

Reincarnation of the Cities Within: the HVAC Scene

Introduction

by Hiru M. Jhangiani
Editorial Advisor

All large cities keep changing over the course of time as some parts, dominated by certain industries located there grow, get overtaken by circumstances or competition, and are reincarnated with new looks and activities. Pittsburgh, the Steel City in the USA was a major producer of steel in the 1930s and 1940s, but with cheaper steel being produced by BRIC (Brazil, Russia, India, China), the major developing countries of the world, Pittsburgh has undergone a complete face lift and is no longer the city of steel, soot and grime, which it once was. Detroit, the Motor City of America and the world at one time, has undergone a similar change after Japan started dominating the car market. The Docklands of London, during the heydays of the colonial era when Britain dominated the maritime trade with its colonies, has been converted into a modern steel and glass cluster of office buildings and hotels and renamed Canary Wharf.

Nearer home, we have the examples of Delhi and Bombay. Delhi is generally considered a close-to 5,000 year old city and has historically been the capital of some culture throughout its existence, making it one of the longest-serving capitals in the world. The present-day city of New Delhi was designed by British architects Edward Lutyens and Edward Baker and formally inaugurated in 1931. The modern city contains the remnants of at least eleven cities, starting from Indraprastha, built by the Pandavas in the Ancient Era, to Shahjahanabad, the walled city now known as Old Delhi, built by Shah Jahan.

In Bombay, closer to the present time, the 130 odd Textile Mills that dominated the skyline with stone chimneys in the late 1800s (the first cotton mill, Bombay Spinning & Weaving Company, was set up in 1865), were all closed down in the 1980s after the disastrous labour strike in January 1982. One such chimney of Shakti Mills still stands right across the street from the ISHRAE, Mumbai chapter office even today, awaiting new owners. The

textile industry has since largely disappeared from the city and huge tracts of land in the heart of present day Mumbai have and are still being converted into tall, modern residential towers, office complexes, hotels and shopping/entertainment centres. Phoenix High Street Plaza in Lower Parel is one such example, with its stone chimney, a remnant of Phoenix Mills, still intact for memory's sake. Some other examples are: the Srinivas Mills, Lower Parel, where 'World One', Asia's tallest residential tower is being built; Gokaldas Morarjee Mills No. 2, where the Peninsula Corporate Park stands today; Shree Ram Mills, Worli, where the

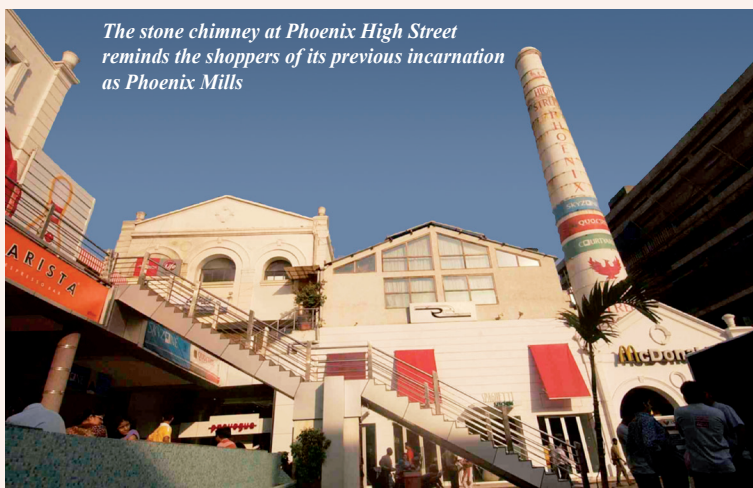
Palais Royale residential tower has come up; and many more....too numerous to list here.

The modern Kohinoor City in Kurla, (please read the article by Ajey Joshi that follows) was originally a part of the factory of Premier Automobiles, manufacturers of Fiat and Padmini cars that started production in 1964 and continued until the late 1990s, when Japanese and Korean brands started

dominating the market. Remnants of the Premier Padmini black and yellow taxis still ply the roads of Mumbai.

