MARCH 2020

VIEWPOINT

OFFICIAL QUARTERLY MAGAZINE OF CEAI

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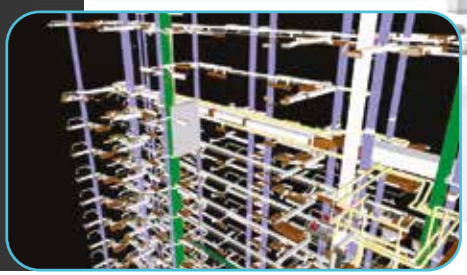

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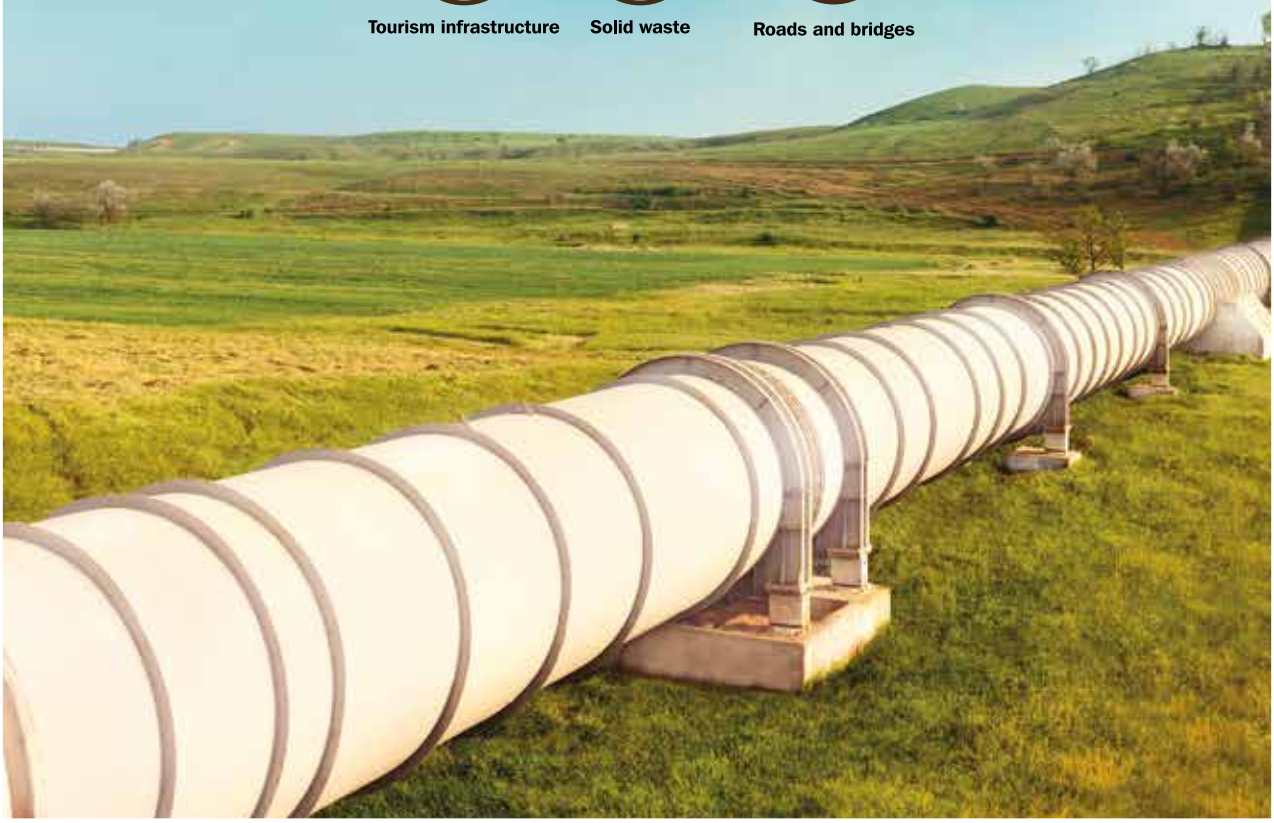

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We are one of the foremost construction companies in India having expertise in design and construction of Long Span Bridges such as Cable Stayed Bridges, Extradosed Bridges, Cantilever Bridges, Steel Superstructure Bridges across mighty rivers / creeks / water bodies and Elevated Metro Rail Corridors, BRTS, ROBs, RUBs in densely populated areas of cities. In last 22 years we have successfully completed over 300 projects in India, some of which includes:

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- India's 2nd Longest Cable Stayed span of 350m across River Ravi at Basoli in the state of J&K.
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- The foundation for most of long span bridges are either large dia or Double-D shaped caisson foundations with depth as much as 60m or large dia piles with length upto 65m.
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Building infrastructure for future...

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MESSAGE FROM CHIEF EDITOR

Dear Fellow Consulting Engineers & Readers,

The country, nay the whole world is going through stressing times on account of the COVID-19 which has derailed normal life and the economy. However, good leadership is ensuring, through social distancing that the impact be hemmed and minimized. As responsible human beings it is our civic duty to cooperate, be vigilant and advise those who do not comprehend the gravity of the situation. It's only that which will take us out of this pandemic. This phase has also infact demonstrated as to how important data is, especially of the essential services, for the safety and security of all. It has also shown as to how essential it is record movements of all living things so that their movement can be reviewed, if and when necessary, to provide the appropriate and essential assistance or take recourse to other actions, when the need arises. Needless to say that with such a data repository comes responsibility for its security and prevention of its misuse. Nevertheless it will become a dire necessity in the future.

On the brighter side, CEAI organized three seminars on very topical themes in the first quarter of 2020.

January 2020 started with the ***"Workshop on Global Vision 2030 – Engineering & Construction Services"*** in New Delhi jointly organized by the Service Export Promotion Council (SEPC), Ministry of Commerce and Industry (MOCI), Government of India (GOI) and the Consulting Engineers Association of India.

February 2020 continued with Consulting Engineers Association of India's organized Conference on ***"Water Infrastructure for Urban Areas & Industries"*** at Bhubaneswar in partnership with the Kalinga Institute of Industrial Technology (KIIT), Bhubaneswar.

March 2020 had CEAI's thought provoking seminar on ***"Goodbye L1 - A Route to Sustainable Engineering Development"*** with the support of NITI Aayog, NHAI, CVC, BRO, MES, CPWD, IEEMA and ECI. This was held on 4th March 2020 which had been declared as the ***World Engineers Day for Sustainable Development*** by UNESCO.

UNESCO's ***"Key Message of the World Engineering Day"*** recognizes that Engineers are necessary to "Create a Better Future for the World". There is another good acknowledgement of Engineers in the article on ***"Recognizing the profession: World Engineering Day"***.

With the active support of Members and the like-minded, CEAI continues to strive for the betterment and progress of the fraternity. Read the report on CEAI's pursuits on behalf of the fraternity in this issue.

Moving on to the theme of the current issue - the services in buildings in urban areas. Urbanization is spreading fast and the Municipal or Local Bodies are perpetually struggling to keep up with the demand for the services/ utilities that are essential for living. Although it can be attributed to unplanned growth, the fact remains that there is a lack of will to channelize and limit the development to areas in keeping

with the services/ utilities as planned and available. If the latter is adopted then the services/ utilities to each and every building could be adequately available. COVID-19 has amply proved as to why each and every service in a building and its inter-relation with any urban area is ESSENTIAL for living in modern times.

The limit and responsibility of a public body or a company providing a service/ utility ends at a predetermined boundary after which the building management team becomes responsible. Providing the multitude of services in modern times is an enormous task. The building management team needs to be well versed with integrated management of the services since many of them need to be run in unison to provide an acceptable quality of life.

Each tall building having thousands of occupants is a virtual mini city in itself; thus the task of the Building Management team is enormous. Each and every service needs to be provided on a 24x7 basis and also cater to emergencies but without compromising the safety, security and integrity of the building, its occupants and the goods in it. All this is possible, provided the building and its services have been conceptualized properly, designed, constructed, equipped and maintained correctly by experienced, knowledgeable, dedicated and well-knit teams, who are trained in all the tasks they have to operate plus continue to upgrade their knowledge and skills (continue their Professional development). These buildings require a good number of technicians and engineers to run the show, since automation is key to sustaining buildings that are growing in size – horizontally and vertically.

The advancement in digital technology and integration of communication systems has changed the way that automation works. Engineers must utilize them to the fullest so that all the services as well as the health of the buildings structure are all available in one place with the necessary audio –visual alarms if a threshold value or scenario is likely to be breached. IOT plays a major role in all this but one must guard against false alarms. Manual over ride of the system also must be provided for in all such foreseeable eventualities so that failures as have caused disasters in other sectors do not repeat in the building sector. This is essential since the integrated system is very complex and needs to be understood and represented correctly so that the outcomes are as desired and its automation results be effectively and efficiently deployable.

This issue of Viewpoint is all about Building Services and covers the important ones and draws attention to the various aspects essential for ensuring that they are provided correctly and function as intended. While digitization and other enamouring shibboleths are good for publicity and are being actively provided for all the main interfaces, thought must also be given to dealing with the waste created which has to be collected, transport/ treated and disposed. All these activities could also be automated to quite an extent but very few are working towards providing alternatives for getting the drudgery and hazards out of those activities. Robots would be ideal for such activities.

It is the Engineers and the planners who need to foresee all the requirements that could arise during the life of the structure and even keep provisions for options open if there is a change in the usage of the structure in the future. The shafts, ducts, raceways, racks, chutes, etc. for the services would need to be sized and located such as to provide proper access for maintenance, additions and alterations. In addition they need to be such that can be periodically cleaned to maintain hygienic conditions. It's only then that the habitants of the buildings would be able to improve their quality of life.

The Engineers to provide state of the art engineering services must continuously update their knowledge and skills. Only then along with the necessary experience and requisite capabilities would they be able to plan, design, install, operate and maintain the services in buildings to meet the expectations of the owner and the occupants.

To ensure that the above fructify there is a dire need for a body or bodies to register the Engineers and continuously appraise them. For that Legislation for Engineers is essential as for so many other professions.

Happy Reading & Learning for Better Building Services

A P Mull

MESSAGE FROM THE GUEST EDITOR

Building Engineering Services constitute a major part of a building or development. Efficient functioning of these services is thus a fundamental prerequisite for the successful working of the building/ development. Planning of all the building engineering services in the initial stages itself is essential to obviate issues arising due to non provision of the requisite space later on. The Consulting Engineers for the Building Services provide the Planners, Architects, Structural Engineers, et althe key data to develop the plans and help in keeping a control on the environment by use of appropriate engineering systems and technologies to obtain maximum economy. Consulting Engineers dealing with the various services provide the inputs in a structured and comprehensive manner. Their advice results in overall better coordination and efficient planning. Most important is that the operations and maintenance aspects also get built into the planning and design based on the experience and the data available with the Consulting Engineers.

The complexities in buildings have increased over the years with advancement in building construction techniques, highrise buildings and real estate priorities for phase-wise development thus bringing in multiple challenges. All large building projects need to abide by the Environment Impact Assessment Regulations of Government of India with emphasis on energy and water conservation. It is not only the Capital Expenditure but the ROM (Running, Operation and Maintenance) aspects that also need to be considered for the selection of any system, plant and equipment. Rainwater harvesting and decentralized sewage treatment coupled with recycling have resulted in upto 30% reduction on fresh water demand in large projects. Many buildings are being planned on a ***NET ZERO ENERGY*** basis. Water Neutrality is also being practiced in projects. Living within the means with regeneration on natural habitat is being practiced by Consulting Engineers in various buildings in India and around the globe.

In this issue of View Point, working professionals, many of them from specialist Building Services fields, have shared various Design Practices and Case Studies with View Point readers.

There is a small anecdote from my early consulting days that is worth sharing. Mr. Mike Ewy, MEP Head, McDonald's International during a site inspection in 1996, remarked that ***a customer enjoys the burger and drinks only if the building services are working well - good ventilation, good lighting, no odour in the toilets and with well lit kitchen. Any mal-functioning of the MEP services, leads to poor footfalls.*** The ***Building Services Engineers*** are SILENT WARRIORS who make a building/ development successful by being involved with it right from its inception. With high rise buildings becoming the norm, their services are also called for during the life of the asset.

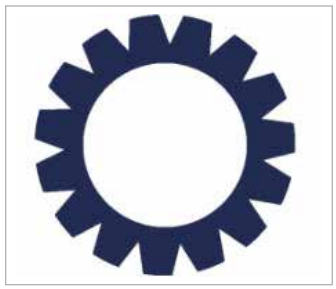
Enjoy this issue and do share your feedbacks for us to improve in the future.

Girish Chandra Mishra
Principal Consultant & Director
SAVIRAM Engineering Consultants Pvt. Ltd.

KEY MESSAGE OF THE WORLD ENGINEERING DAY –

The Role of Engineering

Engineering plays a key role in achieving the UN Sustainable Development Goals (SDGs) as it utilizes the principles of science and mathematics to develop practical applications in food, water, energy, environment, sustainable cities, natural disaster resilience and other areas which are crucial to all mankind. It is also crucial to the development of new technologies enabling the 4th Industrial Revolution such as artificial intelligence, Internet of Things, robotics or quantum computing, etc. Engineering is at the heart of our modern world and will shape the future, as has been the case for millennia.



4th March – the World Engineering Day for Sustainable Development

WORLD ENGINEERING DAY FOR SUSTAINABLE DEVELOPMENT

Realizing the key role of engineering for humanity and its environment, UNESCO, with support of all its member countries and more than 80 engineering organizations worldwide, decided to proclaim the 4th March every year as the World Engineering Day for Sustainable Development, to engage with governments, industries, non-governmental organizations and the public at large to address the need for engineering capacity and the quality of engineers to solve the world's most pressing problems.

Be an Engineer and Create a Better Future for the World

Important as engineering is, engineers have made a great value on society and have a significant impact on improving everyone's life with lasting benefits. Engineers are essential for resilience to climate change and to design and develop resilient infrastructure that will withstand the increasing weather-related events – floods, cyclones, and bush fires especially in developing countries.

Engineers are essential for sustainable economic development as they are needed to support the growth and development of essential infrastructures such as roads, dams, water supply, and sanitation in both developed and developing countries.

Engineers are indispensable to *technological innovation* that will benefit people and the planet for greater prosperity and better quality of life and leave no one behind, *especially to ensure equal access to technology for women and in rural areas.*

Engineers are needed more than ever before to meet the requirements of the 4th Industrial Revolution and to address the pressing needs of sustainable development of humanity and the planet. The World Engineering Day can be used for inclusive access to engineering for women and girls, and encourage young people, especially girls, to consider engineering as a career and say ***"If you want to change the world for the better, become an engineer."***

Source: *https://worldengineeringday.net/key-message-of-the-world-engineering-day/*

RECOGNISING THE PROFESSION: WORLD ENGINEERING DAY –

Summary

UNESCO's recent declaration that 4 March will henceforth be celebrated as World Engineering Day for Sustainable Development was a significant moment for both early-career and established engineers alike. Starting in 2020, the annual celebration presents a global opportunity to recognise the profession and encourage the next generation of engineers to solve the challenges of the future.

Engineering is everywhere

I realised quite recently that the expression "engineering is everywhere" could come across as hyperbolic, to some. How could this sweeping assertion – which admittedly sounds like it was written by some rather-chuffed-with-themselves marketing department – possibly hold a measure of truth to it?

I can understand that line of thinking. I mean, everywhere? How can one profession take us to the stars and yet also manipulate the properties of atoms? How can one profession connect the whole world and yet also empower an individual? In fact, how can one profession help to tackle the effects of climate change and yet also power the world, clean our water, save our lives, entertain us, create entirely new forms of intelligence, grow more food with less space, build the world's infrastructure (and help us to navigate it), and more?

And yet that's precisely the case. Engineering is the foundation of our society; it propelled us from our first use of tools to our first journey into space, and it will be fundamental to solving future global (and, potentially, interstellar) challenges. However, despite how much we rely on engineering, we rarely consider the work that engineers perform behind the scenes. As a prime example of this, consider the internet: in 2019, over four billion people use over 26 billion connected devices worldwide, but how many of them know who created it? More often than not, as QEPrize Judge Ilya Marotta pointed out, we "take the tools and services around us for granted. We use them, but we don't know how they work or how they were created."

Recognising the Profession

Thankfully, this should start to change. A source for immense celebration came from a recent announcement from the United Nations Educational, Scientific and Cultural Organization (UNESCO). On 16 April 2019, the UNESCO Executive Board voted unanimously to declare 4 March henceforth as World Engineering Day for Sustainable Development. The final confirmation by the UNESCO General Conference comprising all member states is due in November 2019. The proposal, led by the World Federation of Engineering Organizations (WFEO), was backed by over 40 countries worldwide. It's a significant moment for both early-career and established engineers alike, and an opportunity to celebrate the profession, engage with the next generation, and encourage them to take up a career in engineering.

The inspiration behind the proposal

In September 2015, the United Nations General Assembly announced the 2030 agenda for sustainable development along with its 17 sustainable development goals. The goals take an integrated approach to future development; they combine progress in economic prosperity, social inclusion, and environmental sustainability.

WFEO, which represents nearly 100 nations and 30 million engineers, recognised the importance of engineering in achieving these goals. On 4 March 2018, as part of their 50th-anniversary celebrations, they committed to advancing the UN sustainable development goals through engineering.

According to WFEO President Dr Marlene Kanga, who led the initiative, engineers and engineering are critical for achieving the UN sustainable development goals. They will:

- Develop and implement the technologies and systems needed to progress the UN sustainable development goals as they relate to water, energy, the environment, sustainable cities, and natural disaster resilience
- Design and develop infrastructure resilient to the increasing number of weather-related events such as floods, cyclones, and bush fires (especially in developing countries that are most exposed to these risks)
- Support the growth and development of essential infrastructure in developed and developing countries alike
- Create more inclusive technologies and innovations; their work will help to address the currently unequal access to technology, leading to greater prosperity and quality of life for all.

Global celebration and collaboration

Current engineering celebrations are small-scale and regional – often organised through institutions within that region. As Dr Kanga points out, "an international day with co-ordinated celebrations across the world will be an opportunity to increase the profile of engineering and to gain media coverage for the events." WFEO intends to ask institutions to register their events through a dedicated web site to build the momentum for celebrations. The goal for these events is, over time, to grow in both number and importance as more nations take part and take pride in their engineers.

4th March will also provide annual opportunities for government and industry to engage. The hope is that this will help both to address the ongoing shortage of engineers and to develop strategic frameworks for the implementation of engineering solutions for sustainable development

Source: *https://worldengineeringday.net/recognising-the-profession-world-engineering-day/*

INTEGRATED BUILDING MANAGEMENT SYSTEMS – A PERSPECTIVE FOR FUTURE BUILDINGS

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ABSTRACT

The advent of the industrial revolution and subsequent technological innovations have brought about transformational changes to society. Mechanization, mass production of goods, new manufacturing techniques, etc. brought about a shift from largely agrarian societies to urbanization. This in turn altered the urban landscape with smart buildings evolving to suit the emerging requirements of the new populace and their improved lifestyles. Today, the Integrated Building Management Systems have become an important facet of intelligent buildings. This article covers all the utility systems which integrate into a cohesive entity and allows all systems to share information seamlessly, work effectively, reduce operational cost plus provide improved safety and security.

INTRODUCTION

Businesses continually need to ensure customer satisfaction and high quality of their products/ services even while maintaining high productivity and keeping their costs low to be competitive and profitable. Among other things, Smart automation systems have significantly contributed in furthering this business objective in various industries and processes. Integrated Building Management System (IBMS) provides this functionality to facility managers – be they Owners or realtors – by enabling centralized operation and monitoring of various building utilities and services while ensuring superior comfort and safety for occupants, enabling quick response to the concerns and minimizing energy and labour costs.

Hence, today a growing number of commercial and residential buildings are incorporating smart technology in design and for regular control and monitoring. IIOT technology allows smart devices in buildings to communicate and facilitate various tasks like controls, monitoring of building's mechanical and electrical (M&E) utilities and the safety and security systems. IBMS controls and monitors various subsystems like HVAC, utilities electrical power systems, lighting, CCTV, fire detection system, elevators, etc. Conventionally, each of the above sub-systems of building automation operate as standalone system and have own operation and maintenance solutions. The recent trend is that most of the equipment vendors adopt product life cycle management approach in the industry, so requirement is for IOT platform integrator to provide end customer a holistic solution for all operations and maintenance of all Building Utility plant & equipment and the services.

The technologies utilized in IBMS are:

- Smart sensors for measuring various parameters,
- Fault detection and diagnosing tool to analyze data and provide optimal guidelines for efficient performance through data analytics in IBMS,

- Mobile devices which allow for quick on-site services, fast and efficient management anytime and anywhere,
- Keep track of each individual to know who is where, so that they can be evacuated in case of an emergency such as fire, and
- High architecture configurations, which offers quality identification and latest method to access sensitive data and support reliability.

BENEFITS DERIVED ARE:

- Reduce energy consumption,
- Building service efficiency improved,
- Predictive maintenance,
- Increase productivity of the sub systems, and
- Better utilization of resources, improved individual safety response.

IN ADDITION TO:

- Remote access control,
- Centralized management facility,
- Easy interface with all utility sub-systems,
- Reduced maintenance cost using predictive maintenance, and
- Remote test facility.

