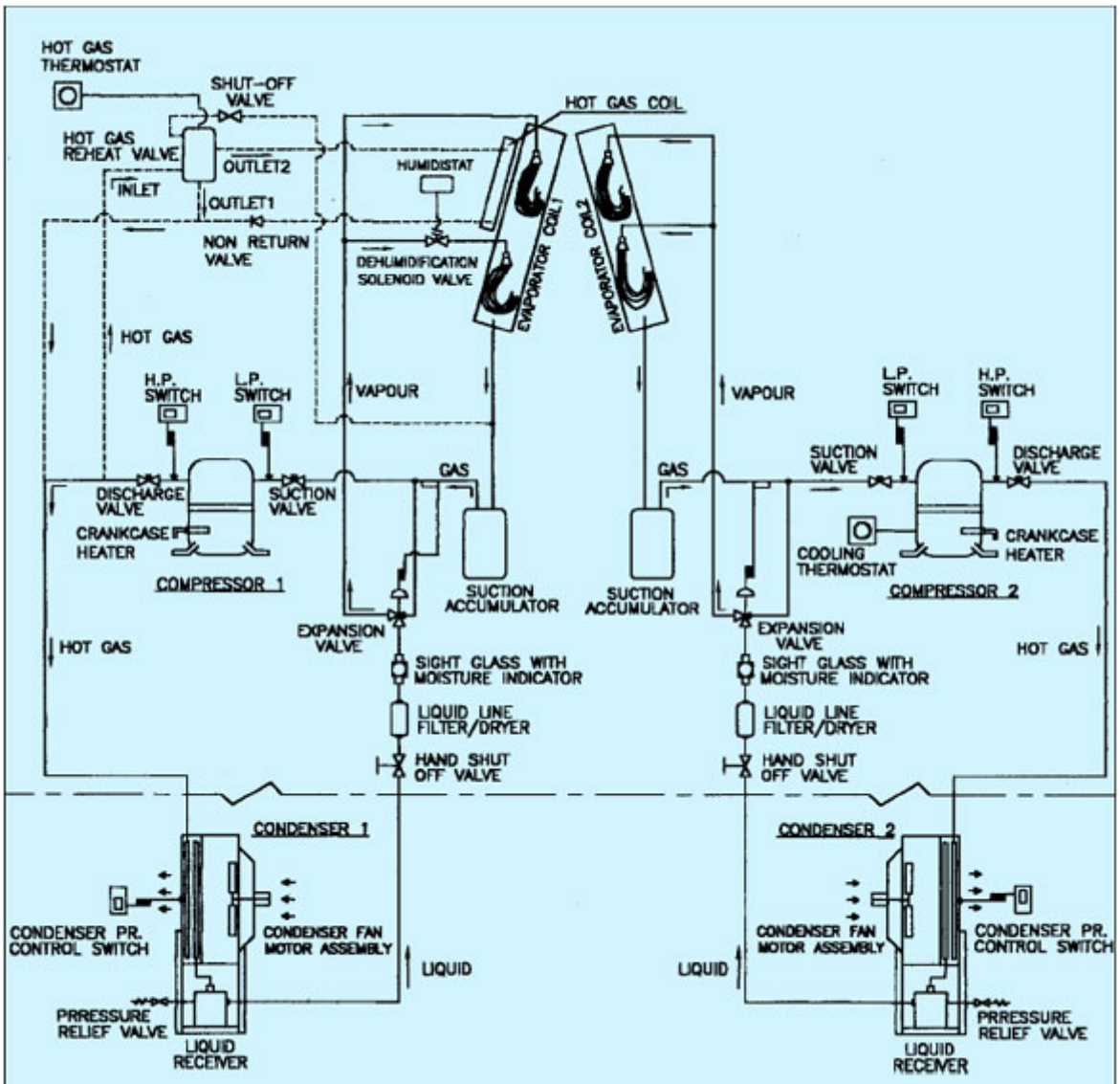
Table 1 - Specifications of a typical packaged air conditioner.

01	1 Rated capacity	:	7 ± 0.5 ton (sensible cooling capacity).
02	Flow direction	:	Upward flow / downward flow.
03	Air inlet temp (return air)	:	25´° C dry bulb.

04	Saturated suction temp.	:	Between 9° C and 10° C.
05	Minimum super heat	:	6° C.
06	Saturated discharge temp.	:	Max. 53°C (at ambient of 43° C).
07	Ambient air design temp. (entering the condenser)	:	43° C (however the system shall be able to work with ambient going up to 50° C).
08	Air quantity	:	550 to 650 CFM/TON
09	Supply air temp.	:	16° C to 20° C.
10	Total static pressure	:	35 mm of Water Gauge between inlet and outlet of package air conditioning unit with filters in position.
11	No. of refrigerant circuits	:	Two
12	Filters	:	1) Filters to be provided on the package unit having 95% efficiency down to 5 microns for EU-3 type and EU-2 filter having efficiency of 90% down to 20 microns.
13	Face velocity across the cooling coil	:	≤2.5 m/sec.
14	Type of load	:	The exchanges have high sensible heat load (sensible heat factor = 0.95).
15	Hot gas reheat cycle (Ref. Note 1 in **Figure 1**)	:	Provision of hot gas reheat in one of the refrigerant circuits of the package air conditioning unit for 50% of heat rejected in the circuit.
16	Dehumidification cycle (Ref. Note 2 in **Figure 1**)	:	Provision of dehumidification by reducing the effective coil area of one of the evaporator coils by a solenoid valve arrangement.

c) Air distribution system

When the E-10 B switches were introduced for the first time in India it was mandatory to provide conditioned supply air from the bottom of the rack. The exchange equipment was installed on a raised floor making provision for an underfloor plenum and supply air was fed into the plenum and kept under pressure. Whereas with the introduction of high technology switches, the underfloor plenum is no longer a mandatory requirement and conventional air distribution by ducts above the switch room racks is adequate. The criteria for supply air quantity fixed for electronic exchanges was 550 CFM/TON initially and now on the basis of experience gained, 600 to 650 CFM/TON is considered as optimum. Air distribution is through G. I. ducts and grilles / diffusers for supply air and return air is provided as per normal practice in a typical comfort air conditioning installation.