The second part of the article (by Santosh Rasane) is about the planned redevelopment of a 200-year old part of Bombay city. History has recorded that Bhendi Bazaar was first set up by the British rulers following the Great Fire of Bombay of 1803, as a resettlement to decongest the nearby Fort area (still called by that name). Today, it has become one of the most congested, unhygienic and chaotic neighbourhoods with dilapidated buildings and streets so narrow that only two-wheelers and pedestrians can move through them. It is largely inhabited by Dawoodi Bohris, mostly traders, who owe allegiance to Dr. Syedna Mohammad Burhanuddin, head of the Saifee Burhani Upliftment Trust.

This public charitable trust, which has undertaken a massive redevelopment and transformation of the 200-year old part of



The stone chimney at Phoenix High Street reminds the shoppers of its previous incarnation as Phoenix Mills



The educational complex in the integrated Kohinoor City in Mumbai

Kohinoor City: Integrated City Within a City

By Ajey Joshi

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Introduction

Kohinoor City is one of the first integrated city concepts in India. It is situated in the commercial capital of India, at the central suburb of Kurla. The location has easy connectivity and access from the central and western suburbs and satellite areas like Thane and Navi Mumbai.

Kohinoor City consists of a retail mall, commercial offices, a hotel, an educational complex and Asia's first LEED Platinum

rated hospital. It also contains premium housing with lush green gardens and a state of the art club house and swimming pool.

The integrated concept provides all the necessary amenities

About the Author

Ajey Joshi is a graduate mechanical engineer from University of Pune, with 18 years of experience in electro-mechanical services design for high rise commercial buildings, hotels, hospitals, IT buildings, data centres, nuclear power projects, sub-zero refrigeration plants and industrial projects. He specialises in energy conservation, humidity control and advanced control logics. Currently he is Associate – Building Engineering and ISO Quality Representative at Aecom.

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the city, will foot the entire bill for the work and has already started by buying most of the old buildings in the area from the previous owners. Once the old buildings are converted into apartments and shops, these will be given to the current residents and tenants, free of cost, who will then become the new owners. Work on the Rs.20 billion project has already begun and is planned for completion in seven years. Bhandi Bazaar covers 16.5 acres and includes about 1,250 businesses and 3,200 homes in 250 buildings. Of all the aspects of redevelopment, the biggest concern is making sure that the cost of living for the 3,000 odd families stays the same even though most of them will move to bigger, better and greener apartments.

The two projects are totally different in concept. Kohinoor City: Integrated City Within a City is a commercial venture that

has already been completed and all buildings are centrally air conditioned. The residential areas are, however, designed for air conditioning by the individual owners with split or window air conditioners, and the project is meant for persons who can afford the facilities and conveniences provided.

In the Bhandi Bazaar project, being charitable in nature and meant for a relatively poorer part of society, the emphasis has been on a sustainable design, and natural cross ventilation of the living areas with mechanical exhaust of the kitchen and toilets has been planned. Only the shops are planned to be air conditioned. Water and power conservation has been given great importance in order to keep the operating costs within the reach of the *aam admi* or common man. Project completion is far off but the concept and planning is meticulous and worthy of being emulated in other cities of India.

to city residents like food, education, shopping, healthcare, high end work places and recreational spaces.

Electro-mechanical Services Concepts

Kohinoor City is conceptualised with state of the art electro-mechanical services ranging from 100% DG back-up, onsite sewage treatment plants (STPs), electrical sub-stations and building wise central air conditioning system.

Commercial and Retail Spaces

The commercial and retail spaces are planned as part of one building, situated at the entrance of the city.



The commercial and retail building at city entrance

Retail spaces are planned on the two lower floors, which house shops, anchors, atria and common corridors. Offices are situated above the retail complex. The retail area is provided with air cooled screw chillers (4x350TR). Air cooled chillers are selected as make-up water availability from onsite STP is inadequate to support a water cooled plant. Chillers are installed on the retail terrace. They are selected for low power consumption of 1.2-1.3 kW/TR and work on HFC-134a.