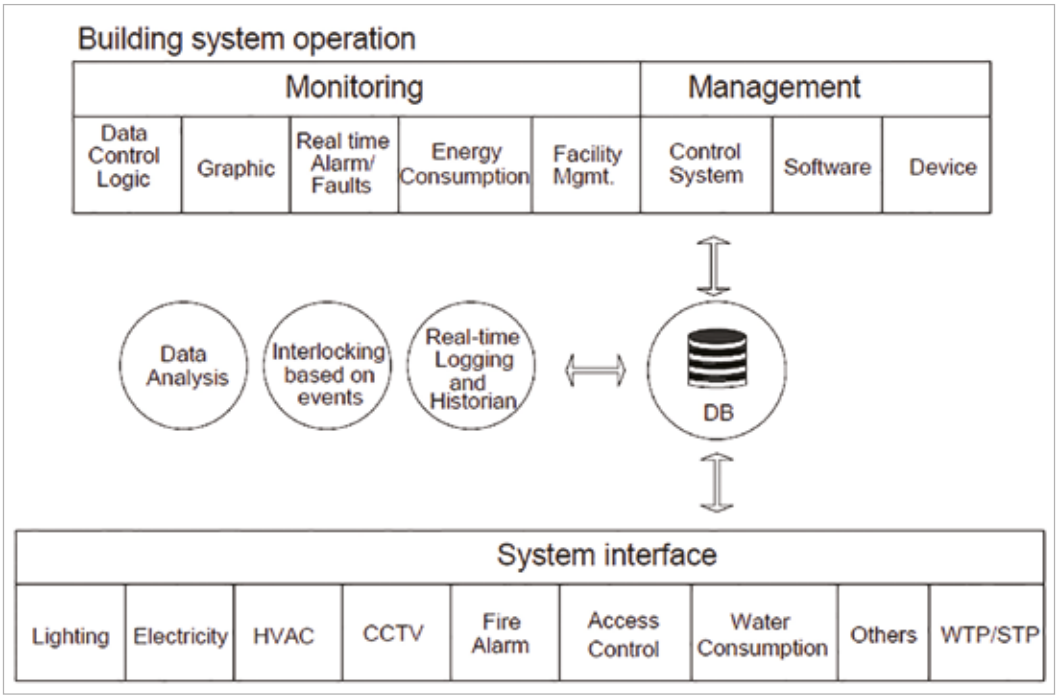


Figure 1: *Typical BMS architecture*

Some of the major sub-systems and typical functions available in the IBMS are:

a) Monitoring and Control of Mechanical and Electrical Plant/ Utilities:

i) HVAC

The Heating, Ventilation, and Air Conditioning (HVAC) system is a major energy consumer in a building. The BMS traditionally would perform sequential start-up and shut-down of the centralized system as per pre-programmed time schedules corresponding to the occupancy schedule. By operating the HVAC equipment as programmed, the system monitors and controls temperature and humidity in the conditioned areas, monitors the indoor air quality and maintains the air flow in ventilated spaces. Time schedules accounting for seasonal changes, holidays, etc. may be pre-programmed. To ensure uniform run-time and wear of the equipment, runtime monitoring and duty cycling sequencing is implemented in the BMS.

However, today with various smart sensors installed for various parameters like air temperatures, damper position, number of occupants, time, etc. all HVAC systems can be dynamically controlled and monitored. So, advanced controls for HVAC systems can reduce consumption in unoccupied zones of a building. They can also continuously adapt the operation to fit the demand and detect needs for maintenance. They are based on sensors and use control strategies adapted to the technology of the system, by modulating temperatures, flow rates, capacity, etc. With sensors to check the healthiness of the equipment and using asset management software, predictive maintenance can be carried out periodically without incurring inconvenience to the occupants and building owner.

ii) Water Management

The IBMS monitors the quality of water (pH, TDS, hardness), operates transfer pumps to ensure topping up the overhead tanks and monitors the status of various potable, waste water and storm water pumps the status of water and waste water treatment systems and the status of rain water harvesting system.

iii) Electrical Installation

Monitoring the status and major parameters of transformers, important breakers, solar generation, back up diesel generators, UPS, etc. keeps the operator abreast of the healthiness of the power distribution systems.

iv) Lighting Control

Lights may be operated based on lux levels or pre-programmed time schedules. Recent developments allow lighting control to be implemented at the level of individual lights/ fixtures based on occupancy or lux levels. This is a significant step-up from legacy lighting controls implemented at the level of a lighting circuit involving multiple lights.

v) Elevators, Escalators, Moving Walks, Facade Cleaning Systems

The IBMS monitors the operational and trip status allowing operators to initiate quick response to abnormal/ alarm conditions.

b) Fire Detection and Alarm System

The analog addressable Fire Detection Alarm System (FDAS) allows individual detectors, monitor modules, manual call points and control modules to be addressed thereby identifying the device in alarm/ actuation mode. The devices are connected in a loop to the fire alarm panel. Fire alarm panels in multiple buildings/ floors are inter linked over a

network that is connected to the centralized system in the control room for overall control and monitoring. Sensitive locations such as data centers are provided with aspirating type smoke detectors for very early detection of fire.

When fire is detected in any location, the IBMS typically performs the following actions in the corresponding location by appropriate interface to the respective systems.

- switch off the air handling unit of the air-conditioning system,
- move the lifts in the corresponding lift core to the ground floor,
- switch on the corresponding lift shaft and staircase pressurization fans,
- close the corresponding AHU dampers and open the fire dampers in the lift lobby of the affected floor,
- disable access control for the corresponding access-controlled doors/ barriers,
- play pre-recorded evacuation messages over the Public Address (PA) system in the affected area, and
- Identify as to who all are in the danger areas in buildings/ facilities where different areas have access control.

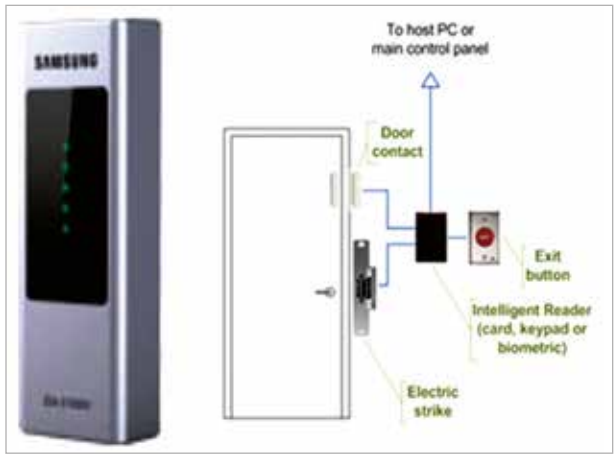
c) Access Control System (ACS)

Access Control System (ACS) are extremely essential in highrise buildings and those with large a footprints. The type and extent of the systems incorporated would depend on the expected threats and consequences of un-authorized access and need to identify occupants of a zone in danger. Vehicular access to facilities can be guarded by devices such tyre killers, bollards, boom barriers, etc.

Various perimeter intrusion detection systems based on infrared motion detection, microwave motion detection, thermal imaging, pressure sensitive cable, laser scanners, CCTV based analytics, etc. are available for varying applications and budgets.

Type of access barriers for personnel access to the buildings would vary based on the type of premises like multi-tenanted or self occupied residential or commercial buildings.

General purpose access regulation can be achieved by doors provided with electromagnetic locks. Various types of card readers like RFID readers and contactless smart card readers are typically used. For higher security requirements, fingerprint readers, retinal scanner, hand geometry or facial recognition are employed.



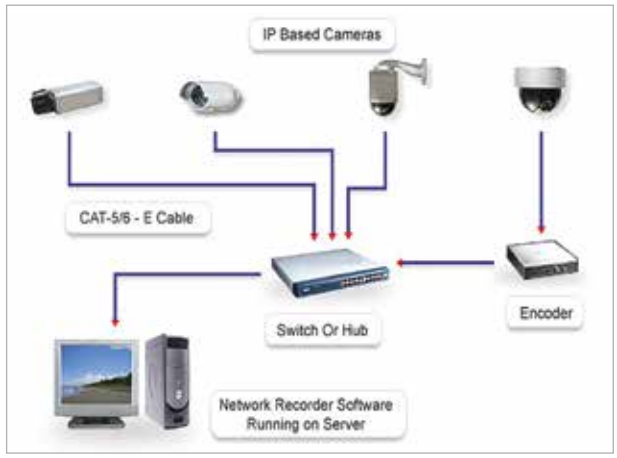
Access Control System (ACS) – Electromechanical Hardware with Electronic Controllers, Contactless readers, etc.,

Access controllers are interconnected over a network and connected to the HMI in the control room for centralized monitoring and administering of the system. The HMI software allows the security personnel to add or remove users and to configure authorized access zones and days/times as permitted for each user. Since the access control system logs all events and user transactions, they may also be used for attendance logs, for visitor management, for evacuee audit in the case of emergencies like fire, etc.

d) Closed Circuit Television (CCTV) System

CCTV system for general surveillance, especially the IP based ones have become the norm. Digitizing the video signals have opened up huge possibilities to analyze the images to automatically detect various situations without requiring operator intervention. These could include intrusion detection, unattended baggage identification at airports, facial recognition, loitering detection, crowd detection, license plate reading and several other possibilities. Video recording may be optimized by adopting motion-based recording based on movement on any part or selected part of the CCTV image – thus cutting out uneventful recordings.

Recording may also be triggered by access control system alarms to allow recording of images from related cameras. Buffered storage allows recording to commence from a configurable time before the alarm occurred.



IP Based CCTV System with IP Camera, Video Management Software for on-line display of video images on monitor

PUBLIC ADDRESS SYSTEM

The Public Address and Evacuation Messaging system for an entire building or all buildings in a complex combines all the essential functionality like zone wise paging and voice paging along with other messages to other systems. They perform the three basic functions:

- Public address announcements
- Emergency notifications
- Status facilities

e) Structural Health Monitoring

Several sensors installed in the structure allow continuous monitoring of the building for changes to the material or geometric properties that are indicative of damages due to aging and degradation and even during seismic activity or high winds. In the aftermath of extreme events such as earthquakes, this helps to have reliable information about the structural integrity or damage in real time.

f) IOT, Communications, Data Analytics

Aggregating the sensor data from multiple buildings in the cloud allows manufacturers to apply machine learning and data analytics techniques to implement advanced control techniques and predictive maintenance. For instance, these techniques can help to arrive at better set point for optimal operation of the HVAC system. They can precisely identify particular device (e.g. smoke detector) that is likely to fail thereby enabling the planning of maintenance or replacement. Such focused predictive maintenance, instead of routine, time-based preventive maintenance of a set of devices, offers significant cost and time benefits while minimizing occupant discomfort.

Use of smartphone applications and communications enable individual user interaction and integration into the IBMS. For instance, smart phone applications allow individual users to provide feedback about the temperature in their location thereby acting as 'human temperature sensors' that allow immediate corrective action in the HVAC system. This eliminates the need for the occupant to contact the O&M personnel and await their action.

CASE STUDIES

Case Study-1: Manufacturing facility

For the complex comprising multiple buildings, a centralized system was installed to provide common centralized control operation, monitoring and management facilities to provide safe working environment for the personnel in the buildings.

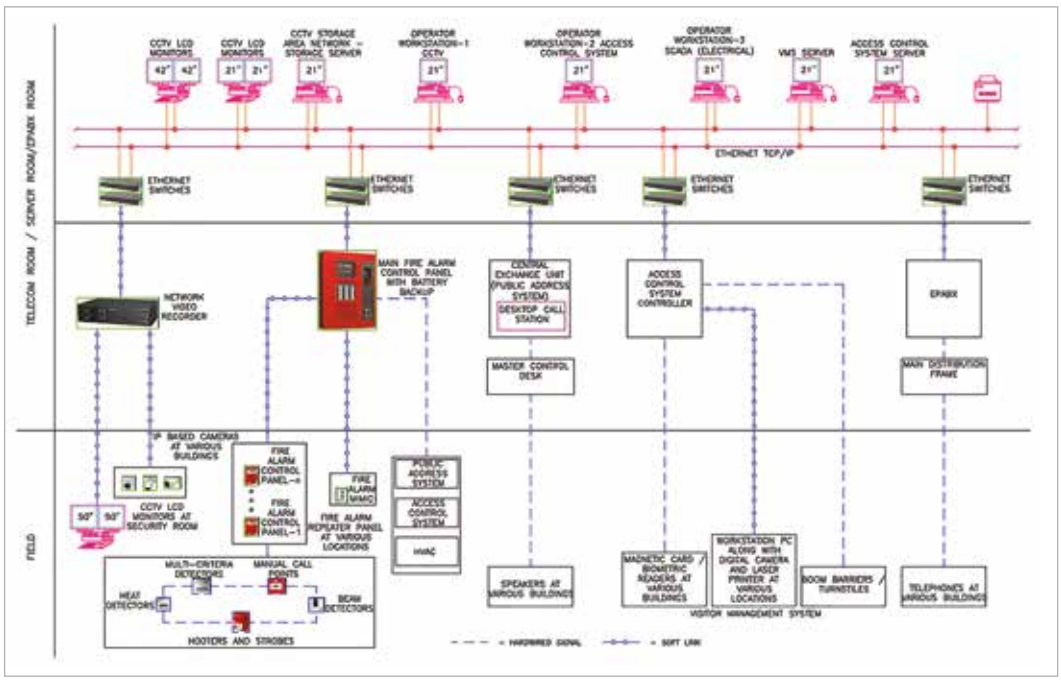
The following sub-systems were included:

- IP based closed circuit surveillance system,
- Smart card-based access control system,
- Analog addressable fire detection system,
- Public address and emergency voice system, and
- Telephone system.

IP based CCTV and Access Control System were used due to the advantage of scalability, digital and easy integration with other systems. The system reduced the cabling, since power over ethernet switches that have been used allow single Ethernet cable to carry both video data and power.

Fire Detection and Alarm System were installed for the complete plant area with a visible annunciation at predetermined locations to alert the personnel and transmit information to the Centralized Command System.

Public Address System was critical to be able to communicate with personnel during routine and emergency situations and was interfaced with the Fire Alarm System. The Telephone system was for regular communication among the personnel in the plant.



Case Study-2: Smart Building Services for Software Tech Complex

The IBMS included:

- Workstations with relevant software, controllers (DDC), portable operator terminal (POT), field Instruments (sensors, transmitters, valves, etc.), etc. Automated data collection to display status of mechanical (HVAC, water management, etc.)/ electrical systems (power distribution, elevators, DG sets, etc.) on workstations.
- Fire Detection and Alarm System with various type of detectors.
- Addressable system integrated with the PA system, and
- Closed Circuit Television System (CCTV system)

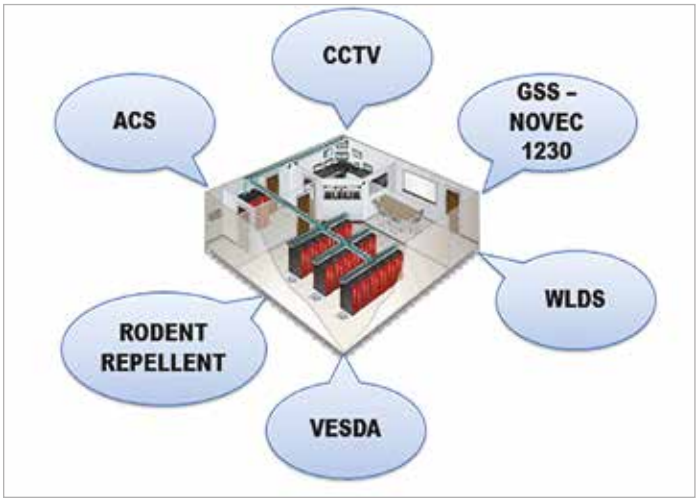
SUB SYSTEMS FOR CRITICAL DATA CENTRE

Smoke Aspiration System - Addressable intelligent spot type laser detector with sensitivity 50 times higher than photoelectric detectors

Water Leak Detection (for data centre) Tape Sensor, WLD module, Condensation detector with I/O module and sounder

Gas Suppression System - Audible (discharge siren) and visual alarm

Rodent Repellent System - Ultrasonic signal generator (20kHz to 60kHz), microcontroller module with dedicated drivers for transducers



Typical Diagram - Data Center with all sub systems

Case Study-3: Industrial and Logistic Park

In this case, the IBMS integrated the following systems:

- HVAC
- Fire Detection and Alarm System
- Access control system
- Water Treatment plant
- Sewage Treatment Plant
- Electrical panels

These operators supervise and control these systems through workstations provided in a central IBMS room.

Each of the IBMS sub-systems such as CCTV, ACS and PA systems are available with various features/ options. These include video analytics-based surveillance systems, screening system, robots for security guards, smart servicing, facial recognition, etc. Also, emerging technologies like cloud computing, data analytics, better sensors, the internet, specialized software, etc. are throwing up numerous possibilities and operational benefits. Depending upon the type of building and the user's decision considering the operational benefits vs investment required, the extent of smart automation is recommended by the consultant.

If client requires a maximum operational benefit from the Smart building automation, then future concepts are:

Intelligent Building Management systems – This system shall employ hundreds of sensors connected/ embedded to the equipment/ buildings to check the healthiness of the systems and transmit data to centralized data centre/ cloud. Using this input data, predictive software generates information on predictive maintenance and life cycle management of the systems.

Energy efficient and green building software – By good design of the electrical, water systems and by monitoring all the required parameters of these equipment, the performance of these systems can be optimized to make the building energy efficient. So, it will be possible to get a green energy efficient building experience both to Owner and occupants who work in the environment.

CONCLUSIONS

Providing centralized operation and monitoring from a Control Room for all the utility sub systems, the IBMS facilitates an integrated oversight of the facility to the operators. That allows them to manage the facility efficiently and respond to evolving operational requirements without compromising on occupant comfort or safety. The automated controls together with optimized control strategies for various plant and equipment keep energy consumption to the minimum required thereby reducing operational costs. These factors have made IBMS an indispensable tool in administering modern facilities – whether they are single building entities or large complexes. Smart buildings are becoming the order of the day and with them the adoption of new technologies.

The core benefits from fully integrated IOT enabled IBMS are:

- With open communication at field level, integrated storage and analysis of diverse information is available on a common platform,
- With automated point data and strategic insights due to smart devices, intelligent decision making is made possible,
- Integration with asset management and predictive analytical solution,
- Enhanced end client experience,
- Eco friendly systems,
- Improved and optimized resources, and
- Improved building security and safety.

REFERENCES

1) https://www.iotforall.com/iot-meets-building-automation/

2) https://www.trueoccupancy.com/blog/5-key-benefits-of-smart-buildings

RESPONSE HUB - FOR INDIA'S SECURITY & SAFETY NEEDS

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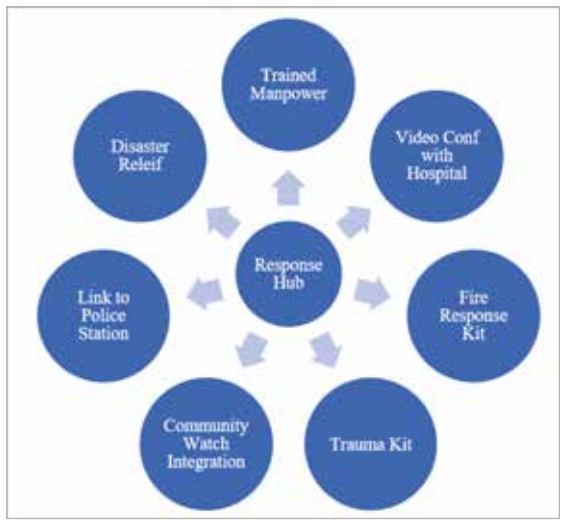
There has been an ever snowballing challenge for Indian cities to provide time-effective response to emergency situations. Media has been incessantly reporting that ambulances and fire tenders are not able to perform their allocated duties as traffic doesn't allow them to move swiftly. These contests only seem to be going upwards as the urban population of India grows; in 2011 it was 31% of the total population and would be more than 40% in 2030. There are many towns that will grow into large cities very soon. The problem in India is not urbanization rather it is unplanned urbanization. It is envisaged that these challenges can hit the overall security and safety landscape in India, as explained below:

- **Larger Urban Population:** leading to higher density of population in more number of cities, uneven distribution of resources, traffic congestions, capacities of utilities & services becoming inadequate, etc.
- **Socio Economic Divide:** Unless the trend is reversed, the socio economic divide can continue to deepen leading to lack of understanding among various factions of the society.
- **Lack of Integration & Interoperability:** The propensity of safety and security organizations to procure technology in piece-meal manner would lead to lack of integration and ultimately result in less than effective response.
- **Numbers and Spread of Response Forces:** The inadequate number of response forces and their strength such as police, fire, medical, engineers and disaster response teams have been regularly highlighted by various experts. Another challenge that the congested areas pose is non-availability of quick response teams near an incidence site. There is a significant time gap that can take away the effectiveness and efficacy of the response and at times even the need of response.
- **Untrained population:** India needs to inculcate safety & security into its DNA. As of now there is a need for training of the populace on security aspects and prevention and response to unsafe situation.

These challenges could cause much greater damage by way of loss of life and property through higher number of incidences and make Indian cities unsafe.



A suggested solution could be the RESPONSE HUBs being managed by dedicated Response Forces. The Response Hub would be a specialized micro unit operated by highly trained personnel for fast and effective response to emergency situations in community areas. The Response Hub would also be integrated with bigger response mechanisms and thus contribute overall as well.

A Response Hub can be planned for every 5 sqkm or a population of every 5 lakhs. More the spread and number of units the better would be the response. There could be additional Response Hubs for critical and sensitive areas. The key elements for success of a Response Hub would be – spread out for good monitoring, effective response, community engagement, integration with existing system and trained manpower. The first response mechanism for first aid, security incidences, disaster situations, fire incidences etc. could be provided by Response Hub. The Response Hub personnel would also be able to handover the situation to higher degree of experts once needed and those experts reach the incidence site.

The Response Hub could also serve to engage the local community and increase awareness for better prevention, detection and response. Indians as a community need to take responsibility of their own safety and security. From population standpoint this can be quite a shift from disparaging government agencies to ensuring safety and security by local communities themselves.