Note 1 : Function of hot gas reheat cycle :
The purpose of hot gas reheat cycle is to maintain required minimum supply air temperature. For the same, a thermostat is placed in the supply air side. When, during dehumidification cycle, the supply air temperature reaches below the set value, the thermostat actuates the hot gas valve coil installed in one of the compressor's discharge line. The hot gas valve will allow the hot discharge gas from compressor to flow through the hot gas coil. Due to the same, the temperature of the supply air which is passing over the hot gas coil, will increase & reach to the set value.

Note 2 : Function of Dehumidification cycle :
The purpose of Dehumidification cycle is to maintain required humidity inside the conditioned space. For the same, a humidistate is placed in the return air stream. When the humidity inside the conditioned space reaches above the set value, the humidistat cuts–of the supply of the solenoid valve & thus approximately 50% area of one the the evaporator coil becomes ineffective. Due to this, condensation of water from the air takes place & hence the humidity inside the conditioned space is reduced down to set value.

Figure 1 : Typical refrigeration circuit diagram with hot gas reheat & dehumidification arrangements for 7 ton air cooled packaged airconditioning unit

d) Standards of cleanliness in switching equipment rooms

Specially designed package air conditioning units for telecommunication applications have built in provision for the following filters: EU-2 (coarse filter, efficiency 90% down to 20 microns) and EU-3 (filter, having efficiency 95% down to 5 microns). In addition the fresh air system is provided with filters of the following categories: EU-2 (coarse filter, efficiency 90% down to 20 microns) and EU-5 (fine filter, efficiency 99.9% down to 5 microns).

It has been our experience that with the provision of above filters, the requisite cleanliness standards are achieved.

e) Fire Safety Provisions

A typical electronic exchange is provided with an automatic fire detection and alarm system with heat and smoke detectors. In addition fire dampers are also provided in the supply air ducts.

For fire fighting, only manual CO_2 type fire extinguishers are provided.

Changing Scenario in Telecom Network Expansion-Challenges to be Met

The Electronic switching era has brought in a telecom revolution and has opened avenues for several value added services like mobile telephone, e-mail, internet, video phone, video conferencing etc., to name a few. The new technologies have also made it possible to extend telecommunication facilities for all rural areas more economically. Countrywide coverage by cellular phones is also being accomplished in a year or two. With all these developments the HVAC needs are also increasing enormously. The air conditioning capacity added during the years 1991-92 to 2000-2001 (10 years) for telecom network expansion is given in **Table 2**.

The high capacity growth rate apart, the most challenging aspect is to provide several thousands of small capacity air conditioning system modules scattered at remote places all over the country. The departmental experience with regard to use of commercial grade window air conditioning or split air conditioning units has not been satisfactory especially under high ambient temperatures reaching up to 50° C and ambient air with high level of dust concentration. To cope with the challenging situation, it is our intention to take the support of the Indian industry to develop specially designed air conditioning units of 1 / 1.5/2 ton capacities.

Table 2 - Growth of air conditioning in telecom network

Year	Capacity (tons)	Year	Capacity (tons)

1991-92	6500	1992-93	9460
1993-94	11000	1994-95	11680
1995-96	13680	1996-97	14080
1997-98	21610	1998-99	29300
1999-2000	41750	2000-2001	41780

Energy Crisis-Energy Audit and Energy Conservation Measures

BSNL is presently spending about Rs. 2500 to 3000 crores (US$ 500 to 600 million) on energy bills annually. With the programmed objective of extensive network expansion and introduction of cellular phones at national level and a host of other activities this figure may be much more. In order to tackle the problem of mounting energy bills two important considerations are:

- To implement remote monitoring and control of all unmanned stations.
- To review the present standards with regard to air conditioning and re-design the system modules with emphasis on energy saving.

Switching Over to Alternative Technologies for HVAC-a Must for Saving Energy

Because of the energy crunch, it has become a compelling necessity for BSNL to explore alternate technologies for meeting the air conditioning needs in lieu of high power consuming mechanical refrigeration. It is proposed to take up a few pilot projets using Absorption technology / Desiccant and Evaporative cooling technology in order to make a beginning.

The smaller version of air conditioning systems are required for remote stations for rural telephone exchanges, cellular phones etc. on a very large scale. The possibility of introducing Panel Cooling concept exclusively for the switching rack which has a smaller volume, instead of treating the enter room area is under active consideration. The miniaturized refrigeration system based on panel cooling concept is intended to accomplish the twin objective of power saving and rugged performance in a hostile environment.

Conclusion

Revolutionary changes in telecom technology and enormous growth at a much faster pace of communications warrant cost effective HVAC solution packages for speedier

implementation. BSNL engineers are consciously making their efforts in this direction to met the challenges ahead. Alternative technologies are being considered seriously for energy saving and conservation.