Variable speed zone chilled water system is designed for retail spaces. Zones are conceptualised based on the building orientation, and each zone is provided with a secondary pumping system working on demand based variable water flow. Each shop/anchor is provided with chilled water connection with isolation valve and thermal energy meter with RS-485 port for remote connection with the building management system billing subroutine.

Common areas are provided with floor mounted air handlers with aerofoil profile fans for maximum efficiency. Variable frequency drives are fitted on each AHU for energy conservation and dew point control.

Atria are provided with stratification exhaust fans to remove stratified heat, thereby reducing heat load in the occupied zone. Atria are

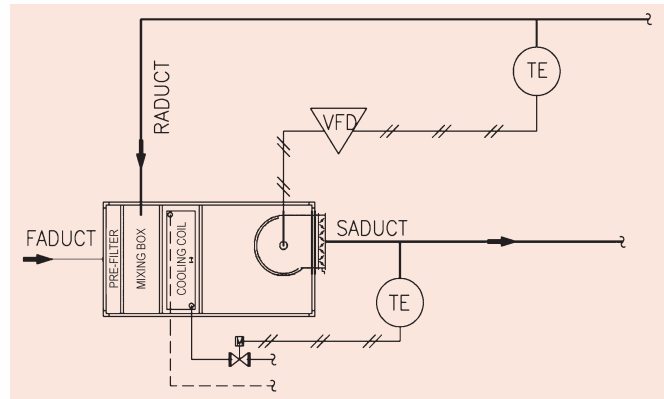


Figure 1: AHU arrangement with VFD, without VAV box

also provided with smoke evacuation fans for 12 ACPH based on recommendations in NBC-2005.

Offices are provided with air cooled chillers (3 x 350TR), and this selection provides excellent synergy with the retail chiller system in terms of maintenance and spares inventory. The office area is zoned based on orientation, and each zone is provided with a set of secondary pumps designed for variable flow based on demand. Chilled water tapping along with isolation valve and thermal energy meter is provided for each office. Each office is also provided with an outdoor air duct tap providing fresh air to the AHU room. Each tapping is provided with a motorized volume control damper to facilitate demand controlled ventilation based on VOC/CO₂ level.

Hotel

Kohinoor Elite Hotel is situated next to the retail-cum-office space on the main vista. It is a 100 room hotel, mainly aimed at short duration occupancy for international transit travellers at Mumbai International Airport.



Kohinoor Elite Hotel

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Figure 2: Water cooled chiller for the hotel

The hotel houses common areas on the ground and first floors. This includes a grand reception, the kitchen, restaurants and Back of House (BOH) areas. The upper floors house guest rooms. The terrace houses electro-mechanical plants like the HVAC and hot water system.

The hotel is designed with a water cooled chilled water plant. 2 x 100TR water cooled heat pumps provide air-conditioning to the hotel. Simultaneous hot water is obtained at 55°C, and is used for the kitchen and bathrooms. Heat pumps are selected to match the cooling load profile and hot water demand profile. Complete heating output is obtained from the heat pump even during lower cooling load conditions, i.e. early morning hours in December-January. It is a dual set point machine. In cooling mode, the compressor works to keep the chilled water outlet temperature to set point, while in heating mode it works to keep the hot water temperature to set point. In heating mode, the cooling tower circuit is by-passed and hot water is directed towards a plate heat exchanger through automatic control valves.

Common areas are provided with double skin air handlers with variable frequency drives.

Guest rooms are provided with two-pipe fan coil units (FCUs) placed above room entry vestibules. Treated fresh air (TFA) at controlled dew point is supplied to each room via a corridor air distribution system. TFA conditions are designed to take care of the latent load in the room; hence the FCU works as a dry coil and takes care of only sensible load.

Corridors are provided with smoke evacuation systems as recommended by NBC-2005 with 12 ACPH.

Educational Complex

The educational complex is an integrated complex within itself housing educational facilities from KG to graduation. This facility is located at the furthest end of the city.