OPERATIONS OF RESPONSE HUB

The operational capability of the response hubs could be managed with the following deployment:

- **Manpower:** Each of the personnel deployed do an 8-hour shift. Thus a complete day would be managed by three shifts of 8-hour each.
  - Team Leader – 01
  - Team Members – 03
- **Medical Equipment**
  - Defibrillator – 01
  - Medical bed – 01
  - Oxygen – based on area needs
  - Stretcher – 01 or more based on area needs
  - Trauma kit – 02
  - Medical supplies – based on area needs
- **Fire**
  - Fire extinguishers – 10 (size and type based on area needs)
  - New age fire controllers such as Throw Balls, Torches – based on area needs
  - Fire hose – 01 (pressure and water based on area needs)
  - Blankets – 10
  - Fire beaters – 05

- **Disaster Relief**
  - Earth mover machine – 01 (number can also be altered for one among multiple Response Hubs based on area needs plus the speed of deployment)
  - Inflatable boats with life jackets and floats – based on area needs
  - Iron cutter – 01
  - Tree cutter – 01
- **Communication**
  - Computers – 02
  - Mobile phone sets – 04
  - Fixed line with high speed broad band internet connectivity – 02
  - Direct connection with the nearest hospital for video conference
  - Direct connection with nearest fire station for video conference
  - Direct connection with nearest police station for video conference
  - Direct connection with all Ambulance service providers
  - Direct connection with the Municipal/ Local Body Disaster Control Room
  - Direct connection with other Response Hubs for video conference
- **Mobility**
  - Four wheeler/ two wheeler – based on area needs

One of the most critical factors that would contribute to the success of Response Hubs would be the skillets of the personnel deployed. There would have to be extensive class room coaching, on the job training and periodic refresher trainings to ensure that the small team at Response Hub provides an effective response.

It would also be necessary to ensure that each and every member of the Response Team are and remain physically and mentally fit at all times.

BENEFITS OF RESPONSE HUBS

The response hub would offer the following immediate benefit to India:

- Effective response leading to better safety and higher security
- Scalable model for wider implementation with minor customizations
- Immediate employment opportunity to join the Response Hub as highly skilled personnel
- Deployed personnel can run community programs during lean time ensuring populace become more responsible
- Opportunity to develop a Public Private Partnership resulting in reduced capital burden on government and much speedy implementation
- Boost to economy by ensuring planned equipment is designed and manufactured in India

BUILDING SERVICES IN THE ENVIRONMENTAL LANDSCAPE

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OVERVIEW

Historically, most of the development comes from the environmental possibilism theory of the possibility that can be drawn from the requirement of the client's vision, which is mainly for business purposes within the landscape market. The built construction involving any type of facilities would undergo the environmental process as part of project management that always occurs from start to finish using a methodology in alignment with the country's statutory law requirements. However, engineering management of building services which are at the heart of any building facility, must be right from the design up to the construction stage and later for maintenance need to be addressed by the architects, structural engineer, environmental engineer, and the building services engineer to provide the client's requirements. An example was presented in the author's article, *"Environmental Possibilism" CEAI ViewPoint, March 2018,* which discussed about the environmental perspective and innovation within the socio-cultural development as well as its implication that contributes in the climate change because of the collected pollution generated from various building structures as discussed in another article by the author, *"Environmental Engineering in Built-Up Areas" CEAI ViewPoint, December 2019.*

Building Services are the essential elements and in them the designs of Life Safety and Property Protection systems for a skyscraper building are a multi-disciplinary effort refer *"Skyscraper Fire Protection, an Asset Management Strategy" CEAI ViewPoint, June 2018,* which covers the importance of fire engineering and management systems designed by building services engineers specialized in the HVAC, Electrical, Fire Protection, and Public Health Engineering including Building Instrumentation & Controls, and Information Technology.

BUILT ENVIRONMENT CONSTRUCTION

An appropriate Building Services Engineering Management Plan (BSEMP) needs to be provided as the basis to facilitate the work on built construction and later is maintenance, all complying with the specific work condition, criteria, regulating laws, and standards about the construction development of the building and the building services in the project.

The importance of energy conservation using the latest technology would help a client to conceptualize the vision within the economic ambit as well as keeping the principle of sustainability in mind as the main goal in today's competitive landscape. The fact that energy and water play a significant role in the built environment in reducing the effect on global climate change, have been addressed in the author's article, *"Energy Conservation for Utilities Means Sustainability," CEAI ViewPoint, September 2018.* Energy Conservation would help the world in conserving the environment through building services engineering technology and at the same time would create revenue from innovative design works.

The focal purpose is to provide a structure according to the client's perception and application of the theory that the building would be safe, habitable and functional according to their goal and service for the community as part of environmental possibilism. Most of all, the building design and construction must comply with the local codes as well as following the prevailing international standards and code of practices.

BUILDING BUILT CONSTRUCTION PHASE

Buildings embody the futuristic and idealistic thoughts based on technological innovations which are a must for a country's socio-cultural and economic development. The environmental movement and its relationship have been explained and the ideas developed in the author's article, *"Engineering Consultancy in the World's Environmental Movement," CEAI ViewPoint, December 2018,* to attain the cherished vision of serving the citizens sustainably for a common goal of the crafted policy preferably towards urban greening.

Another of the author's article provided, *"Urban Greening Policy – a Proposal," University of the Philippines Journal, 17th January 2020,* published in Research Gate, explained about the transformation in the way the that built spaces can be managed for sustainably and fructify the implementation into a reality for a common good for public use and mitigating Climate Change. The Urban Greening refers to public landscaping viz. greening areas by providing shrubs, ground covers, and various trees, built-up areas, and road pavings.

As discussed in he author's article, *"Planning, Design & Construction – Safety & Security Policy," CEAI ViewPoint, September 2019,* discussed the holistic approach required in the building-built environment, and the supervision consulting engineer having to performing multiple functions while the building construction is in progress. These function include :

a) Review of the shop drawings, materials, and product data on the plant and equipment being supplied for the project; approval of contractor drawings of the installation,

b) Replying to the contractor's queries on the design details of the work included in the design documentation as well as making periodic visits to check the installation.

c) Preparing lists on all points of discrepancy in the completed work done by the contractor against all design plans, specifications and authorities approvals, and

d) Frequently the engineer in charge would be requested to approve the contractor's invoices for the completed work once complied following the plans & specifications.

On project completion, the design team would be asked to assist and determine the date or dates of substantial completion by the contractor. These are critical dates as they usually establish the time when the warranties by the contractors and equipment manufacturers/ suppliers commence.

BUILDING SERVICES FUNCTION ON BIM TECHNOLOGY

As a practitioner within the Program Management and with the BIM technology, it is an essential tool that simplifies the construction issues. However, the building services design plan must be developed an economically viable strategic approach in transforming through environmentally and financially sustainable enterprise. Nowadays, as technology innovates and with the use of BIM Technology, Computer-Aided Engineering and the internet become a plus factor in adopting it, especially in following sustainability and the green building context it will make engineering design

works much easier than using the old hand calculation methods, refer *"Energy Conservation for Utilities Means Sustainability," CEAI ViewPoint, September 2018.*

The most significant opportunity lies in being able to provide a fully integrated, multidisciplinary Architectural-Engineering practices where CAE and BIM integration would be done as a continuum of the design process.

BIM provides an accurate virtual model of the building per se and all the services in the building, all digitally accessible through BIM with the benefits it offers reduces the possible risks, and whatever the future challenges may hold for the implementation of the project.

BUILDING SERVICES JOB PREPARATION, DRAWINGS, AND FIELD REPORTS

Good design practices and accurate engineering analyses are essential factors within the team to ensure all information has been validated and reviewed carefully by the concerned design team and the contractors for the building owner's perspective within the project milestone.

Architects and Engineers can discuss and plan all the strategic phases and what needs to be done from the design approach until construction handover. *("Building Services Engineering Management," April 2019, Research Gate).*

DECISION MAKING - IMPORTANCE

In most of the built environment projects, decision-making can be regarded as the mental processes or the cognitive process emanating at the discretion of a course of action among several alternatives within the management aspect. Every decision-making process constructs a final choice for positive output in simplifying the construction methodology towards successful implementation. The output can be an action or an opinion of choice. However, human performance in decision-making terms has been the subject of active research from several perspectives that can be categorized as individuals for the followings:

From a psychological perspective, it is imperative to examine individual decisions in the context of a set of needs, preferences an individual has and the values they seek.

From **a cognitive perspective,** the decision-making process must be regarded as a continuous process integrated into the interchange within the environment.

From a **normative perspective,** the analysis of individual decisions is concerned with the logic of decision making and rationality and the invariant choice it leads to.

At another level within an organization, it might be reckoned as a problem-solving activity, which would be terminated when a satisfactory solution could be found for every activity being implemented, as a methodological approach exercise.

Therefore, decision-making is a reasoning or emotional process which can be rational or irrational and can be based on explicit or tacit assumptions. Furthermore, logical decision-making is an essential part of all science-based engineering professions, whereas specialists apply their knowledge in a given area for making decisions positively.

BUILDING SERVICES APPLICATION IN GREEN BUILDING REVOLUTION

From the environmental perspective, green building revolution around the world became trending since around 2009. It has been incorporated through engineering and architectural design aspects towards technological innovation and value engineering applications that abruptly changes the construction methodology overtime. Eleven years back, green building was introduced in a seminar conducted by the Institution of Engineers India (IEI Qatar Chapter) and followed by ASHRAE Qatar Chapter. It has been followed up consistently since then. The Qatar Professional Engineering Commission amended the Green Building or Sustainability Policy and incorporated it in the Qatar Construction Specification Standards which has now become mandatory. The statutory regulation of standard is being monitored and assessed by the QSAS Authority in the design and construction process. However, the base assessment and guidelines are the adaptation of the USGBC rating system policy for the building built environment application. The author's article, *"Desert Landscape to a Sustainable Environment," Journal of Management and Development Studies, University of the Philippines Open University, December 2019* discusses about the development of Qatar landscape in today's generation, which can be said as an innovative type of progression with the help of technology being applied following the urban greening policy in the desert landscape to a sustainable environment.

The Sustainable Engineering Consultancy's framework as discussed in the previous author article, *"Energy Conservation for Utilities Means Sustainability," CEAI ViewPoint, September 2018,* which considers nine core areas as the fundamental criterion for building certification: 1) Energy Efficiency and Conservation, 2) Water Efficiency and Conservation, 3) Waste Management, 4) Use of Land and Ecology, 5) Environmental Management, 6) Green Materials, 7) Transportation, 8) Indoor Environment Quality, and 9) Emissions.

However, with all the innovations happening around the globe which impacts climate change, the future of engineering would need to meet the requirements demanded by a competitive society. Engineers and scientists must focus more on energy conservation and reducing carbon footprint using renewable energy within the infrastructure and building built environment for innovative engineering resulting in a green environment. *("Future of Engineering within the Ecosystem," CEAI ViewPoint, June 2019).*

BUILDING SERVICES ENGINEERING MANAGEMENT AND VISION

With the evolving of Building Services Engineering Management the Building Services Engineers was created in 1976 by the Chartered Institute of Building Services Engineers (CIBSE, UK), thus formally recognizing building services engineering as a profession and part of the built environment in line with *"its objective (which) is to support the Science, Art, and Practice of building services engineering and it is the engineering of the internal Engineering Management that is the specialized form of management and engineering concerned with the application of engineering principles and business practice."*

The practice of building services engineering management is similar to construction project management in the building built environment, and the only difference is that the building services engineering management deals mostly with MEP works right from design, construction, building maintenance, and operation phases. Hence, it is part of the construction project management within the construction phase. They therefore also involve organizing the forces personnel in administrative and engineering positions necessary for design, supervising labor, awarding subcontracts, purchasing materials, record keeping, financial contractual obligations, and other management functions. All those are to ensure a profitable and timely performance of the job. The *"Decision-Making Importance* as discussed earlier is the combination of managerial talents requiring continuing professional development through training, education,

and lessons learned through experience in both building design and construction. Nevertheless, services engineering management would spell the difference between successful contracting organizations and business failure.

The Case Study is about the lesson learnt prior to the construction and installation as part of building services engineering pertaining to HVAC. It is an important system mainly because it deals with the buildings indoor environment to sustain the needs of occupant health aspect unlike Fire Safety Engineering, Public Health Engineering, Ventilation Engineering, and Electrical Engineering.

The Building Cooling Load Verification is an important factor to cross-check the design drawing versus site condition requirement prior to equipment procurement to meet the client's vision.

For a successful program from the start to finish, the building services engineering manager must work closely with the building services engineers and other construction professionals - architects, structural engineers, and quantity surveyors, for good coordination and communication. Planners need to appreciate the fact that the building services engineering profession today influences the architecture of a building and play a significant role in today's green building or sustainability concerning building energy demand that includes the essential application of renewable energy in reducing the use of the traditional electrical grid. Hence, the building services engineers and manager play a significant role in combating climate change.

Case Study – Cooling Load Verification for the Selected Room Areas

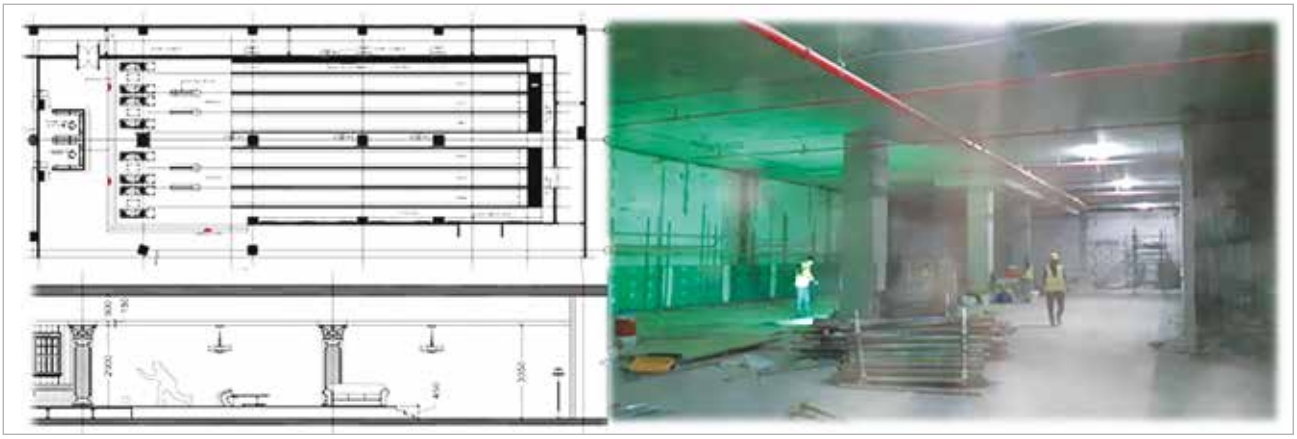

Figure 1: *Vendome Mall Family Entertainment Center Bowling Area*

A.1 Case Study Project Background

The Vendome Mall is situated in Lusail, 11km from Doha and is about 1,000,000 square meter comprising two 5-stars hotels, serviced apartments, up to 400 different retail outlets, Snow Park and family entertainment component showcasing permanent attractions with technologically advanced installations. Accordingly, it is one of Qatar's economic diversification in terms of human and social development aligned with the pillars of Qatar National Vision 2030 from accommodation to entertainment at the highest level of convenience. The HVAC System for the Snow Park and Family Entertainment Center were being served from the existing district cooling network managed by the Lusail Marafeq Authority and distributed through the buildings to the dedicated building AHUs and FCUs throughout the facilities designed to meet ASHRAE's design criteria standards, the Qatar Construction Specification and the Client requirements.

A.2 Purpose of the Study

This paper has been prepared to conduct a verification calculation on the selected areas of concern with reference to the given data as prescribed in Section A.5 Design Criteria, which was based on the site conditions as against the given design schedule which were given in the Issued for Construction (IFC) Drawings for the Vendome Mall Snow Park and Family Entertainment Center Project. The verification calculation had been conducted to ensure the reliability of the designed capacities and compliance with the Project Documents and Specifications before the procurement of the equipment.

A.3 Problem Encountered

The issue was raised because of incomplete data given in the Issued for Construction (IFC) document which was handover by the Design Consultant to the Supervision Consultant. The MEP contractor was unable to finalize the procurement with proper justification. Because of the doubts and confusion, the Supervision Consultant decided to carry out random checks of the design prior to final review and recommendation.

As part of building services case study and lessons learned, the following sections have been provided as guidelines in resolving the issues encountered as part of an engineer's responsibilities.

A.4 REFERENCES

For verification the references used to finalize the cooling load were the following;

- MEP Project Contract Specifications
- Approved Shop Drawings related to the work activity
- 2009 ASHRAE Fundamental Handbook
- Carrier Air Conditioning System Design Manual
- Shaker MEP Concept Design Report
- KAHRAMAA Electrical Regulation – Air Conditioning System Requirement
- QCS 2014 – Section 22 Air Conditioning, Refrigeration, and Ventilation
- Carrier HAP Calculation Software Program

A.5 Design Criteria

The verification calculation was based on the actual data at site and the given outdoor design condition, building façade performance criteria, and the inside (room) design conditions. These were simulated with the input details required by the Carrier HAP Calculation software.

Outdoor Design Conditions

The outdoor design recommendation for Doha, Qatar has been concluded based on the ASHRAE Fundamental Handbook 2009 Edition and the Qatar Construction Specification (QCS 2014) requirements of the following:

- Latitude 25.25 N
- Longitude 51.57 E
- Winter Outdoor Dry Bulb Temperature 11.1° C
- Design Summer Outdoor Dry Bulb Temperature Qatar Construction Specification (QCS - 2014) 46.1° C
- Design Summer Outdoor Wet Bulb Temperature Qatar Construction Specification (QCS - 2014) 30.5° C

Building Façade Performance Criteria

The parameters for simulating the walls and partitions were:

- Wall Construction U-Value 0.50 $W/m^2/K$
- U-Value for the partition barrier between the cold side area and the warm side area (walls, window, doors, and others as applicable) 0.80 $W/m^2/K$

Indoor Design Conditions

Indoor design criteria & parameters recommended by the client for the bowling area were:

- Winter Condition 21° to 23° C, 20 to 30 RH
- Summer Condition 24° to 26° C, 40 to 50 RH
- Noise Criteria 40 to 50 NC (40 NC, 2.8 m/s outlet airflow velocity)
- Slab soffit level to FFL 4.25 m (Bowling Area)
  3.50 m (Offices, and Admin)
  5.50 m (Corridors)
- Occupancy Requirements: Bowling Area 24-nos sitting, 6-nos bowling alleys, 2-nos helpers
  2-nos reception, and 6-nos walking; (40 nos total)
  Offices 2-nos for Offices
  Administration 2-nos for Admin area
  Corridors 2-nos for Corridor area
- Bowling Area 613.5186 square meter
- Offices 20.30 square meter
- Administration 50.60 square meter
- Corridors 173.90 square meter

Equipment Sizing and Selection

For the cooling load calculation proper zoning of the specific rooms within the building area to be designed was done first. Each Zone was to be served by a dedicated air handling unit specifically designed for indoor operation as part of the system. Each zone size was determined to be sufficient for the coverage of the AHU serving it. The model

building was zoned according to the zoning strategy shown in the plan in Figure No.1. However, each zone covered multiple spaces with individual cooling requirements grouped as a single controlled zone for the HVAC cooling system.

Zone Air Handling Units (AHU)

Each Zone's Air Handling Unit was dedicated and designed depending on the room requirement like bowling area was specialized for athletic comfort cooling and suitable for open area. The conditioned air was distributed through a low-pressure ducting to the bowling area. The cooling capacity of each zone, AHU was determined based on the zonal peak simultaneous cooling load for the designated area that included the bowling area. The cooling coil capacity was determined as per the given design criteria above.

Fan Coil Units (FCUs)

Fan Coil Units were selected to serve the areas such offices and corridors. They were sized based on the cooling requirements of the spaces they were intended to serve; using the heat gains in these spaces based on the given design criteria. The FCU capacities were determined by the same procedure as for sizing the zone AHUs.

A.6 IFC Designed Capacity versus Verified Calculated Capacity

The tendered calculation for the Vendome Mall Snow Park and Family Entertainment Center Project had selected the FEC Bowling Area in Figure 01, which was served by 2-nos AHUs (AHU-GF-16); the Ground Floor Corridor in Figure 02, by 3-nos FCUs (FCU-GF-18); the Mezzanine Admin Room in Figure 03, by 1-no FCU, and the Mezzanine Offices in Figure 03, by 1-no FCU (FCU-MZ-8/9) as presented in Table 01 The detailed capacity was based on the IFC drawings.

As mentioned earlier the selected areas were simulated and verified using the Carrier HAP Cooling Load Calculation software. The results are summarized in Table 02. The random verification was to check whether the IFC Designed capacity as in Table 01 was achievable or not. The simulated detailed calculations provided in Table 02, showed that there could be a **saving of about 84% energy** using 1-no AHU only of 254.8 kW cooling capacity instead of 2-nos AHUs with a total rated capacity of 467.8 kW. The saving was not only in the first cost but also in the operating costs.

SN	EQUIPMENT	AREA SERVED	CAPACITY				Remarks
			Supply Flow	O/A Flow	Total	Sensible	
1	FCU-MZ-8/9	Mezzanine Offices	110 lps	21 lps	1.80 kW	1.20 kW	1 FCU served each Office Room (Fig 03)
2	FCU-MZ-5	Mezzanine Admin Room	280 lps	54 lps	4.60 kW	3.2 kW	1-FCU served the Admin Room (Fig 03)
3	FCU-GF-18	Ground Floor Corridor	531 lps	66 lps	8.50 kW	8.20 kW	3 FCUs served the Corridor (Fig 02)
4	AHU-GF-16	FEC Bowling Area	9971 lps	1303 lps	233.9kW	169.45 kW	2-AHUs served the Bowling Area (Fig 01)

Table 01: *Issued for Construction Drawing Designed Capacity Schedule*

SN	EQUIPMENT	AREA SERVED	CAPACITY				Remarks
			Supply Flow	O/A Flow	Total	Sensible	
1	FCU-MZ-8/9	Mezzanine Offices	160 lps	9 lps	1.70 kW	1.40 kW	1 FCU served each Office Room (Fig 03)
2	FCU-MZ-5	Mezzanine Admin Room	326 lps	20 lps	3.80 kW	3.0 kW	1-FCU served the Admin Room (Fig 03)
3	FCU-GF-18	Ground Floor Corridor	904 lps	17.35 lps	10.20 kW	6.97 kW	3 FCUs served the Corridor, Figure 02
4	AHU-GF-16	FEC Bowling Area	19180 lps	568 lps	254.8kW	158.60 kW	1-AHU could serve the Bowling Area (Fig 01)

Table 02: *Verified Calculated for the Selected AHU and FCU*

However, the Supervision Consultant after their comprehensive review of the matter concluded and decided to go with the capacities presented in Table 01.

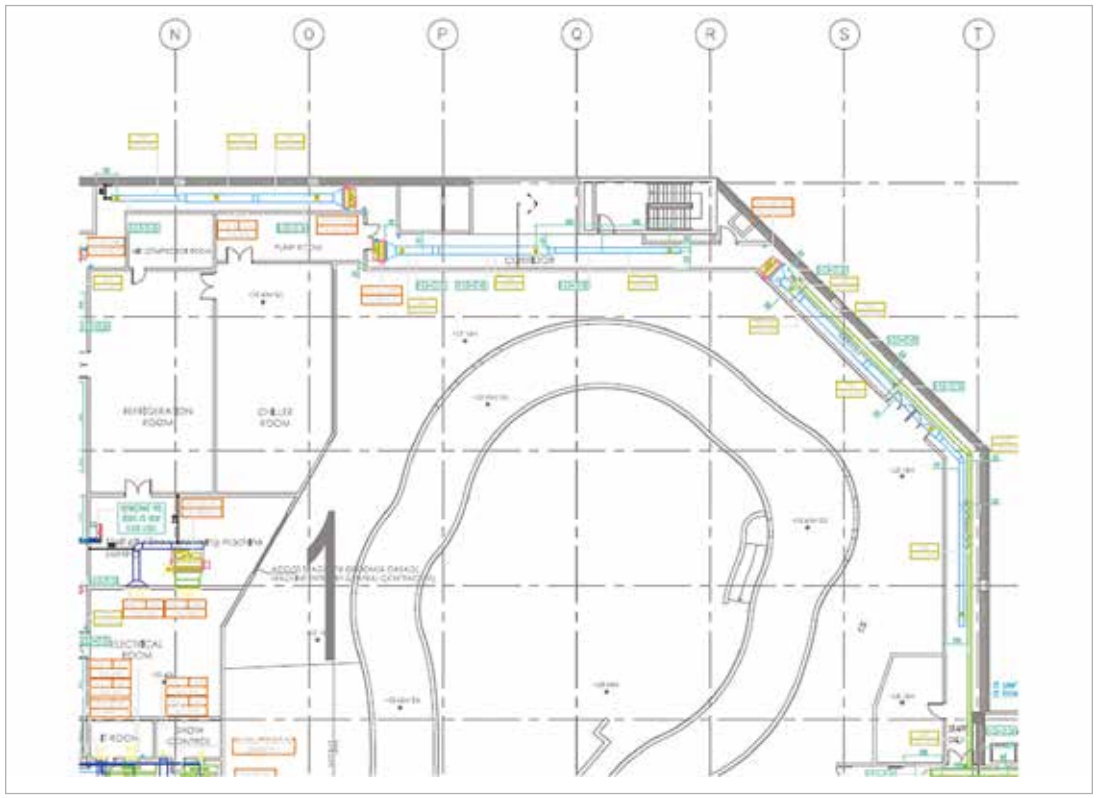

Figure 2: *Vendome Mall Ground Floor Snow Park Corridor Area*

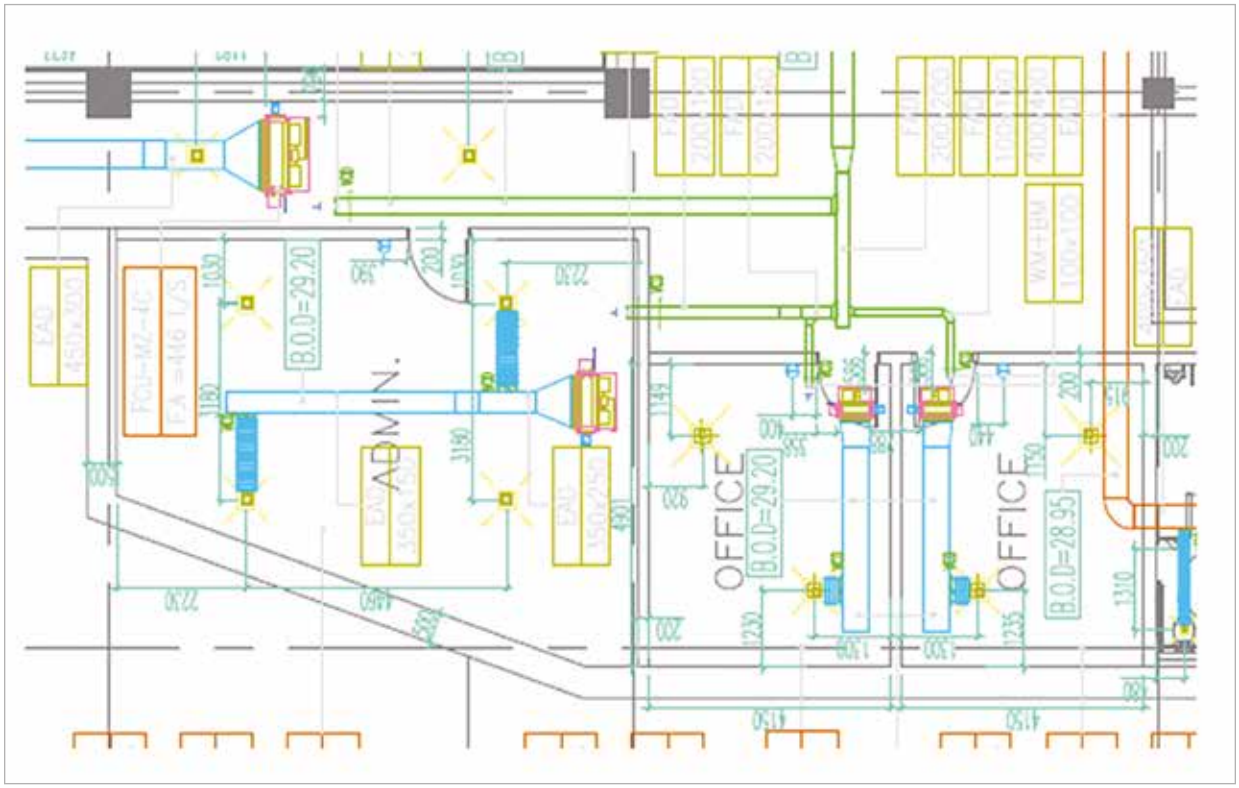

Figure 3: Vendome Mall Mezzanine Floor Office/Admin Areas

A.7 Conclusions

The results presented in Table 02, highlighted that the requirements for the FEC Bowling area could be served by the AHU-GF-16 whereas the IFC Drawings showed 2-nos AHUs. It was thus an apparently over-rated cooling capacity.

It was clarified that the IFC design using 2-AHUs even though more than sufficient were to cater to peak condition due to unexpected variables. The comparison for the other room areas showed that the FCUs proposed were acceptable.

General Analysis, Recommendation, and Conclusion

Based on a client's requirements and perspective, building services design involving Mechanical and Electrical Systems are continually evolving and responding to the market's economic landscape and political concerns as part of country's nation-building. Sophisticated owners and occupants require a particularly intense and comprehensive response from the Architects, Engineering Designer and Contractors.

The case study presented, verification of the impact of air-conditioning system design as part of building services engineering applications based on the country's statutory regulation, and has been documented as part of the learning process.

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ENERGY EFFICIENT DESIGN OF BUILDINGS AND BUILDING UTILITIES

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Architecture needs to consider and provide not only aesthetics and design of spaces, but also give due consideration to adequate space provision for all services like mechanical, plumbing, electrical, fire, etc. It thus has to encompass design of a framework or an interface which brings together the inhabitant, the utilities, and the surroundings. According to a recent study conducted on Energy efficient buildings, the building sector represents a staggering 35% of total energy consumption (Khosla & Singh, 2014). Thus, the need of the day is to adopt energy efficiency measures and approaches to minimise the energy consumption in a building, while responding to the environment and the users more sensibly. Using conventional building materials at a voracious pace is depleting earth's natural resources and is one of the major contributors towards global warming. Hence, an alternate methodology for designing and constructing buildings, which makes efficient and responsible use of key resources like materials, energy, land and water, is the need of the hour. That gave rise to the concept of Green Building. While, there are various methods of determining the performance of a building and various organizations which rate the building performance, all rating systems adhere to the Energy Conservation Building Code (ECBC) issued by the Bureau of Energy Efficiency.

This paper presents two case studies of buildings, one of which is under implementation and the other which has been completed. The designs of these buildings incorporate aspects of energy efficient services. The two case studies bring to the fore:

1. Orientation of the building for maximizing the light giving due consideration to the solar exposure which can increase the heat and consequent running cost of HVAC systems
2. Renewable source of energy
3. Lighting design, and
4. Water conservation.

Case Study-1 - Administration Building of a Power Plant

The building is situated in eastern Uttar Pradesh which has a semi-arid climate. As per the client's brief, the Administrative Building was identified to be an ECBC compliant building. The usage was identified to mostly consist of office spaces along with a few utilities. The space requirement was around 4500 sqm, divided into 3 floors

with approximate area of 1500 sqm each. As a design approach, the ECBC requirements pertinent to the project were drawn to create a checklist of all the provisions that could be made, complying with the technical specifications of the project. The summary of checklist was: (Efficiency, 2017)

- Use of natural light. Maximize opening in the Northern façade to receive the least amount of solar exposure, while harvesting ample daylighting.
- Using fly ash bricks, with lower U-Value than conventional bricks, thus providing a better insulation. Cavity walls/ Insulated walls would cut down heat to a greater extent.
- All insulations must be CFC and HCFC free. All openings except the naturally ventilated areas, to be sealed and weather-stripped.
- The fire suppression systems installed in the building should be free of halon.
- Under deck and over deck insulations to be provided to curb heat gain/ loss.
- Low flow fixtures to restrict water usage and reduce water consumption in a building.
- Installation of High Efficiency Toilets (HET) to save more than 20% of water per usage. Waterless and Ultra Low Flow Urinals to save over 88% water per usage. On site STPs installed to ensure reuse of treated waste water on site and for flush tanks.

Lighting analysis - Due to the large floor plate, the issue of lighting was identified right from the beginning. Light penetrates up to 8m inside the building, from a conventional sized window height of 1500 mm. However, since the depth of the building was large, a central courtyard was planned with a skylight, for allowing entry of light to interior spaces. Office spaces were kept towards the sides for natural light, and the central corridors, were lit by the skylight, providing ample daylight to the central portion of the building. This enhanced the light penetration into the building.

Orientation of a building on site, can affect the amount of solar exposure of the built structure, which directly has an impact on the heat gained by the structure. Heat gain increases the load on HVAC system. The idea in this building's design was to maximize light while minimizing heat penetration/ heat gain. A comprehensive Shadow analysis and a façade analysis have been carried out, to identify zones with minimum and maximum solar exposure. The Northern façade was identified to receive the least amount of sun, while still receiving ample daylighting. The entry to the building was envisaged to be from the northern façade. A triple heighted lobby, with a transparent north wall was provided to bring in maximum lighting to the central services area, which included a panoramic lift, and a series of passage ways. Due to this, the passageways require no lighting during the day time resulting in reduction of electrical load.

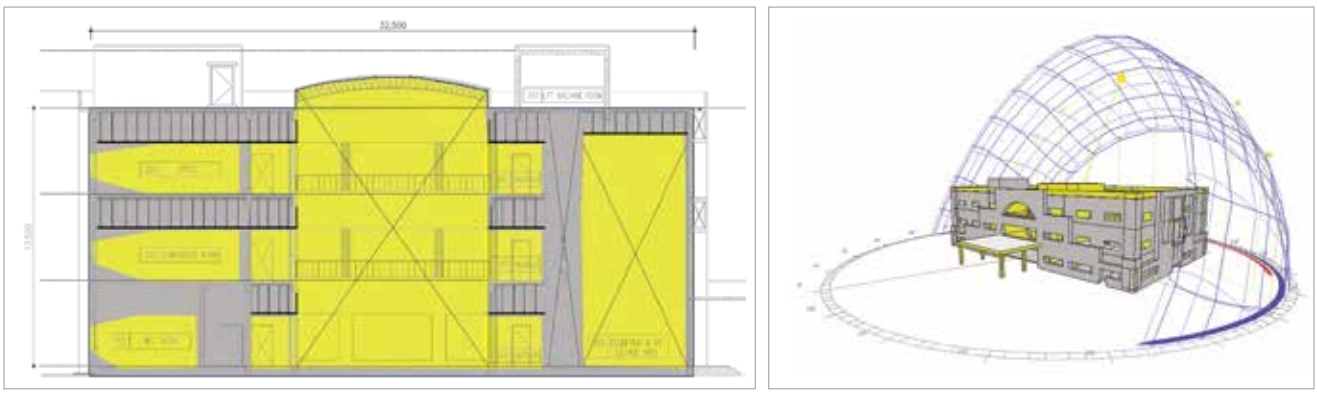


Figure 1: *Light penetration inside the building*

The skylights were to be insulative in nature and comply with the maximum U-factor and SHGC requirements as specified by the ECBC. The skylight area was also not to be more than approximate 5% of the gross roof area.

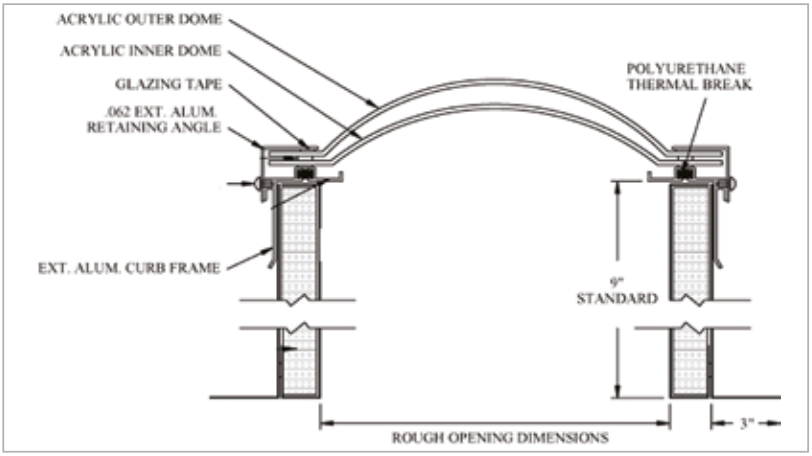


Figure 2: *Details of a double layered vaulted skylight*

Heat Proofing - To counter the amount of heat that follows the natural light, the air-conditioned areas, were insulated with PUF layers to prevent heat loss.

By applying this method of construction, a lot of HVAC load on the building were saved. Roofs and floors separating the AC and non-AC spaces were segregated with Under and Over deck insulations to restrict the amount of heat penetration and prevent heat loss.

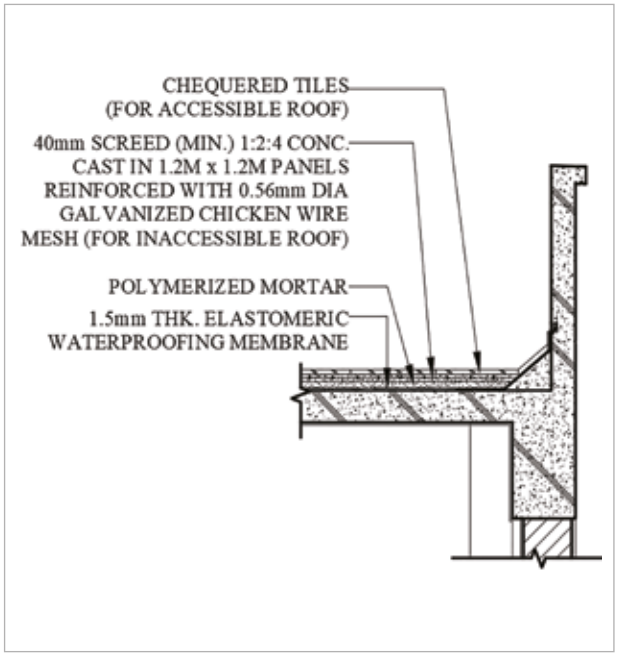


Figure 3: *Roofing membrane layers*

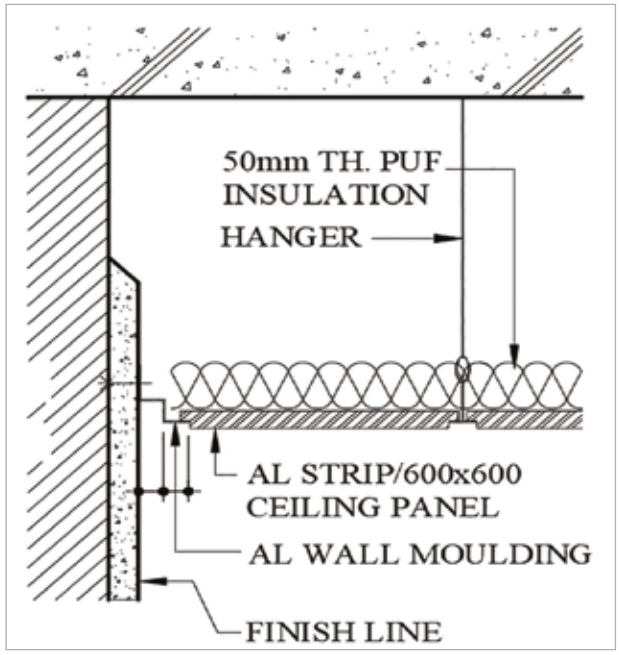


Figure 4: *Detail of PU Foam fixing in false ceiling system*

Opaque External Walls were used with low SHGC fly ash brick cavity walls, having a U value of 1.2, lesser than conventional brick wall.

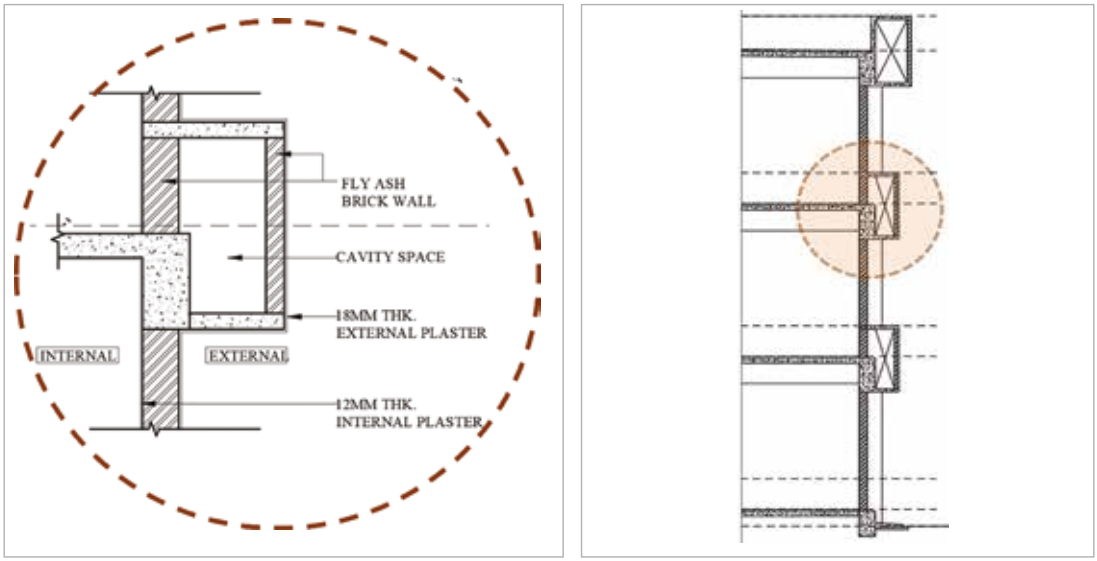


Figure 5: *Fly-ash brick cavity walls*

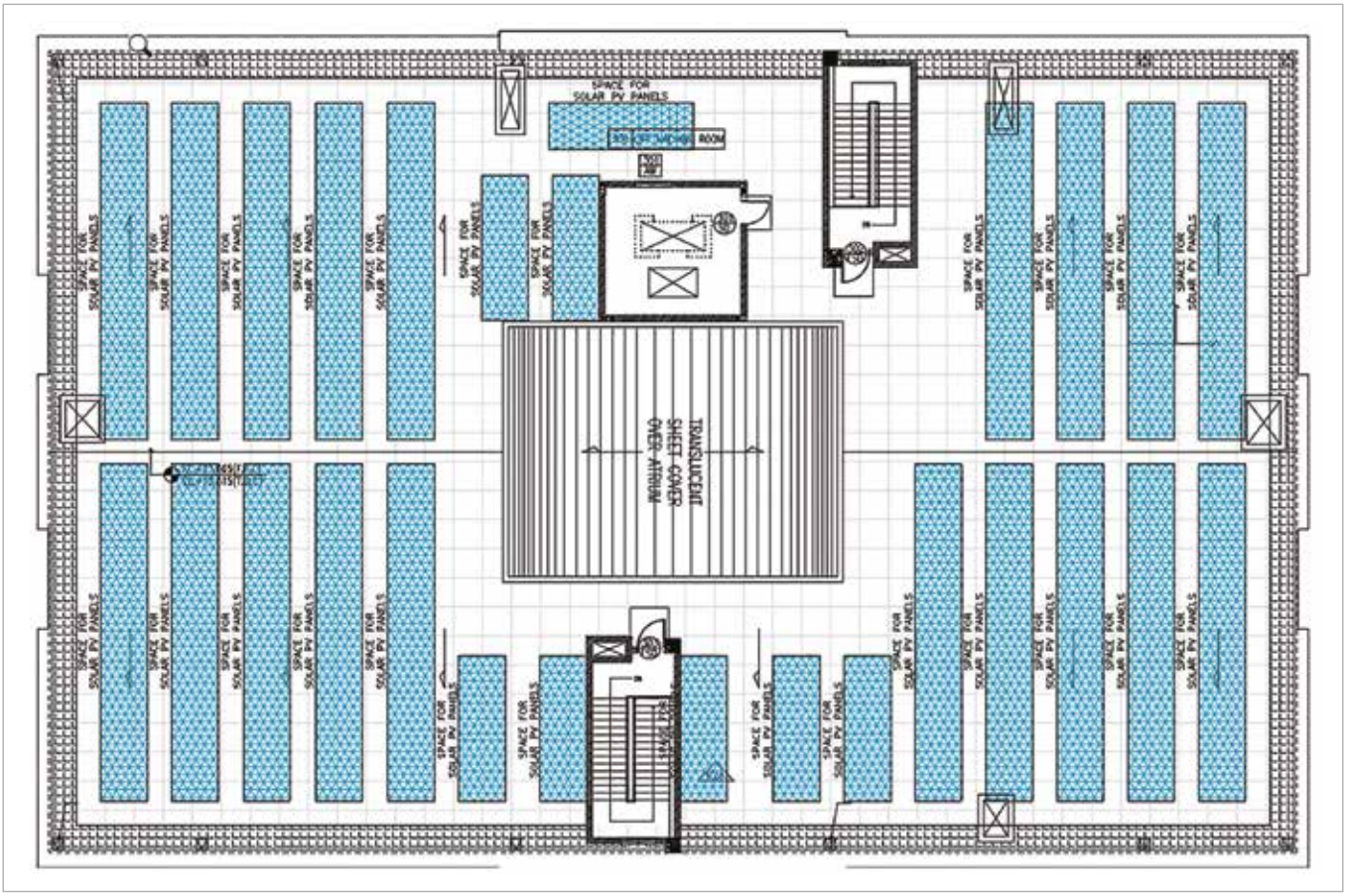


Figure 6: *Layout of Solar panels on Terrace*

Renewable Resources of Energy - In addition to cutting down electrical, HVAC and lighting load, the building's roof area is installed with photovoltaic panel system. Due to the larger floor plate in this building, there was ample provision of large number of panels to be installed. This installation is projected to bring down the electric dependency on conventional sources by a large quantity. A pathway of 1200mm width has been provided between solar panels for movement and maintenance.