Indoor conditions are typically selected for occupant comfort. As occupancy in schools is always seated with low body metabolic rate, relatively higher indoor temperatures are required for thermal comfort. *ASHRAE Application* recommends a range of indoor design conditions in various facilities in

educational complexes. Table 1 gives an abstract of design mean values.

Table 1: Design mean values for educational facilities

Area	Dry bulb temp (°F)	Relative humidity (%)
Class rooms	75	60
Administrative offices	74	60
Cafeteria/ dining rooms	78	-
Kitchen	86	-
(Filtration level of minimum MERV-8 to be provided)		

Class Rooms

Class rooms are important constituents of the educational process. The load in classrooms is predominantly a function of ambient conditions. This is because class rooms typically have exterior exposures, and ventilation load requirement is high. Both these factors contribute to the room sensible load and outside air sensible + latent load. The other load is due to lighting, which is generally minimal during daytime working of the school.

Computer Rooms

These rooms do not face exterior exposure, and are characterised by higher sensible load factors due to computer equipment.

Educational Laboratories

The school houses many laboratories like chemistry, physics, animal (biology), etc. Physics laboratories do not require any exhaust in most cases; however, chemistry and animal laboratories often require exhaust. A dedicated exhaust system is planned and provision is made for make-up air. Exhaust from chemical and/or animal laboratories can contain traces of H₂SO₄, HCL and formic acid. Hence, regular GI ducting is not recommended. FRP ducting is used so that the effect of these chemicals on inner parts of air distribution system can be avoided.

Auditorium

The auditorium requires large latent loads to be removed due to occupancy and ventilation air requirements. Quietness in operation is also very critical. Auditorium air handling system is provided with deeper rows of coil, re-heating arrangement and low velocity ducting and air outlets. Smoke evacuation system is designed as per recommendations of National Building Code of India (NBC).

Locker Rooms

These areas are for keeping the belongings of students and the faculty. Locker rooms are not air conditioned; however, they are provided with an exhaust system in order to avoid stale air and smell accumulation.

The central plant is made up from 3x200TR water cooled screw chillers. The chillers are selected for COP of 6.1 and with excellent part load performance values to take care of variable load in school.

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Table 2: LEED score card of the hospital

S. No	Credits	Rating points	Kohinoor Hospital score
1	Sustainable sites	13	10
2	Water efficiency	6	6
3	Energy and atmosphere	17	13
4	Material and resources	13	8
5	Indoor environmental quality	15	12
6	Innovation and accredited professional	5	5
	TOTAL	69	54

Hospital

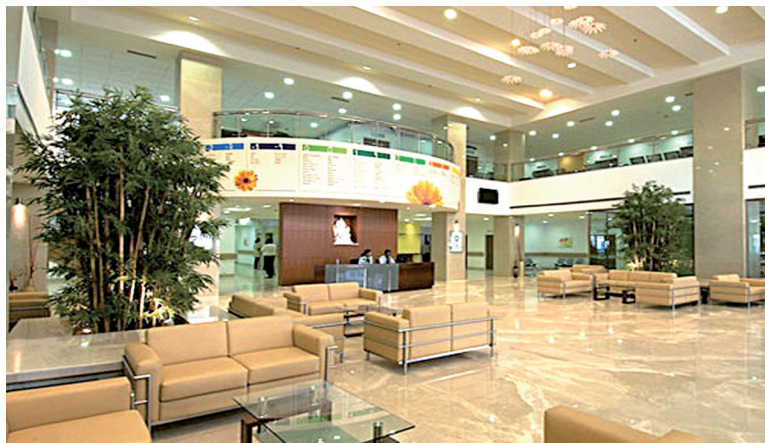
Kohinoor Hospital is Asia's first and the world's second LEED Platinum rated hospital. The owners were very keen to build a sustainable hospital, and design teams were directed accordingly from design inception.

Hospital Facilities

In order to provide multispecialty services, the hospital has the following departments:

- 1) Outpatient department
- 2) Inpatient department including isolation wards and Labour Delivery Recovery and Postpartum (LDRP) suites
- 3) Operating suites
- 4) Cardiac care and catheterization unit
- 5) Orthopaedic centre
- 6) Neuroscience centre
- 7) Ophthalmology centre
- 8) Spine centre
- 9) Cancer centre
- 10) ICCUs/ NICUs/ SICUs, mother and baby care units
- 11) Urology/ nephrology and maxillofacial services
- 12) Radiology with CT scan/ MRI, 2D echo, colour Doppler and high power X-ray
- 13) Blood bank and pathology suites
- 14) Central Sterile and Storage Department (CSSD)

Hospital services systems demand huge amounts of



Kohinoor Hospital is a LEED Platinum hospital

Table 3: Ratings of high side equipment

S. No	Equipment	Numbers and capacity
1	Chillers	3 x 200TR water cooled screw.
2	Transformers	2 x 750 kVA
3	DG sets	2 x 500 kVA
4	UPS	2 x 60kVA + 4 x 10 kVA
5	Solar hot water system	12,000 litres/day
6	Sewage treatment plant	130 kilolitres/day

power due to special requirements like cleanliness, pressure requirements, filtration and large air quantities. On the other hand, new age clinical equipment like MRI, CSSD, Pulmonary Function Test (PFT) units, etc. are also power guzzlers. While medical equipment is essential and one cannot reduce the power requirement of these units, the only choice was to look at services systems and equipment for energy conservation.

Architectural planning of the hospital provides a plethora of opportunities for energy efficiency. An opaque façade with intelligent locations of glass panels reduces heat gain to the building, and at the same time increases light transmittance. Also, a light well provided on the upper floors reduces the load on lighting circuits. Orientation of the building itself ensures optimum heat gains due to solar radiation.

Services systems are designed to complement the above erudite intent to achieve maximum efficiency with high efficiency water cooled screw chillers (ARI COP of 6.1), low water loss cooling towers, efficient variable volume pumping system selected to work exactly at the duty point without unnecessary safety margins, AHUs with airfoil fans and variable frequency drives, demand controlled ventilation with CO₂ sensors in air paths, heat recovery systems for areas with large fresh air requirement like the Operation Theatre (OT), pressure independent VAV system, efficient and intelligent lighting system with LED/CFL combination to achieve overall Lighting Power Density (LPD) of 0.54 W/ft², occupancy sensors in public toilets, low flow plumbing fixtures, solar hot water for dirty utilities, laboratories and HVAC reheating requirement. These features provided excellent power saving tools and fetched 9 points under Exhaust Air (EA) credit 1.

LEED Platinum Rating

Kohinoor Hospital is the world's second and Asia's first LEED Platinum rated hospital. Dell Children Medical Centre, Austin, Texas, USA was the first Platinum rated hospital in the world.

Kohinoor Hospital was able to score 54 out of the 69 available points. Table 2 gives the LEED score card of the hospital. Ratings of the major high side equipment are given in Table 3.

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By Santosh Rasane

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Introduction

The proposed project by Saifee Burhani Upliftment Trust (SBUT) at Bhendi Bazaar, Mumbai is a mixed development project comprising of residential buildings and commercial retail. It is an effort by SBUT to uplift the standard of living of the existing residents and shop owners by providing state of the art apartments, shops, services, landscaped open areas, roads and parking facilities.

The trust has taken up this large effort with a clear mindset to execute this as a non-profit project, as directed by His Holiness Dr. Syedna Burhanuddin (TUS). This is the first large redevelopment project approved by the Government of Maharashtra under Cluster Redevelopment clause 33(9). It is being executed by a team of highly qualified and experienced professionals based on the design from some of the world's most renowned consultants in the sphere of urban planning, architecture, engineering and finance. The project is planned on 16.5 acres of land in the heart of South Mumbai, and is pre-certified as Gold under IGBC Green Homes.

Project Details

The Saifee Burhani Upliftment Project (SBUP) comprises of 17 high rise towers with height ranging from 45m to over 200m. It is configured for two components; one is Rehab and the other is Sale. Within Rehab, the existing 3200 tenements of the area will be provided with modern upgraded homes of larger floor space. Similarly, the 1250 commercial spaces will be upgraded into modern shops. The Sale component will comprise of high rise

towers with high end homes and shops.