Case Study 2 - Medical Research Foundation cum Cancer Hospital

This case study covers the energy efficient measures adopted for a Medical Research Foundation cum Cancer Hospital in Raipur. The climatic conditions are tropical wet and dry. Special emphasis was on strategies for reducing energy demand by providing adequate natural light, shading, landscape to reduce ambient temperature, and energy efficient active building systems. Several energy conservation measures have been adopted to reduce the energy loads of the building. This building was designed to use 70% less energy compared a conventional building. The project adopted green building concepts including conservation and optimization of water by recycling waste water from the site and is a LEED Gold Certification Green Building.

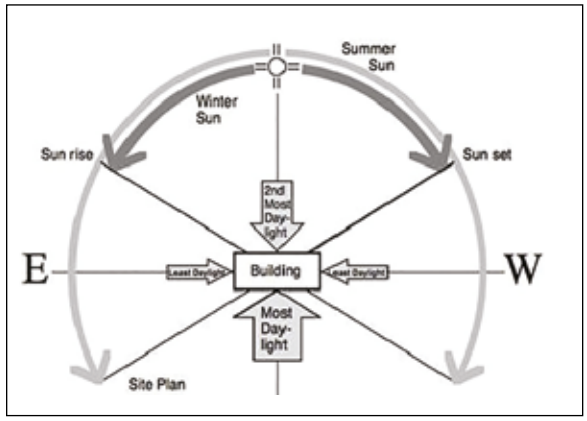


Figure 7: *Orientation for Daylighting*

PASSIVE DESIGN STRATEGIES

a. **Orientation:** Building is north south oriented, with separate blocks connected through corridors and court yard. Orientation minimizes heat ingress. It has an optimal window to wall ratio.

b. **Landscaping:** More than 50% area outside the building is covered with plantation. Circulation roads and pathways are soft paved to enable ground water recharge.

Figure 8: *Landscape layout for Hospital building*

c. **Daylighting:** 75% of building floor space is day lit, thus reducing dependence on artificial sources for lighting. Inner courtyard serves as a light well.

d. **Ventilation:** The central courtyard helps in air movement as there is natural ventilation due to the stack effect. Windows add to the cross ventilation.

e. **Building Envelope and Fenestration:** The building envelope was optimized and the window assembly had U-Value 1.54 W/m2K, Light transmission 32%, External reflection10%, Internal reflection 25%, Solar factor 2.0, Combination of glass 6mmSKN 754 + 12mm air + 6mm clear, Glass was manufactured by float glass technology with a recycled content of 18% (12% industrial and 6% consumer).

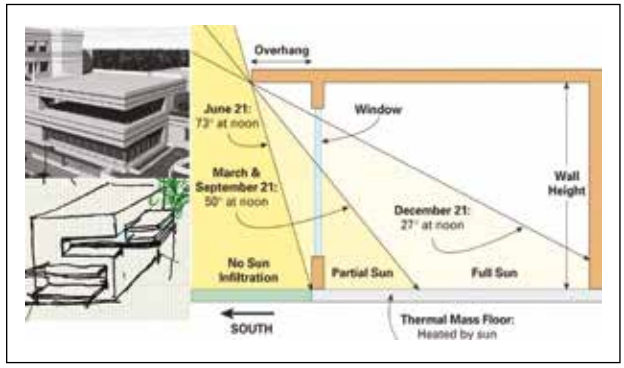


Figure 9: *Daylighting - Shading device*

f. **Materials and construction techniques:** fly ash bricks for the walls, glazing with high efficiency glass, high VLT, low SHGC & Low U-value, optimized by appropriate shading, light shelves for diffused sunlight.

ACTIVE STRATEGIES

a. **Lighting Design**

- Energy efficient lighting system (LPD = 5 W/m^2), nearly 50% more efficient than Energy Conservation Building Code 2007 requirements (LPD = 11 W/m2) reduces energy demand further.
- Use of energy efficient lighting fixtures.
- Use of lux level sensor to optimize operation of artificial lighting.

b. **Water efficiency:** The emphasis was on Water-efficient Landscaping, Innovative Wastewater Technologies, and Water Use Reduction.

i) **Landscaping:** The intent of the Water-efficient Landscaping was to "limit or eliminate" the use of potable water, or other natural surface or subsurface water resources available on or near the project site, for landscape irrigation. Permanent irrigation was provided for the project with main headers, drips and sprinklers. As a part of design, a study was carried out for a Base Line case vs the Design case.

Factor	Base Line Case	Design Case
Total yearly irrigation water requirement (in Gallons)	9,500,878.36	4,780,595.81
Total daily irrigation water requirement (in Gallons)	26,029.80	13,097.52
Total daily irrigation water requirement in KLD	98.65	49.64

WEC1.1: % reduction in irrigation water demand due to water efficient landscaping	50.3%
Treated water availability for landscape irrigation (KLD)	50.00
WEC 1.2: Total reduction in potable water consumption for landscape irrigation	100%

ii) **Innovative waste water technologies:** The intent of the Innovative Wastewater Technologies credit is to "reduce generation of wastewater and potable water demand", while increasing the local aquifer recharge. The sewage generated will include sewage from hospital building. The total sewage generated is given below.

Sewage Generation	
Population	3,702
Water demand (MLD)	0.45
Average Sewage flow (MLD)	0.22
Average Sewage flow including infiltration @10% (MLD)	0.25

One Sewage Treatment Plant was proposed. 100% sewage is tertiary treated to required quality and recycled to minimize fresh water demand. The total amount of treated water from the STP is around 0.25 MLD which would be used for irrigation purpose, heating ventilation and air conditioning (HVAC) make up water purpose and flushing purpose. The water balance diagram is shown below.

iii) Water Use Reduction: The intent of the Water Use Reduction credit was to "maximize water efficiency" within buildings to reduce the burden on municipal water supply and wastewater systems. The Template submitted to LEED India declares that the project uses 52.90% less water than the water use baseline calculated for the building. In the Design case the figures indicate water consumption is reduced from 3,95,92,189 litres to 1,86,48,808 litres through use of water efficient fixtures and on site treated water quantity of 64,99,920 litres

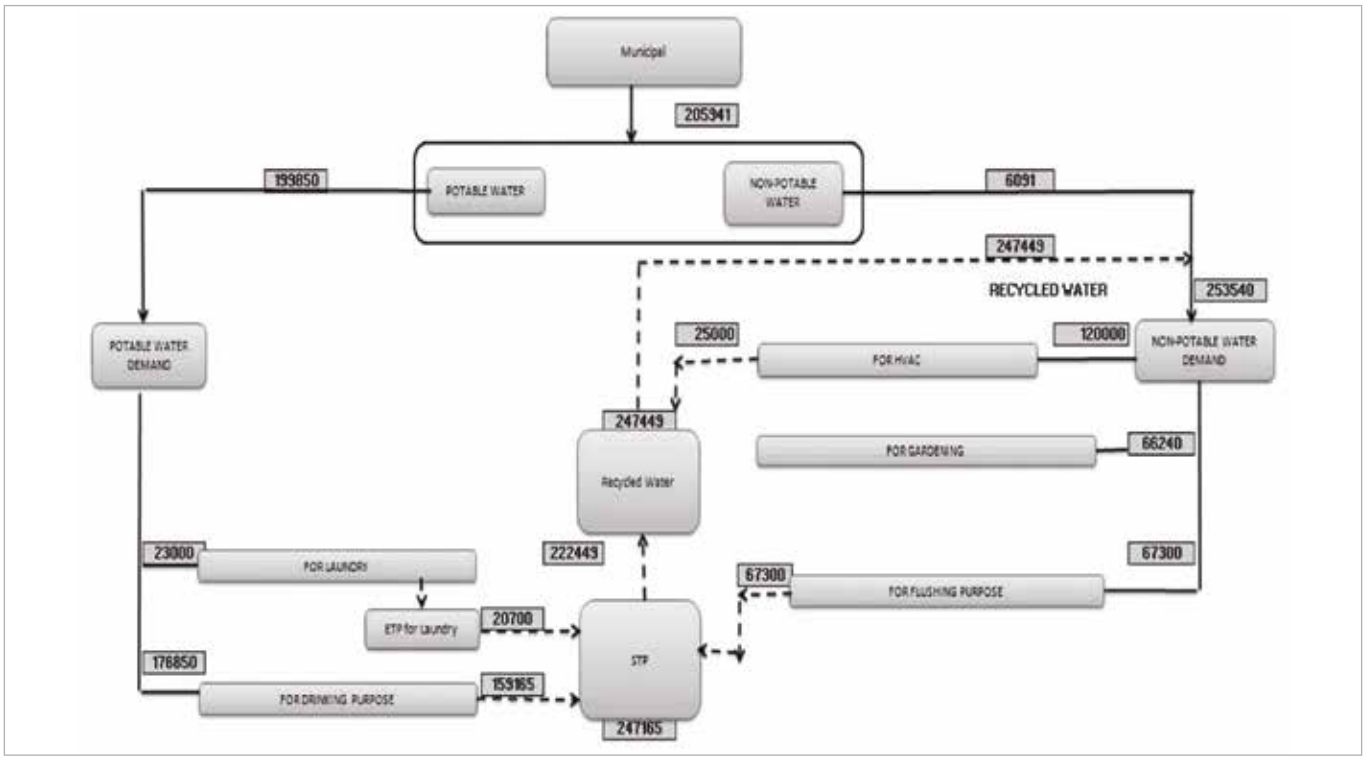
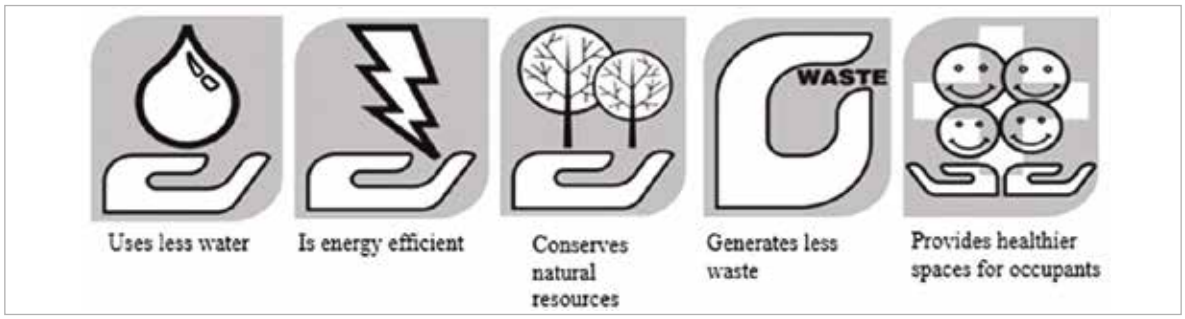


Figure 10: *Water balance diagram*

CONCLUSION

The best way to address environmental challenges is by incorporating simple and efficient measures in the design of buildings, to reduce a substantial amount of energy consumption. The case studies presented above, demonstrate pivotal measures like, orientation of a building to ensure optimum use of natural light, rearrangement of facilities within a building based on usage resulting considerable energy savings. Heat being the natural consequence of light, hence, use of appropriate insulation materials substantially offsets the heat and saves energy. Selection of the Glazing materials and its properties for both the structural glazing as well as the windows exposed to solar radiation is essential and so is, the use of energy efficient light fittings and fixtures. Water being a scarce natural commodity, the emphasis MUST be on recycling of treated water. Plumbing fixtures which use least amount of water, innovative waste water technologies are other necessities to bring down the consumption by nearly half, thus ensuring full efficiency of water management. Incorporation of these efficiency measures in building would help in reducing the substantial amount of energy consumption and water that can see a great future going greener than what it currently is.



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SERVICES IN COMMERCIAL BUILDINGS

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1.0 INTRODUCTION

Food, clothing, and shelter in addition to air and water are the basic needs of human beings. Shelters (residential/ commercial building) protect humans from the elements of nature and provide a comfortable environment inside for wellbeing and productivity.

Modern day buildings require a plethora of electro-mechanical services to create the environment which is conducive to human comfort in commercial buildings and for processes in industrial process plants. This paper focuses more on commercial buildings.

2.0 TYPES OF COMMERCIAL BUILDINGS AND SERVICES

Depending on type of usage, commercial buildings can be of various types viz. Retail, IT/ ITES, Banks, Hotels, Hospitals, Data Centre, Laboratories, Educational Facilities, Airports and many alike. All these buildings require many electro-mechanical services, of which the major ones are listed below.

- Air Conditioning (HVAC)
- Electrical – Power and Lighting
- Plumbing and Sanitation
- Fire Fighting
- Elevators
- Emergency Power Supply System (e.g. DG sets)
- UPS for Uninterrupted Power
- Medical Gas System
- Hot Water, Steam Generation System
- Pneumatic Conveying System
- Sewage and Effluent Treatment
- Rainwater Harvesting & Disposal
- Integrated Building Management which may include automation, Fire Alarm, Security, Public Address, Energy Management (EMS), etc.

and many more……

All the services are energy and water dependant and hence for sustainable development it is necessary that there be reduction in energy and water consumption over time.

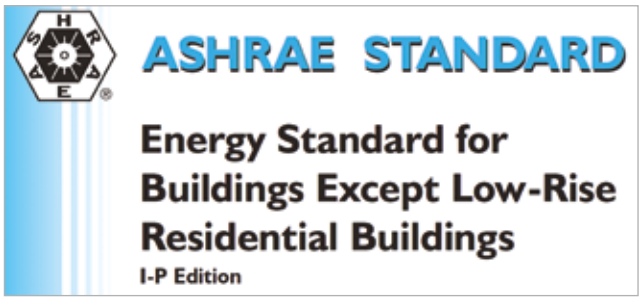
3.0 ENERGY

Electrical energy is the major power source for building services. Apart from electrical energy, other sources like hydro-carbon fuel and waste process heat are also used.

The need for sustainable building infrastructure inevitably calls for a smaller energy footprint since it is directly related to emission of green house gases. That's because a major portion of energy generation in India is still from fossil fuel-based power plants.

Building services designers and equipment OEMs, therefore, are in continuously devising more and more energy efficient systems and equipment.

Many national and international standards are making energy efficiency mandatory and publishing of the minimum energy efficiency ratings for various equipment and systems. Two of these standards are given below.



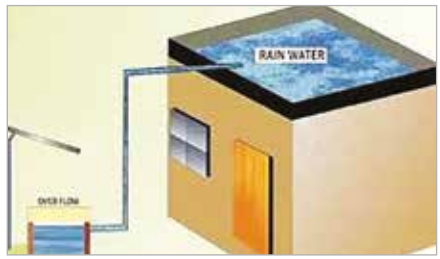
ASHRAE 90.1 Energy Standard for Buildings Except Low Rise Residential Buildings.

Energy Conservation Building Code of India -2017 (ECBC)

Many of these standards are mandatory. For example, for buildings in India – adherence to ECBC is a prerequisite for obtaining environmental clearance from State/ Central Government.

4.0 WATER

Water is a scarce resource due to limited availability of fresh water on our blue planet. Water is required for direct consumption, as mass transfer fluid and as a process element. A large Centralised HVAC system is a major guzzler of water since water is evaporated to the atmosphere to reject heat energy.

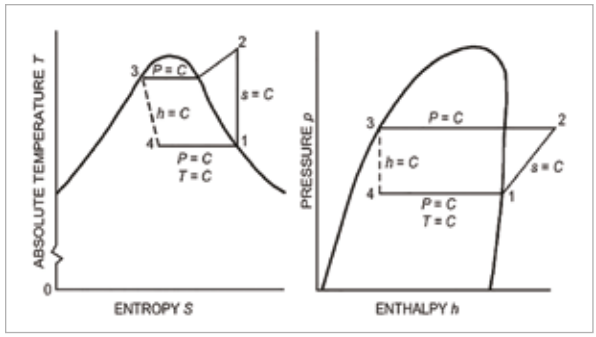


Water conservation is also looked at with same criticality as that for energy. Various techniques such as wastewater re-use/ recycling, rainwater harvesting, and HVAC condensate drain reuse are used in building services.

5.0 CRITICAL BUILDING SERVICES

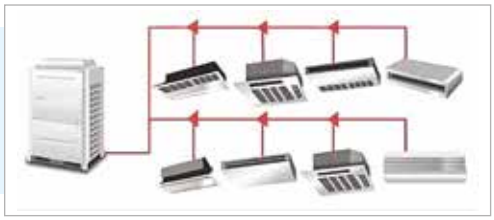
5.1 Air Conditioning System (HVAC)

Thermal comfort at workplace is key factor for productivity. 3-4 decades ago, Air Conditioning used to be considered as a luxury. However, with increasing global temperatures, and atmospheric dust levels plus the use of computers, and other electronic gadgets which need dust free atmosphere, all coupled with the accelerated spending potential in developing countries, Air conditioning is no more a luxury - it has become a basic essential service.



Air conditioning systems works on the Refrigeration Cycle. Refer figure.

Various types of Air conditioning systems are used in building services. The tables below provide the broad applications of the various types of systems.

Window AC	Residential application. Up to 2 TR	
Split Air Conditioner	Residential/ Commercial applications. 1 to 17 TR	
Variable Refrigerant Flow Systems (VRF)	Residential/ Commercial applications.	
Centralised Chilled Water Systems	Commercial/ Industrial applications	

Centralised Chilled Water Systems can be as small as 40-50TR in size and can go as high as 20,000-50,000TR and more for a District Cooling Plant.

A Central Plant uses chillers to produce chilled water, which in turn acts as the heat transfer fluid in an HVAC system. The HVAC industry uses various types of chillers. A few of them are shown below.

Reciprocating Chillers	Not used anymore in commercial buildings. However, use in Refrigeration industry continues.	
Scroll Chillers	Capacity up to ~ 100TR-120 TR	
Screw Chillers	Capacity up to 400TR is available with all major OEMs. Few OEMs offer more than 400TR as well.	
Centrifugal Chillers	Capacity up to 2500TR is available with all major OEMs. Few OEMs offer more than 2500TR as well.	

HVAC system is single largest power consumer in a commercial building using up to 40% of the building power.

Hence various energy efficiency techniques are implemented for large HVAC systems – during design as well as during their operation.

5.11 Efficiency by Design

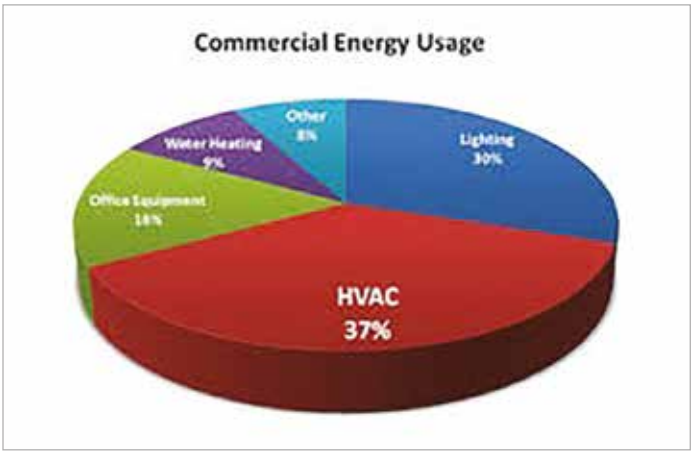
One of the key aspects of energy efficient design is to avoid oversizing of equipment. That calls for accurate load estimation, which should be as near as possible to the real world scenario.

Various load estimation methods/ algorithms are used in the industry. ASHRAE has developed an algorithm called as the "Heat Balance Method".

A Commercial building's HVAC plant is usually designed for Maximum Peak Demand Load at design day ambient conditions. These could be for cumulative occurrence frequency of 0.4%, 1%, or 2 %, depending upon application to be served.

Instantaneous Cooling Load, on the other hand, is a complex function of ambient weather profile, heat sources, convective and radiative split of heat transfer, storage effect of structure, pattern profiles, cloud cover, type of control system and associated "swing" in controlled variable and many alike. All these variables are transient in nature and hardly reach to any steady state.

Hence instantaneous cooling load is highly variable in nature and its dependence on multiple- independent variables makes it almost impossible for a designer to estimate it accurately to the last digit.



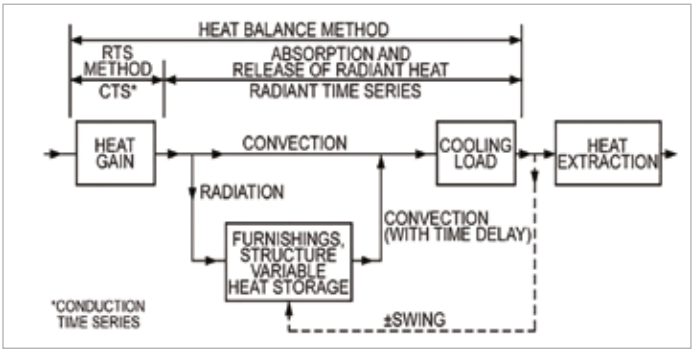


Figure 1: *Origin of Difference Between Magnitude of Instantaneous Heat Gain and Instantaneous Cooling Load*

Another critical aspect is stratification and storage of heat. Not all heat gains manifests into cooling load at a given instant. Convective and radiative split of heat gain decides what portion of heat manifests into instantaneous cooling load. Radiant portion of heat contributes to cooling load after a "delay" and never adds instantaneously as shown in figure below.

The Heat Balance Method takes care of the various "delay" functions along with the various operational diversities, thereby predicting a "near accurate" load.

5.12 Efficiency in Operation

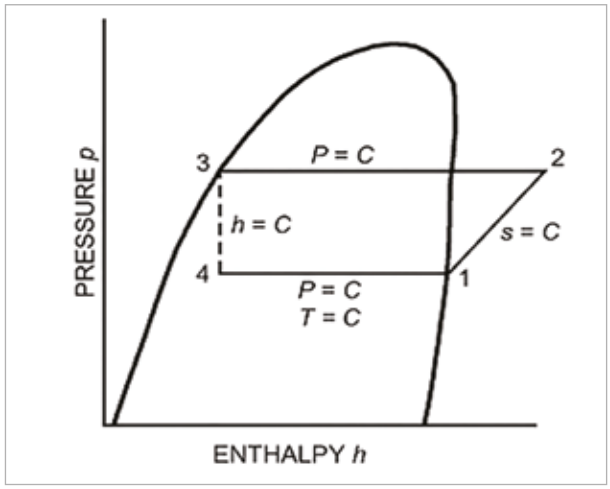
Efficient equipment and systems can provide desired efficiency levels only if the control systems operate the system efficiently.

Modern control systems can understand equipment performance maps of various equipment under various operating conditions. The Control System effectively tries to communicate with all the equipment and decides the best operation

point of each of these. The resultant would be an operation which would consume least power for a given load and the design ambient conditions.

Chiller Performance Map

A Chiller's performance is a direct function of the refrigeration load (i.e. cooling load) and pressure lift. Pressure lift is the difference in the Saturated Evaporation Pressure (SEP) and the Saturated Condensing Pressure (SCP). Lift = SCP - SEP



SEP is a direct function of the refrigeration load. As the refrigeration load decreases, SEP tends to drop to adjust the reduced Log Mean Temperature Difference (LMTD) due to lower return water temperature.

SCP is predominantly a function of the inlet condenser water temperature from the cooling tower. The condenser water inlet temperature is a complex function of the cooling tower thermal design and ambient wet bulb temperature. These inter-relations are elaborated further under cooling tower section.

Power consumption of a chiller increases as the lift increases. The inverse is also true.

ASHRAE/ DOE have developed algorithms to predict the performance of a chiller under varying load and varying condenser water inlet temperature.

Control systems uses algorithm to compute instantaneous power requirement based on percent load and entering condenser water temperature

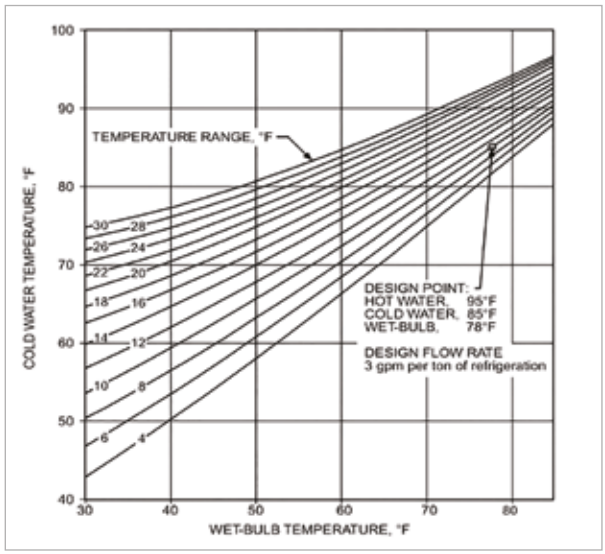
Pump Performance

Pumps follow affinity laws which define pump performance as function of speed, flow, and pressure. The Control system maps the equations for the parameters and generates the pump performance map.

Cooling Tower Performance

The Cooling Tower is the final heat rejection device in a HVAC system and works on mass transfer for rejecting heat to the atmosphere.

The effectiveness of a cooling tower is measured in terms of Approach, which is difference between the cooling tower outlet water temperature and the wet bulb temperature. Lower the Approach, lower is the cooling water outlet temperature.



However, Approach of cooling tower is not constant and is a function of the wet bulb temperature. The graphs indicate variation of Approach with respect to the wet bulb temperature.

As can be seen from adjoining graph, Approach increases with reduction in wet bulb temperature. The inverse is also true.

Modern day algorithm maps cooling tower performance from these curves and uses this data to optimize energy consumption of the overall system. The reliability of the automated control system is key in this.

5.2 Electrical System

Building electrical services form the backbone for all other services.

Building gets its incoming power supply from the Power Generation/ Distribution company which could be at 11, 22 or 33kV, depending upon the load requirement of the building. It is prudent to have 2 supplies from two different stations to increase reliability of the power supply. Many international occupants specify two incomers as prerequisite to using the premises. That is to ensure uninterrupted uptime.

The buildings have their own substation to convert the higher voltage level to 415V and inter alia include various power quality correction systems like Power Factor Corrector, Harmonic Mitigators, etc.

The 415V power is distributed to the various loads via cables or bus ducts. It needs to be ensured that all cables and the wirings are neatly dressed, clamped and tagged. They should be easily accessible so that tracing a fault and repairs to it can be easily done.

Buildings also require emergency power source in case of mains power loss. This requirement is usually catered with Diesel Generator sets. Back up can be 100% or partial, depending upon usage. Buildings like Hospitals, Hotels, Data Centres, Grade A commercial buildings, etc essentially operate with 100% backup. Grade B commercial buildings and other less critical applications may operate with partial backup. The partial back up is to cater to all emergency services (fire fighting, fire elevators, etc) and emergency lighting as a minimum.

5.21 Power Quality

Clean power is desired by all building occupants. The building power can get “impure” due to non linier loads, IGBTs, Variable Frequency Drives, etc. All these non linier loads tend to disturb the clean sine wave form of AC supply and introduce disturbances called Harmonics, which are detrimental to many critical equipment.; They must be controlled to acceptable level. In addition, higher harmonics also invite penalty from the Power supply companies. System design and operation should therefore ensure than the total Current Harmonics at apex panel level does not exceed 5%.

IT industry uses UPS system for clean power and uninterrupted power supply. The UPS system is backed up by batteries, so that the IT equipment can function even after mains power is off. The battery backup can be 10, 15 or 30 minutes depending upon application. UPS is often used with isolation transformer to circumvent harmonics in the circuit.

5.3 Fire Fighting and Fire Protection System

These systems are very critical for life and safety of occupants. The requirements and provisions of these systems are largely governed by the National Building Code of India (2016) and the local Chief Fire Office (CFO) must give a No Objection Certificate before they can be occupied. The fire fighting systems are triggered by Fire Detection systems. For effective fire fighting the minimum requirements are Fire Pumps and Fire Water Tanks, Sprinklers and Hydrants, Fire Extinguishers, Fire Alarm System, and a Public Address System.

NBC calls for various types of pumps and allied accessories based of type of usage and height of the building. Pumping is required for sprinklers, hydrants and water curtains. Smaller jockey pumps are installed to make up minor pressure losses in the system. Sprinklers and Hydrant network are laid so that every corner of the building gets covered in the demarcated coverage area. Piping material conforms to IS-1239, however non ferrous piping systems are also used in a few buildings.

Automatic fire alarm systems create audio alarms in case of fire. In addition to alerting building occupants, the Fire Alarm System also initiates building electro-mechanical system operations like smoke evacuation, pressurization, lift grounding etc. In case of distress, the Fire Alarm System's integration with Public Address System generates pre-recorded evacuation messages.

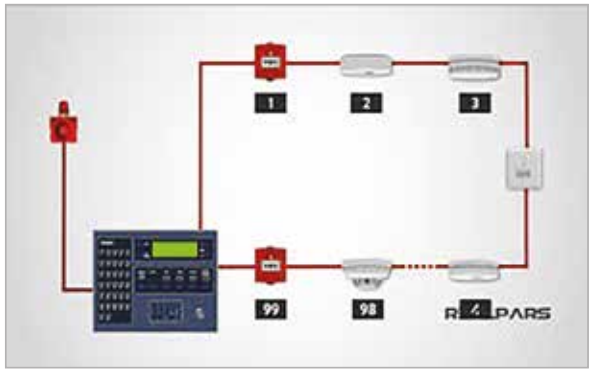
5.4 Plumbing and Sanitation

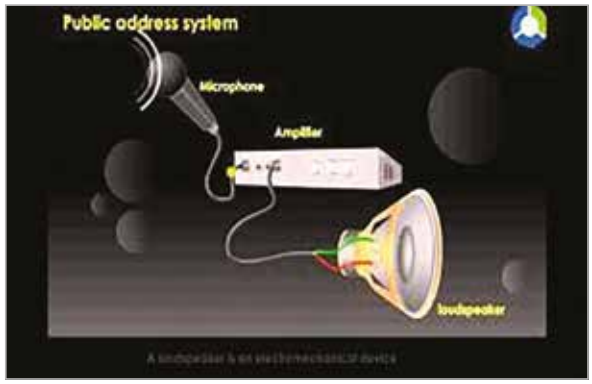
One of the necessities for human life is water and the building's plumbing systems are designed to provide water of desired quality and quantity to the occupants and the processes that need it.

Buildings receive water from municipal source into their underground tanks. In many cities especially those where new treatment facilities have been provided the quality of municipal water is good, however the same is not the case with many others.

Where the public water supply is not properly treated it is necessary that the building houses a water treatment plant to remove hardness and any suspended solids it may contain. The treated water could be supplied to the occupants by either of following methods:

- Gravity feed: Treated water is pumped up on overhead tanks, from which it is then distributed to various fixtures under gravity pressure. Pressure reducing valves would be necessary in high rise buildings.
- Hydro-pneumatic feed: Treated water is directly fed to fixtures by a Hydro-pneumatic pumping system. Pumps are equipped with variable frequency drive to modulate speed in response to requirement.
- Buildings also generate wastewater from wash basins, toilets, urinals and kitchens/ pantries. It is mandatory in buildings to treat this water and re-use. Therefore, Sewage Treatment Plants are installed in commercial buildings to treat the sewage and reuse the grey water.





Various STP technologies are available such as:

- MBR Technology
- MBBR Technology
- SBR Technology
- Electro-Chemical Technology

which treat the sewage and produce water which has the following properties.

Sr. No.	Parameters	Units	Inlet	Outlet
1	pH	mg/lt	7.5 – 8.5	7.0 – 8.5
2	Biochemical Oxygen Demand (BOD)	mg/lt	250-400	< 10
3	Chemical Oxygen Demand (COD)	mg/lt	400-600	< 30
4	Total Suspended Solids (TSS)	mg/lt	200-350	<10
5	Oil and Grease	mg/lt	50	NIL

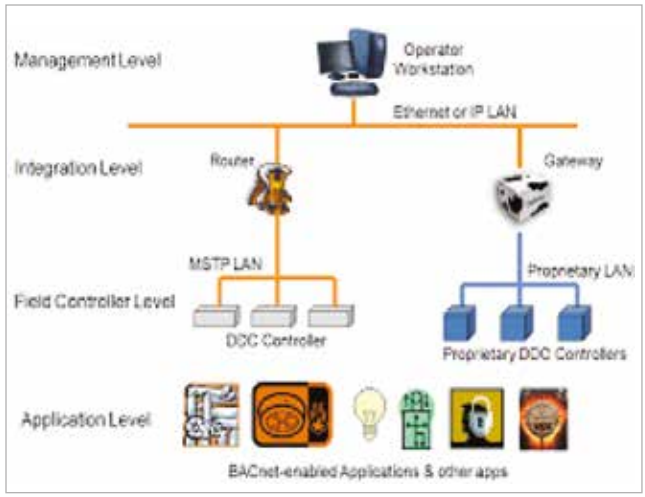
The STP treated water/ grey water is used for flushing, gardening, and HVAC system make-up.

5.5 Building Automation System

With ever increasing complexities of Electro-mechanical equipment and systems, manual control of building services is not possible, especially for those with a large footprint or high-rise/ tall ones. For those the Building Automation System (BAS) provides the solution to monitor and control various equipment and systems. A typical building BAS would:

- Control Chiller Plant Staging/ De-staging, Air Handing Unit speed and capacity control, Pump speed control, etc.
- Monitoring of Panel Breaker status, Power Consumption, Power Quality, Run Hours of equipment, etc.
- Energy Management
- Alarms, and
- Analysis of measured data and dash boards.

BAS also integrates with Fire Alarm System so that both work in a cohesive and coordinated manner in case of fire or distress.



6.0 Efficient Buildings

The table 'Comparison of Efficiency of Buildings' illustrates how three similar buildings get categorised. The buildings are for IT/ ITES applications and for 24*7 operating time.

7.0 Conclusion

With Buildings requiring a plethora of services, many in addition to those described above, successful building operations largely depends on the following major factors:

- Serviceability of various equipment and systems. Design should permit optimum spaces for day to day maintenance and servicing,
- Energy efficiency,
- Water efficiency,
- Predictive Maintenance approach. BAS provides a plethora of opportunities to develop predictive maintenance algorithms so that the Facility Management team don't have to wait till equipment or a system fails. Early diagnosis could help prevent failure and ensure required uptime.

Ever increasing complexities and dynamic business requirements are actually providing great opportunity as never before for Services Design Engineers to apply their skills in terms of knowledge and experience to come up with sustainable working environment and achieve professional satisfaction.

Services industry has enough talent to rise to the occasion and take the nation on an accelerated path for growth.

Comparison of Efficiency of Buildings

Design Parameters	Efficient Building	Super-Efficient Building	Ultra-Efficient Building
EPI (kW.hr/m2/year)	140	100	80
Building Envelope (W/ft2)	3	< 2	< 1.5
Visual Comfort	>55% workspaces at >110 lux	>75% workspaces at >110 lux	>75% workspaces at > 300 lux with Façade Design for Shading & Glare Control
Cooling Load (ft2/TR)	250-300	300-350	350-400
HVAC Energy Demand (W/ft2)	4	2.5	>2
Microclimate	Higher Perceptible Temperatures for Pedestrians	No Change	2 to 3 deg C Reduction in Perceptible Temperatures
IAQ	Normal	CO2: Ambient +700 ppm PM 2.5: <15 µg/m3 PM 10: <50 µg/m3	CO2: Ambient +350 ppm PM 2.5: <15 µg/m3 PM 10: <50 µg/m3
% of Renewable Energy	< 1%	2%	3%

ENERGY ENGINEERING SYNERGYSING WITH GEOTHERMAL HEAT SINKS TO OPTIMISE SYSTEM AND OPERATING COSTS

Pramod Dhir
Partner (Founding Member)
Dewpoint Services Consultants LLP

1.0 INTRODUCTION

This article aspires to raise the bar of energy conservation, and brings out the benefits of synergysing the mechanical and plumbing (hot water generation) systems.

An upcoming hospital in the Delhi NCR was selected for the study, and the Chilled/ Hot Water & Steam Generation Systems were analysed. In the process, some tweaking in the heat sinks and the usage of heat pumps in the chiller plant room were also analysed. The energy for hot water generation for space heating, kitchens, laundry and CSSD and other ablution/ domestic usage is being drawn from the steam produced. It was observed that almost 75% of the steam being generated is being used to generate hot water. The cost of producing steam is definitely more than that for hot water using various other sources. Based on this finding, a comprehensive and a holistic approach towards the feasibility of reducing the energy bills was carried out.

The water source (ground coupled) heat pumps in the chiller plant room, produce chilled and hot water throughout the year. The hot water would be supplied to the public health plant room, thereby, reducing the installed capacity of the steam generators, besides eliminating a cooling tower, using the ground source, Sewage Treatment Plant (STP) and other sources of heat sinks available at the site.

Geo-thermal sinks identified in the project:

a) Horizontal loop (closed): 25 Acres

b) STP reclaimed water discharge

c) Bore-wells and Municipal water

1.1 Avenues of Energy Conservation, by way of Utilising the Energy Synergy available

Heat Rejection Calculations		
Municipal/ Bore well Water Flow per day		
Domestic Water Consumption per day	l/d	2,078,145.00
Total Water per day	l/d	2,078,145.00
Heat Rejection Capacity with 98.6/86.5°F (12 hours a day)	US gpm	380.99
	TR	156
STP Water Flow per day: (12 hours a day)		
Total Water per day	l/d	1,296,198.00
Heat Rejection Capacity with 98.6/86.5°F	US gpm	237.64
	TR	97
Horizontal Geothermal		
Land used	Acres	25.00
sqm per TR	sqm/TR	125.00
Heat Rejection Capacity with 98.6/85.1°F	TR	1,000.00

1.2 Existing Hot Water Generation Strategy in the MEP Design

Hot Water Generation	CURRENT STRATEGY	
Steam consumption per day for Domestic Hot Water	kg/h	2,068.00
Steam consumption per day for Space Heating	kg/h	3,500.00

Break-Up of Final Consumption of Steam

Equivalent Heat Capacity with 50/55°C		
Domestic Hot Water	kW	1,417.44
Space Heating	kW	2,398.96
Total Heating Capacity required	kW	3,816.40

Heat Pump for Hot Water Generation Proposed in the Study

Selecting Heat Pumps of 500 TR each 2 Nos		
Cooling Capacity at 7/12°C	TR	500.00
Heating Capacity at 50/55°C	kW	2,100.00
Total Heating Capacity	kW	4,200.00

Power consumption of the 500 TR Total Heat Recovery Machine	kW	496.00
Power consumption of the 500 TR Chiller	kW	315.00
Extra Power consumption over the 500 TR Chiller	kW	161.00

2 Potential Savings in Steam Generation Scheme as per Analysis

Savings in Steam during Summer		
Heat Energy required to raise water temp from 25 to 100°C	kcal/kg	75.00
Latent Heat of Vaporization of Water	kcal/kg	540.00
Heat Energy required to raise Steam temp to 130°C	kcal/kg	15.00
Total Energy required to transform 1 kg of Water at 25°C to 1 kg of Steam at 130°C	kcal/kg	630.00
Calorific value of PNG	kcal/kg	8,500.00
Steam consumption per day for Domestic Hot Water	kg/h	2,068.00
PNG required/kg of Steam	kg	0.083
Cost of Steam using PNG	Rs	3.98
Hourly Cost for Hospital for Domestic Hot Water	Rs/h	8,228.46

Equivalent Heat Capacity with 50/55°C: Domestic Hot Water	kW	1,417.44
	TR	403.06
Extra Power consumption over the 400 TR Chiller	kW	129.00
Hourly Running Cost	Rs/h	1,419.00
Savings per hour	Rs/h	6,809.46
Savings for 8 months with 50% diversity	Rs	19,611,253.89

Savings in Steam during Winter		
Steam consumption per day for Domestic Hot Water		2,068.00
Steam consumption per day for Space Heating	kg/h	3,500.00
PNG required/kg of Steam		0.083
Cost of Steam using PNG	Rs	3.98
Hourly cost for Hospital for Domestic Hot Water	Rs/h	22,154.78
Domestic Hot Water	kW	3,816.40
	TR	1,085.22
Extra Power consumption over the 1000 TR Chiller	kW	322.00
Hourly Running Cost	Rs	3,542.00
Savings per hour	Rs	18,612.78
Savings for 4 months with 50% diversity	Rs	26,802,401.68
Yearly Savings in Heating	Rs	**46,413,655.58**

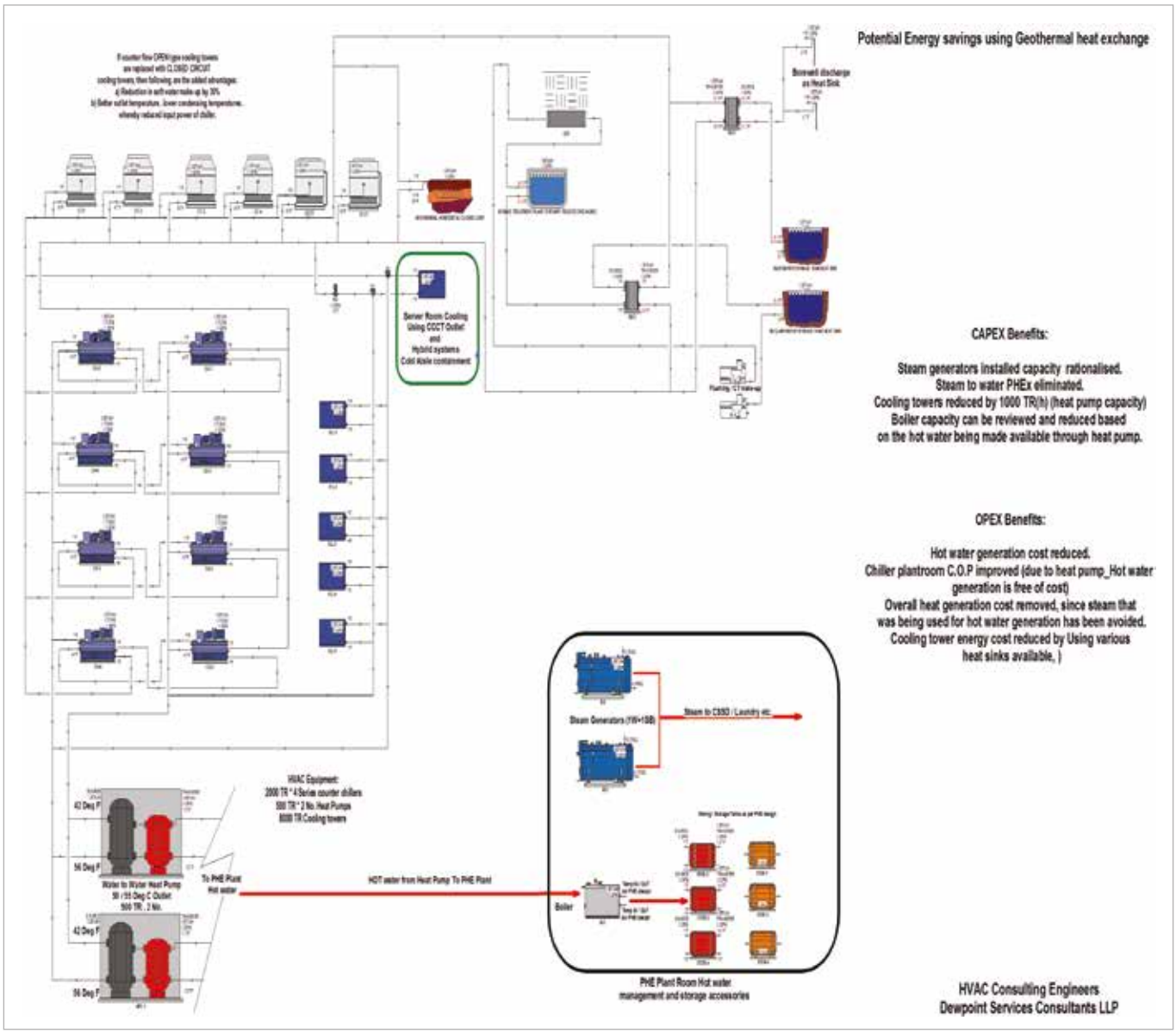


Figure-1: *Schematic representation of the design proposal*

3 Executive Summary of the Energy Engineering Proposal

The chiller plant room comprises of 4 banks of 2000 TR series Counter Flow Chillers along with 1000 TR * 2 No. Parallel Flow Chillers.