The Project's Strengths and Significance to the Region

The proposed project is a role model for redevelopment schemes, and promises a better future for the city. In view of the fact that it is an upliftment effort on the part of SBUT, it is imperative that the designer be sensitive towards the running cost once the tenants reoccupy their premises.

General References

- National Building Code of India 2005
- Central Public Health & Environmental Engineering Organization (CPHEEO) Manuals
- I E Rules (2000): for general guidelines
- IS 1255: 1983 – Installation of HT Cables
- Relevant BIS codes for Public Health Engineering
- IGBC Guidelines for Green Homes
- Ministry of Environment and Forests (MoEF) Manual

MEP Services Concepts

The project is being designed with state of the art services for the common areas and apartments considering its longevity in

About the Author

Santosh Rasane is a graduate civil engineer from University of Pune and is working as an Associate with Aecom. He has been in the MEP services field for the last 13 years. He is currently engaged in the design of high rise buildings, mass housing schemes and township projects. He is a member of ASPE and FSAI.

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terms of relevance and operation. Since the project is divided in 9 clusters, each cluster will be self sufficient in terms of utilities with independent substation, D.G set, sewage treatment plant (STP), fire storage and pumping. Each cluster will have its own basement, which will be ventilated.

Proposed Steps Towards Sustainable Design

As far as possible, cross ventilation is being explored in residential units, parking and common area corridors. Best efforts are also being made in design to provide as much natural lighting as possible in the interest of energy conservation.

The architect has designed the buildings in such a way that all regularly occupied spaces are within 13 feet of operable windows/doors, with operable area of windows/doors more than 15% of the carpet area. This will meet the minimum fresh air requirement of the residents.

Air conditioning will be provided only for common areas such as amenities and gymnasium, which will use CFC free refrigerant. In order to reduce the effect of heat island, it is proposed to use high solar reflective index white mosaic tiles or high albedo paint on terrace.

The entire water for flushing and irrigation will be sourced from tertiary treated recycled sewage, thus reducing the load on municipal potable water supplies, complying with Green building norms and meeting commitments made to State Level Environmental Impact Assessment Authority (SEIAA), Government of Maharashtra.

Rain water from roof tops will partly be stored and reused during monsoons for domestic purposes and the remaining part will be recharged into the ground.

Water can be conserved by installing low flow fixtures in the toilets. The following list shows the flow offered by efficient plumbing fixtures which are normally recommended for a credit under Green building innovative wastewater technology, for water use reduction by 20% to 30%:

- Water closets : 6.1 lit per flush
- Urinals : 3.8 lit per flush
- Shower heads : 9.5 lit per minute
- Faucets : 9.5 lit per minute
- Metering faucets : 0.95 lit per cycle

Solar stand-alone poles will be installed in the privately maintained open spaces. Bus bars in all distribution panels are specified as copper, to reduce losses and improve reliability. The trust is also exploring the feasibility of installing solar panels to harness solar power for common area lighting.

Copper conductor cables are specified for sizes upto 16 sq mm. This will reduce losses and improve reliability. Above 16 sq mm, aluminium conductor cables will be used to reduce the overall cost. Power factor will be maintained at 0.95 or higher for the common service loads for the premises. This will reduce electrical power distribution losses in the installation. Timers and photo-electric sensors will be used to switch ON/ OFF the external landscape and façade lighting. Compact Fluorescent Lamps (CFLs) with high frequency ballast will be used for apartments and commercial areas. Energy efficient fluorescent tube lights (T-5) will



Visualization of the completed project

be used for kitchens, washrooms and service areas.

All fluorescent light fixtures are specified to incorporate electronic chokes which have less watt-loss compared to electro-magnetic chokes and result in superior operating power factor. This indirectly saves energy. Electronic chokes also improve the life of fluorescent lamps. Energy efficient fluorescent lamps and CFL lamps give approximately 30% more light output for the same watts consumed, and therefore require less number of fixtures and corresponding lower point wiring costs. LED lights have been proposed for the corridors and lift lobbies, as they are energy efficient with 50 % more light output for the same watts consumed by TL type lamps. Dimmers will be provided for public area lighting as specified by the Lighting Consultant.