The Public Health Plant Room proposes 2000 kgh Steam boilers, which are used to generate steam for further consumption as noted in item No. 1.2 above.

Based on the Heat Balance and the Potential Heat Rejection Calculations, considering the various avenues, as listed under para 1.1 above, it is evident that the system indeed has a huge potential of Capex and Opex savings.

3.1 Design Alterations and Capex Savings

- Replace 1000 TR Chiller with a ground coupled heat pump (500 TR * 2 No.)
- Eliminate 3 No. 2000 kg/h Steam (2 Working + 1 Stand-by = 6000 kg/h steam generation installed capacity and instead use 700 kg * 4 No. Steam Generators. (2800 kg/h proposed installed capacity : Saving of 3200 kg/h steam generators)
- Eliminate the steam to water plate heat exchangers and other peripheral equipment.
- Eliminate 1000 TR Cooling tower for heat pumps, and use the geo-thermal sinks.
- Review the impact of these systems and accordingly re-size the hot water generation systems.
- Review the impact of this proposal and re-configure the chiller plant room.

3.2 Operating Philosophy

- **Summer Operation**

Out of the total heat load of 9000 TR, 1253 TR would be rejected in the following:

1000 TR in Closed Circuit Horizontal Geothermal circuit with Supply/ Return temperatures of 98.6/ 85.1°F

156 TR in Municipal/ Borewell water heat exchange circuit with Supply/ Return temperatures of 98.6/ 86.5°F

97 TR in STP water heat exchange circuit with Supply/ Return temperatures of 98.6/ 85.6°F

Hot water requirement of 50/55°C will be given by 1 No Heat pump of 500 TR operating at 80% capacity with 1417 kW of heat and 400 TR of free cooling.

Hence total of 1653 TR of cooling will be provided by the system along with 1417 kW of heat

- **Winter Operation**

Hot water requirement of 50/55°C will be given by 2 No Heat pump of 500 TR operating at 100% capacity with 3816 kW of heat and 1000 TR of free cooling.

In case cooling requirement is less then shortfall heat will be picked up from the geothermal circuit saving energy further.

For example if cooling need is 300 TR then chilled water equivalent of 300 TR will be produced and 700 TR of heat i.e. 2463 kW will be picked up from the Geothermal circuit.

Hence total of 1000 TR of cooling will be provided by the system along with 3816 kW of heat

4 Return On Investments Calculations (Simple Pay-Back Analysis)

#	Description	Units	Water Cooled Chiller with steam for Hot Water Generation	Ground Source Heat Pump + Horizontal Geothermal Closed Circuit System+ Open Circuit STP Geo system
1	Capacity of Chiller	TR	1,253	1,253
2	Power consumption (Chiller)	kW/TR	0.63	0.60
3	Power consumption	kW	789.39	751.80
4	Power Consumption for condenser water Pump	kW	75.00	75.00
5	Power consumption for cooling tower fan	kW	75.00	
6	Extra Energy Consumption in Chiller due to Fouling in the condenser tubes	kW	157.88	
7	Extra Energy Consumption in condenser pumps due to clogging of condenser pipes	kW	22.50	
8	Operating hours	h/d	24.00	24.00
9	Daily energy consumption	kWh	26,874.43	19,843.20
10	Annual working days	h	365.00	365.00
11	Annual energy consumption	kWhr	8,533,975.88	6,301,208.16
12	Rate of Electricity	Rs/ kWh	11.00	11.00
13	Annual energy consumption with 70% diversity	Rs/year	65,711,614.29	48,519,302.83
14	Water Consumption	lt/yr	113,926,442.72	-

#	Description	Units	Water Cooled Chiller with steam for Hot Water Generation	Ground Source Heat Pump + Horizontal Geothermal Closed Circuit System+ Open Circuit STP Geo system
15	Rate of water	Rs/lt	0.12	0.12
16	Cost of water	Rs	13,671,173.13	-
17	Total operating cost per annum	Rs	79,382,787.41	48,519,302.83
18	Savings per year	Rs		30,863,484.58
19	Hot water Generator savings per year with 50 % diversity	Rs		46,413,655.58
20	Life of equipment (chiller only) Water cooled chiller life reduced due to fouling	years	18.00	25.00
21	Cost of System 9000 TR (chiller and accessories)	Rs	850,000,000.00	850,000,000.00
22	Total Cost	Rs	850,000,000.00	850,000,000.00
23	Additional Cost for 1000 TR Horizontal Geothermal loop	Rs		90,000,000.00
24	Additional Cost for 250 TR Open Borewell/STP Geothermal	Rs		15,000,000.00
25	Additional Cost for 500 TR x 2 nos Heat Pump	Rs		30,000,000.00
26	Reduction Cost for 1253 TR Cooling Tower	Rs		(5,600,000.00)
27	Reduction Cost for 1000 TR x 1 nos Chillers	Rs		(18,000,000.00)

#	Description	Units	Water Cooled Chiller with steam for Hot Water Generation	Ground Source Heat Pump + Horizontal Geothermal Closed Circuit System+ Open Circuit STP Geo system
28	Reduction Cost for 3200 kg/hr Steam Boiler (new configuration 700 x 4 kg/hr)	Rs		(7,280,000.00)
29	Reduction Cost for PHEs	Rs		(5,000,000.00)
30	Net Cost of the System	Rs	850,000,000.00	949,120,000.00
30	Net Cost of the System	Rs	850,000,000.00	949,120,000.00
31	Net Additional Cost	Rs		99,120,000.00
32	Additional cost after Chiller replacement after 18 years in water cooled + CT	Rs	5,381,250.00	93,738,750.00
33	**TOTAL SAVINGS PER YEAR**	**Rs**		77,277,140.16
34	**ROI**	**years**		**1.2**
35	**Savings in 25 years**	**Rs**		1,838,189,754.03

5 Conclusion

The example establishes the potential of deploying renewable energy in upcoming/ retrofit projects, and at the same time prompts designers to start challenging the conventional design approaches, to enable the industry to start reversing the changes that have caused irreparable damage to the earth and thus help build a world with life systems that are green.

SUSTAINABLE SOLUTION FOR HVAC SYSTEM OF AN IT PARK

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Tata Consulting Engineers Limited

INTRODUCTION

Energy consumed in the building sector comprising residential and commercial users accounts for about 20% of the total energy consumed worldwide. As per EIA's (US Energy Information Administration) International Energy Outlook 2017 estimates, the fastest growth in building energy consumption would be in India till 2040. The energy consumption in commercial and residential building sector in India is expected to increase at an average rate of 2.7% per year during the period 2015 to 2040. This would be more than twice the global average increase. Fast track economic growth, rising income, growth in population are the key factors in the growth in India's building energy consumption. India has the highest projected GDP growth rate averaging 5% per year from 2015 to 2040. About 45% of India's population would be living in urban areas by 2040. The commercial sector energy usage in India would increase at an average rate of 3.4% per year. Due to this there would be an increase in demand for lighting and cooling equipment. The sector wise energy consumption in India is shown in Figure-1. For commercial buildings, the Heating Ventilation and Air Conditioning (HVAC) system is generally responsible for a significant proportion of the total building energy consumption. A typical break up for an office building is given in Figure-2.

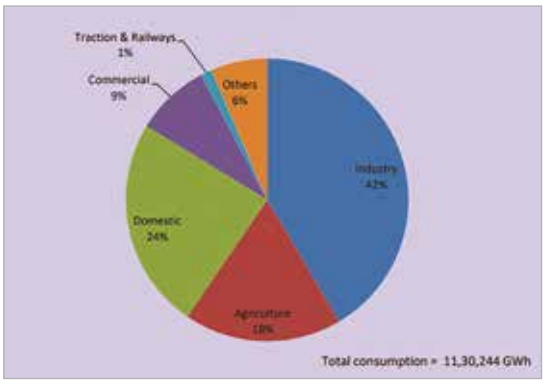


Figure-1: *Sector Wise Energy Consumption in India*

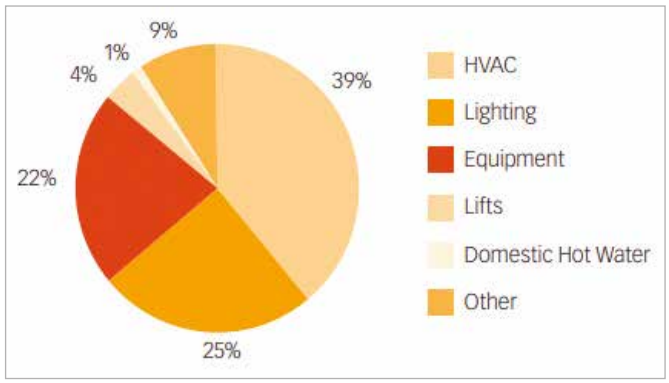


Figure-2: *Energy Usage in an Office Building*

In an HVAC system, the fans for circulation account for the maximum energy consumption. A typical break up for an office building is shown in Figure-3.

PROJECT BRIEF

With increased awareness about global warming, users have become more sensitive towards the need for a sustainable set up while developing any new project. One such case study for an IT set up is considered in this paper. In any

IT Park, an effective & efficient HVAC system is a pre-requisite while planning a project. The project under consideration had a built-up area of around 92,903 sqm (1 million sft) and was planned for LEED certification. Various measures were adopted towards sustainable and green initiatives. This paper covers the optimization options studied for the HVAC System.

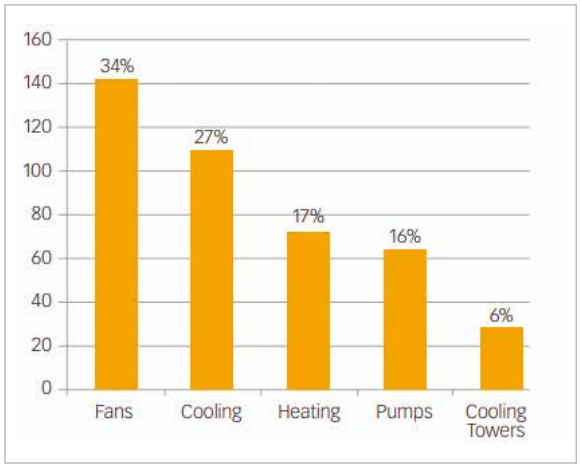


***Figure-3:** : Energy Consumption of HVAC System Components in an Office Building*

DESIGN INPUT CONSIDERATIONS

The HVAC system was designed to meet the requirements of applicable standards - ASHRAE, NFPA and NBC. To achieve comfort conditions, the temperature and humidity in different areas are to be maintained within acceptable limits. The design considerations were as below:

1. Office area/ Library/UPS room - DBT deg C - 24±1 º C, % RH – Between 50 to 60%
2. Data Center - DBT deg C - 22±1 º C, % RH – ≤ 60%

The set up was planned to operate on a 24 x 7 basis.

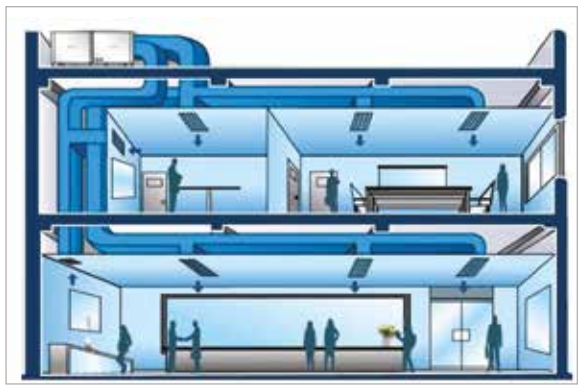
OPTIONS FOR HVAC SYSTEM

Following options were considered for evaluation:

1. Centralised Chilled Water System
2. Radiant Cooling System
   - With overhead ducting
   - With under floor air distribution
3. Under Floor Cooling System
   - Without ceiling fans
   - With ceiling fans

Option 1 - Centralised Chilled Water System

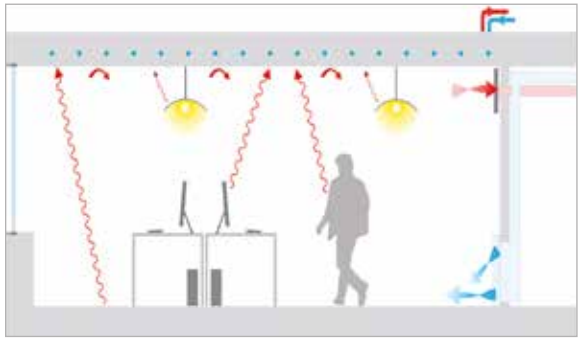
That is a conventional system. The AHU would be placed inside the AHU room with provisions of chilled water pipeline and fresh air duct connections. The cooled and filtered air generated from the AHU would be supplied to the area to be air conditioned by sheet metal ducting. This conditioned air would be distributed at the user points through Grills/ Diffusers. The Return Air would be taken back to AHU through return ducts. The Fresh Air requirement would be supplied through the fresh air duct connected to a dedicated outdoor system.



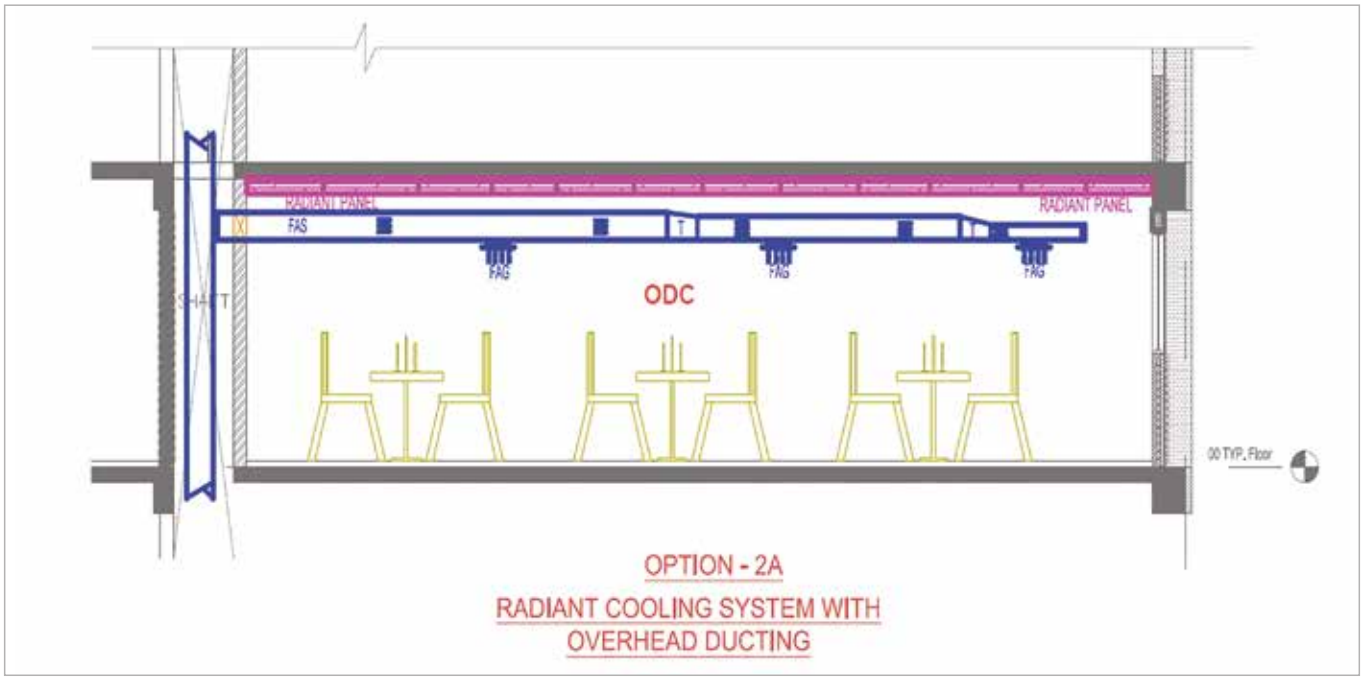
Option 2- Radiant Cooling System

There are two types of loads in buildings viz. sensible and latent loads with the split being about 70:30. The sensible loads are the heat loads from people, lighting, equipment and solar (through facade) while latent loads are towards control of humidity.

The Radiant Cooled System is used for sensible cooling and dehumidified air is used to control the RH. The Radiant Cooling technology is based on the use of water to cool surfaces within the building. These surfaces absorb the heat energy from the sensible loads in the surrounding space. The sensible load is transferred to the cooler surfaces by radiation producing a cooling effect. The cooled air being heavier moves downwards near to the working level. There is no duct for supply air. That results in a reduction of the Air Handling Unit capacity which would be only to the extent of Fresh Air supply which would be about 25-30%.

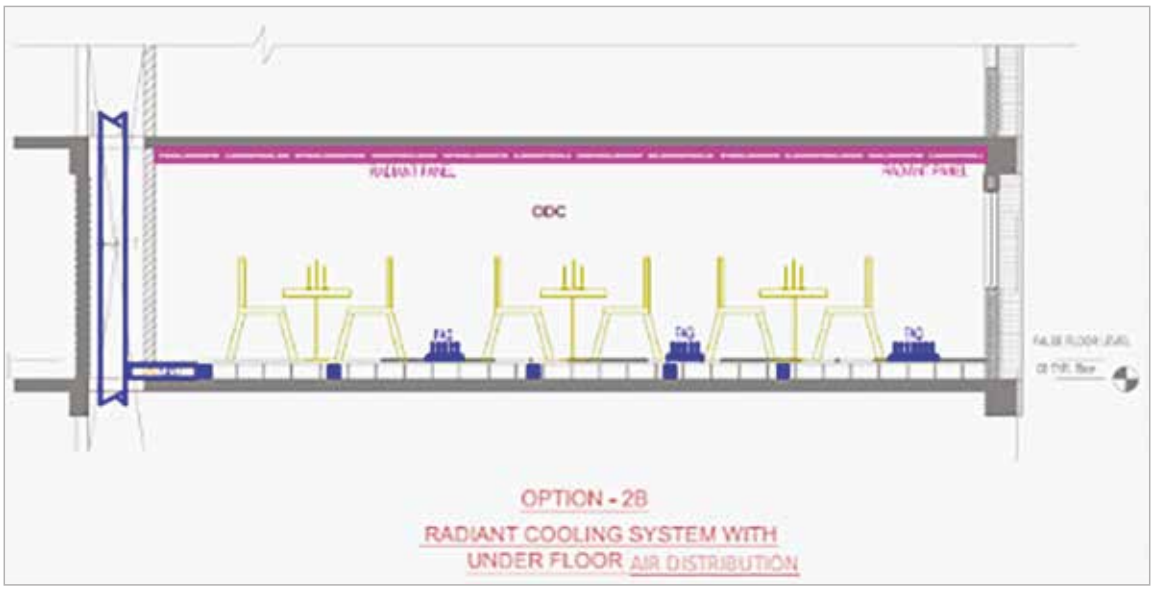


Option 2 A - Radiant Cooling System With Overhead Ducting



In this system chilled water is supplied through a main riser and distributed at each floor level through insulated piping routed on radiant panels. This is a closed loop system and hence there is no loss of water in the cooling circuit. Chilled water at 15 deg C is supplied to the cooling elements (for sensible loads which account for about 70% of total load) and is returned to the chillers with a temperature difference of 3-5 deg C. Fresh Air is inducted into the building through an outdoor air system where outside air is cooled and dehumidified as it passes through the outdoor air system. The treated air is distributed inside the air-conditioned space through overhead ducting. The latent cooling is at 6.7 deg C (for latent loads of about 30%).