An Automatic Power Factor Correction (APFC) relay based on thyristor switching is proposed to effect the power factor correction/ improvement within a few cycles of deviation from the setting and to reduce inrush currents for the localized loads where the power factor is to be maintained. All cables will be derated to avoid heating during use. This also indirectly reduces losses and improves reliability.

Air Conditioning System for Shops

Basis of Design

Site location	: Bhendi Bazaar, Mumbai
Geographic location	: 18.5 deg. N
Altitude	: 11m above mean sea level

Outdoor Design Conditions : Outdoor Design Conditions for Mumbai are based on Weather Data compiled and published jointly by ISHRAE and ASHRAE India Chapter (AIC) corresponding to 0.4% annual cumulative frequency of occurrence, and are considered as follows:

Summer

Dry Bulb Temperature	: 95°F (35°C)
Mean Coincident Wet Bulb Temperature	: 73°F (22.7°C)

Monsoon

Wet Bulb Temperature	: 82.2°F (27.8°C)
Mean Coincident Dry Bulb Temperature	: 89.2°F (31.8°C)

Winter

Dry Bulb Temperature	: 62°F (16.5°C)
Mean Coincident Wet Bulb Temperature	: 57°F (13.8°C)

Building Construction Data

Physical characteristics of buildings such as U values of roof,

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walls and glass are decided based on recommended values under Energy Conservation Building Code. These values will be fine-tuned based on the actual selection of glass by the architect or client. The type and thickness of thermal insulation will be finalized based on the wall and roof construction details in consultation with the Project Architects, and the U-values will be finalised accordingly.

Ventilation

Car Park (Basement)

Basement ventilation is designed keeping in view air changes required as per the code to maintain suitable indoor air conditions. Mechanical ventilation fans will operate on VFD based on the concentration of CO₂.

Car Park (Above Ground Level)

Above ground car parking areas will be naturally ventilated.

Toilet Exhaust for Residential Flats

Individual propeller fans for individual toilets and kitchen exhaust air will be provided in the shaft, which will be extracted at service floor and at terrace level.

STP & Plumbing Plant Room

All plant rooms will be mechanically ventilated as per code requirement.

Heat Pump/Air Water Heater Operation

For individual flats, it is proposed to provide air-to-water heat pumps, as they have the dual application of water heating

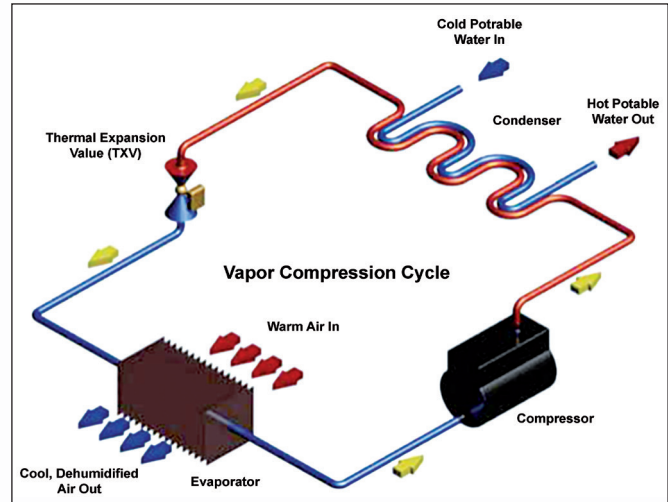


Figure 3: Hot water generation schematic

and cooling of surrounding areas. The feasibility of providing an air to water heat pump within each flat is being explored. This will provide the dual benefit of hot water with very low power consumption and almost free cooling of the room.

Heat pumps have the ability to move heat energy from one environment to another, and in either direction. The principle of production of hot water for domestic requirement as well as cooling of air is indicated in Figure 3. ❖