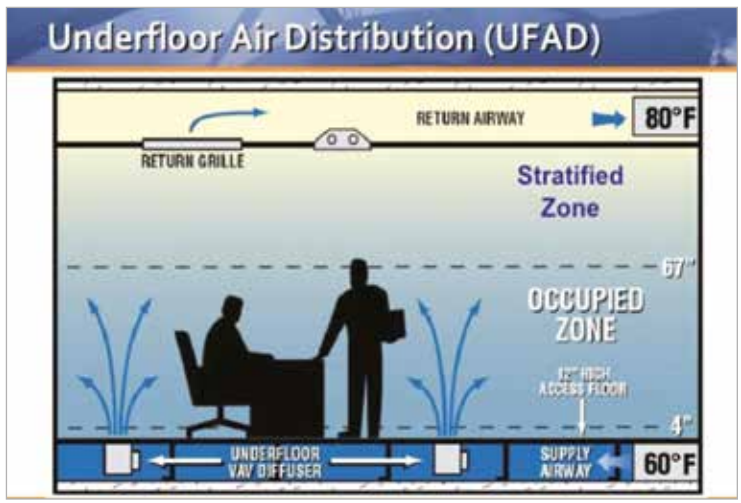
Option 2 B- Radiant Cooling Systems With Under Floor Air Distribution



The system is same as that discussed for Option-2A except that the cooled and dehumidified fresh air is distributed through under floor plenum. This arrangement offers two more benefits viz. clean air is supplied in breathing zone in the work space and air is thrown inside the raised floor directly therefore the ducting required for fresh air supply is less. This reduces the fan power consumption and the operating costs.

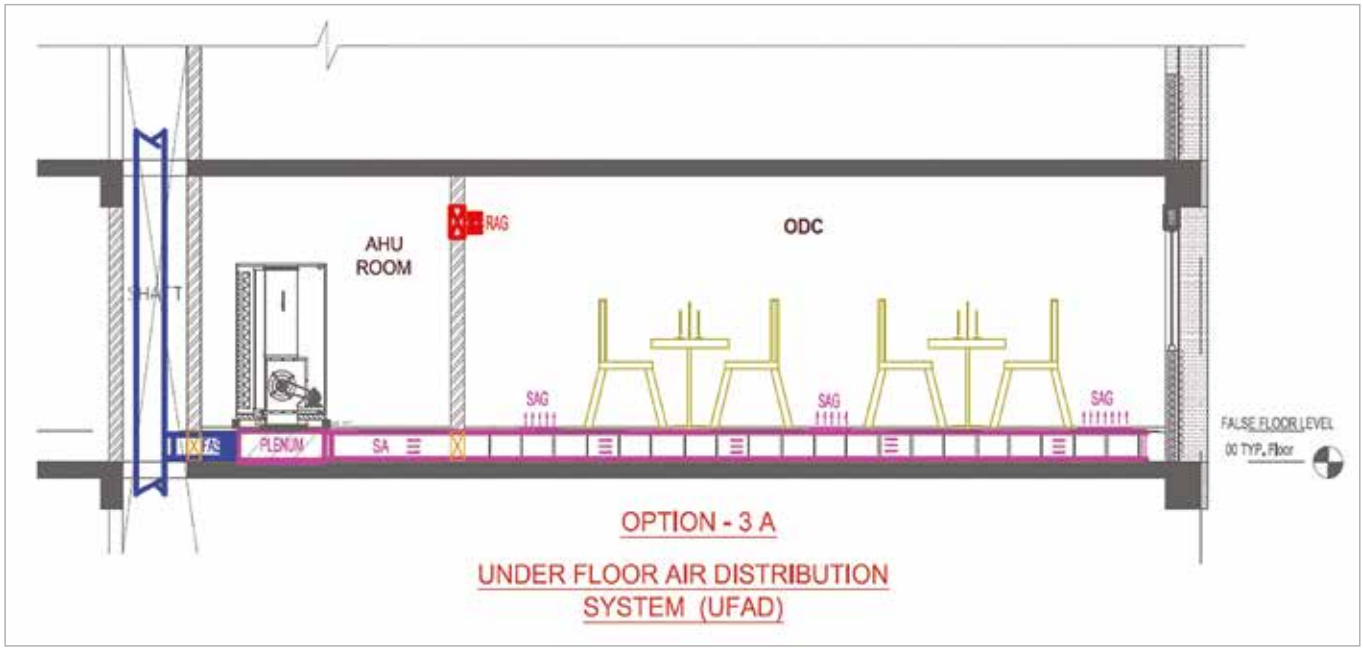
Option 3 - Under Floor Cooling System (Under floor air Distribution-UFAD)

Option 3A - Under Floor Cooling System Without Ceiling Fans

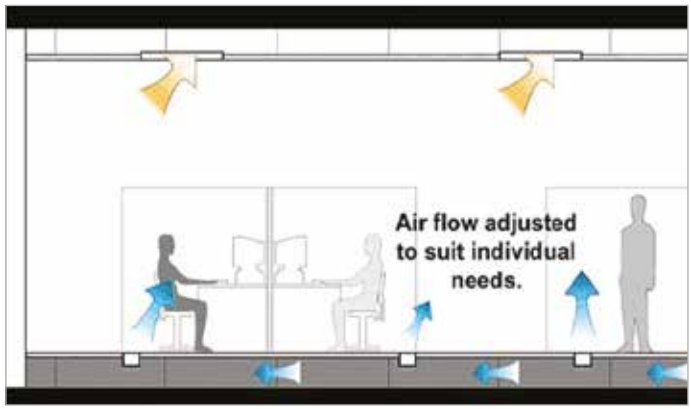


A working space is divided into two zones, an occupied zone extending from the floor to head level, and an unoccupied zone extending from the top of the occupied zone to the ceiling. The system is designed to condition the occupied zone. The temperature conditions in the upper zone can be above normal comfort ranges.

The sensible loads from people, lighting, equipment, and solar (through facade) are taken care by the Chilled Water Coil inside the AHU which is designed based on the sensible heat. The AHU would be placed inside AHU room which would generate the necessary amount of cooled and filtered air. A raised floor is used as a supply air plenum to put in conditioned air through floor diffusers/ grills directly into the area to be air conditioned. The warm air due to heat sources such as occupants and equipment being lighter, moves to the top and goes back to AHU through the return air terminals located near the ceiling.



This is in contrast to the conventional overhead conditioned system wherein supply and return air is at the ceiling level. Thus, a significant amount of the ducting work would get eliminated. This would also lead to a reduction in fan power requirements and operating costs.

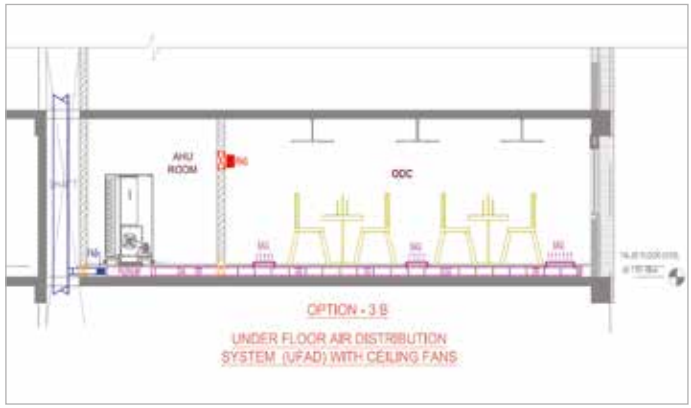


Treated Fresh Air is inducted into the building through a dedicated outdoor air system where outside air is cooled and dehumidified. This treated Fresh Air is responsible for control of humidity and air quality within the building.

This system provides an opportunity for individuals to control the airflow. This system also provides flexibility to rearrange air distribution outlets to suit interior layout of conditioned space.

Option 3B - Under Floor Cooling System With Ceiling Fans

This system is the same as discussed in Option-3A but in addition ceiling fans are used to increase the velocity of cold air inside the room by fan rotation. This allows system to design for a higher room temperature. The system also gives a flexibility of non-operation of chiller system during cold seasons. However, the running cost of ceiling fans gets added to the operational expenses.



COMPARISON

OVERALL COMPARISON OF ALL SYSTEMS						
Sr. No.	**DESCRIPTION**	**OPTION 1**	**OPTION 2A**	**OPTION 2B**	**Option 3A**	**OPTION 3B**
1	Power consumption kVA/ Person	0.249	0.159	0.157	0.174	0.218
2	AC load per person TR/ Person	0.152	0.124	0.124	0.124	0.124
3	Total Area/ TR	611	753	753	753	753
4	Capital Cost (Rs lakhs)	3087	3488	3494	3592	3585
5	Operating Cost @Rs 10 per kW.hr for one year (Rs lakhs)	835	532	528	612	782
6	Make up water requirement per day kld	264	210	210	210	210
7	Level of expertise required for installation	Low	High	High	Medium	Medium
8	Flexibility of modification/ rearrangement	Low	Medium	Medium	High	High
9	Installation time	Low	High	High	Medium	Medium

ANALYSIS

Based on the above comparison the observations are as below:

1. Options 2 and 3 are better than the conventional chilled water system.
2. Option 2A (Radiant Cooling System) is advantageous in terms of Capex + Opex with payback period of less than 1.5 years (additional Capex of about Rs 4 Cr is recovered in < 1.5 years).
3. Option 3A (UFAD system without ceiling fan) is advantageous in terms of Capex + Opex with payback period of less than 2.5 years (additional Capex of about Rs 5 Cr is recovered in < 2.5 years).
4. Reduction in Energy Consumption is as below:

Option 2A with respect to Option 1 – 30.3 Lakh units per year

Option 3A with respect to Option 1 – 22.3 Lakh units per year

This would also mean corresponding reduction in CO_2 generation due to lesser energy consumption.

For Options 2 and 3, the chillers required for sensible and latent loads are different since the chillers for sensible loads run with elevated temperature. Due to this, the Capex is higher but there is a significant benefit in Opex due to the running at elevated temperature. This aspect has also been considered in the ROI calculations mentioned above.

RECOMMENDATION FOR IMPLEMENTATION

1. Though Option 2 is better than Option-3A, the latter is recommended for implementation considering the advantages with respect to Option-2 as mentioned below:
   (a) Flexibility in future modifications due to change in interior layouts. In an IT park the interiors need to be flexible for specific requirements like change of nature of business model, nature of job, etc. This is possible in Option -3 reasonably easily, as the entire flooring is being used for supply of air conditioned air. For Option-2 once the radiant panels carrying the chilled water piping are installed, revised interior layout would mean rerouting of chilled water piping by relocating the radiant panels. This would not be easily possible plus Capex would be required.
   (b) Radiant Cooling System (Option 2) involves more complexity in design and the level of expertise required for installation is High.
   (c) Installation time is less for Option 3 as compared to Option 2.
2. Both Radiant Cooling and Under Floor Air distribution systems have reduced fan power requirements. Apart from the saving in energy consumption because of this in both the options, there is also a reduction in maintenance of fans and filters in case of radiant cooling system due to reduction in number of fans. This would give an additional benefit in Opex.
3. For a given project, specific analysis needs to be done considering the requirements like nature of operation, extent of use, extent of imported items, etc. and the appropriate system needs to be selected based on the ROI, functional needs and anticipated change of usage of the premises.

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INTRODUCTION TO ELEVATORING DESIGN

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1.0 Introduction

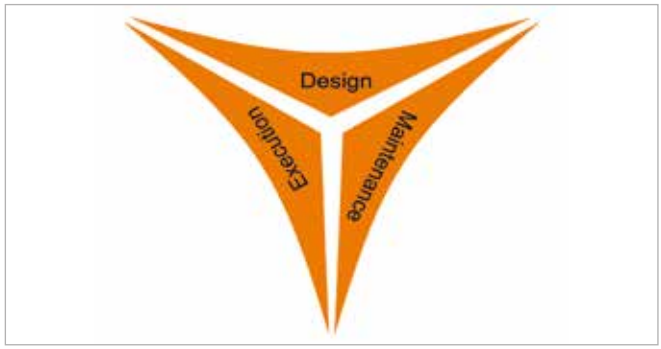
With stairs as the only practical safe means for vertical transportation buildings of over six floors were rare till the 19th century. Having to climb a great numbers of stairs was impractical for the inhabitants. Though forms of lifting mechanisms existed, the first documented reference in 236BC being the Archimedes' contraption, they were considered unsafe. In 1853, Elisha Graves Otis, at the World Fair held at the Crystal Palace, New York demonstrated a safety mechanism that would stop a free-falling elevator. This invention was the primary trigger to the changing skylines of the cities around the world. To this day the elevator limitations remain the primary barrier to man's tall ambitions.

Safety gear demonstration by Otis

Anybody having to climb stairs due to the absence of an elevator would vouch that an elevator is what makes even a building of a few floors viable. However, when a person is somebody with special needs, even two floors become a challenge. The same applies to the older generation. That goes to show without doubt that elevatoring is the life line for buildings.

2.0 Elevatoring Life Cycle

Putting together a sustainable and optimum elevatoring solution requires a fine balance through the 3 stages of the elevatoring life cycle. A building with inadequate elevatoring cannot be corrected even if well specified, procured, installed and maintained or vice versa. However, the stark reality is that the life line of a building is treated as an orphan through its entire life cycle from design to procurement and execution to maintenance.



Elevatoring Life Cycle Triangle

Cost priorities invariably drive the specifications and vendor selection process and not the project and the safety requirements. During the installation process, the same oulook to elevators continues.

Water in the hoistway pit

Slurry on the door sills

Passenger Elevator used as a Garbage Elevator

Elevator lobby with debris stacked against the door

During the maintenance phase costs are cut to the extent that proper maintenance is well nigh an impossibility. Users too tend to misuse the elevators with the hoistway being treated as a garbage chute. All these have dangerous consequences and affect the life of the elevator.

This paper addresses the key steps through the design stage of the elevatoring life cycle.

Clarifying notes:

(a) Elevators (US) and Lifts (UK) may be used interchangeably.

(b) The term Elevatoring is coined to describe the whole elevator life cycle.

Paan stains on doors

3.0 At what stage of the building design should the elevatoring design process begin?

A question like that reveals the need for understanding and appreciating the priority that vertical transportation aspect of a project deserves.

It is not uncommon to find even tall buildings with finalised plans and sometimes under construction without an elevatoring design basis. At a recent panel discussion, the author enquired from the panellists and the audience as to what would be the number of buildings in India that would have detailed design basis for their elevatoring. The most optimistic estimate was that 50% buildings would have a design basis and the most pessimistic estimate was that only 10%. Either way, the number of buildings already existing or being constructed or being designed without a proper design basis for its elevatoring is very high.

The answer to the question 'At what stage of the building design should the elevatoring design process begin?' is that it must start at the conceptual planning stage and move on along with the schematic design of the building. The life-lines have to be integrated into the project at the concept stage and not fitted in as an afterthought.

Unlike any other aspect of the building, once the building core is finalised with inadequate elevators or wrong hoistway sizing, there is no real remedy available other than redesign of the core and the building. While this is an expensive and time consuming affair, the alternative is worse.

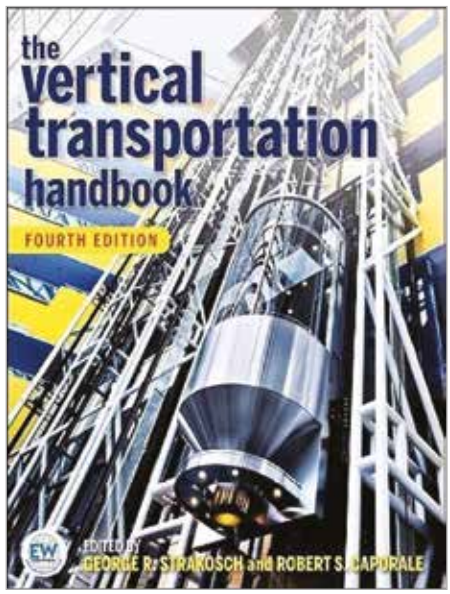
If the building moves into the construction stage and completion with the incorrect core, the only practical remedy for the inadequate elevatoring is to demolish and rebuild. The numerous buildings with their infamous queues and long waiting times dotting the skyline around the country stand testimony to this fact.

Elevator queues extending outside the lobby

4.0 The Genesis of the Science

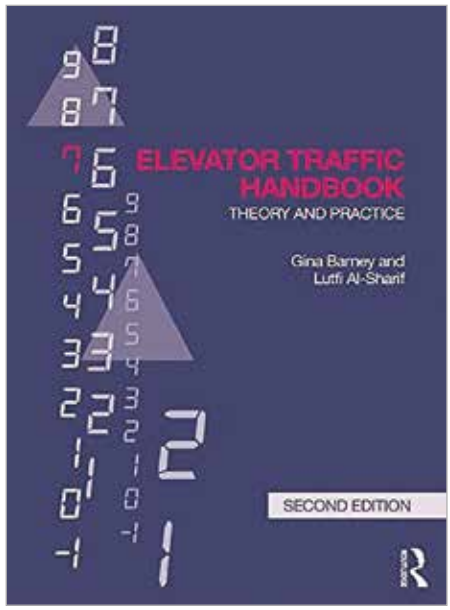
Elevatoring science, contrary to common opinion, is not a neo science. The first principles of traffic analysis have been in place for over five decades and remain the basis for elevatoring around the world. Strakosch's first handbook which often is considered the original bible of the vertical transportation industry is from 1967. The latest edition of this elevatoring bible is the fourth edition. Sergio do Santos and Barney published *"Lift Traffic Analysis, Design and Control" in 1977.*

Elevatoring science, also contrary to common opinion, is very complex. Gina Barney, in her *'Elevator Traffic Handbook', states – "The planning and selection of transportation equipment is a very involved subject. Although the basic calculations are relatively simple, the theory on which they are based is complex. The results obtained need to be tempered with a great deal of working experience of existing buildings in order to ensure satisfactory design results." She goes on to stress – "Without such experience, the reader of this book will not be an expert".*



People should not style themselves as so called experts and provide recommendations with limited understanding. Elevatoring inter alia involves strategic safety planning requirements and a complex design algorithm.

With the advent of computer assisted traffic analysis and simulations, professional looking reports should not be relied upon since they may not be based on an adequate understanding of the fundamentals. As Richard Peters, the author of **Elevate** while introducing his **"industry standard" traffic analysis software warns, "Elevate is an extremely powerful traffic analysis tool. However, it will not make the user an elevator traffic analysis expert."**



Architects, developers, consultants, experts and even the elevator industry professionals must pay heed to Barney's and Peter's warnings.

5.0 Elevator Traffic Analysis Parameters

The efficiency of a system is traditionally defined in terms of the quantity of service **(Handling Capacity)** and quality of service **(Passenger Waiting Time).**

5 minute Handling Capacity (HC) is the total number of passengers that the system can transport in a 5 minute period with a specified average car loading expressed as a percentage of the total building population.

Interval (INT) also referred to as Average Interval or Waiting Interval is the average time, in seconds, between successive lift car arrivals at the main terminal floor with cars loaded to any level.

HC and INT are in turn calculated from the **Round Trip Time (RTT)** of a single elevator.

RTT, HC and INT are formulae based calculations and remain the basis for an apple to apple comparison. The formulae involved is detailed in chapter 8.0 of this paper.

Average Waiting Time (AWT) is the average period of time, in seconds that an average passenger waits for a lift, measured from the instant that the passenger registers a landing call (or arrives at a landing), until the instant the passenger can enter the lift. Typically this would be the sum of the waiting times of all the passengers divided by the total number of passengers.

Two points of caution. (i) It needs to be clearly recognized that **Interval ≠ Average Waiting Time.** The Average Waiting Time can be realistically established only through a simulation, which would depend on the simulation algorithm and assumptions. (ii) The average car loading should never be expected to cross 80% of the rated car capacity.

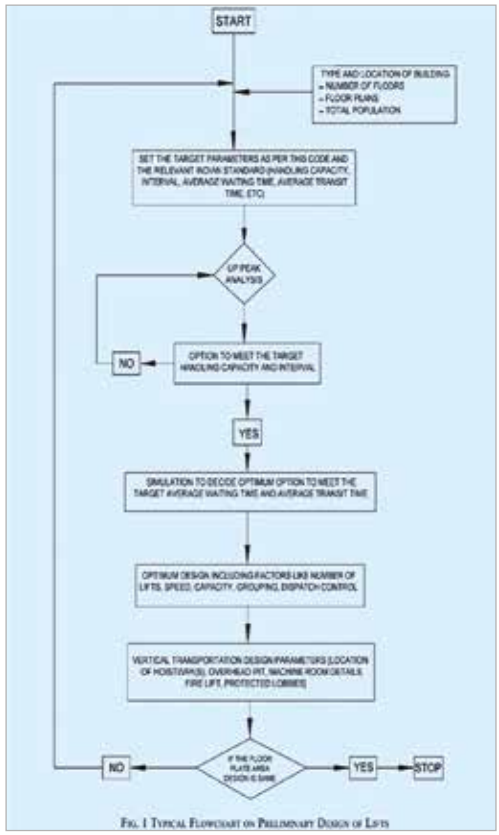
6.0 Elevatoring Design – The First Step

Understanding the building and establishing the assumptions is the first step. Based on experience, 75% of the work and discussions related to the overall elevatoring design should be in establishing the assumptions and the input data. Very close collaboration is required between all the constituents (developer and the commercial team, architect, traffic consultant, etc.) to understand the characteristics of the building, the population, the requirements and expectations. Future change in usage should also be kept in mind where that is a possibility.

Any short cut of this process would have a cascading effect on the overall elevatoring and sustainability of the building. The elevatoring design reports should not be based on assumptions that are established to suit the available elevator core - meaning that the input should not become the design objective. Because when the building is complete and occupied, it would follow it's originally planned characteristics and not the elevatoring design inputs leading to long queues and waiting times. It is not uncommon to see tenants vacating buildings on account of this.

7.0 Elevatoring Design – The NBC 2016 way

Most countries (barring UK with the CIBSE Guide D) do not lay out details and guidelines for elevatoring design and recommend minimum requirements. The National Building Code of India (NBC) is an exception.



Extract from Section 5A, Part 8, NBC 2016

While NBC 2005 had a chapter on elevatoring design, NBC 2016 has gone into more details. Chapter 4, Section 5A of Part 8 of NBC 2016 provides significant elaboration and guidelines, for those who understand the fundamentals of elevatoring.

A caution, just like a novice would not be expected to carry out the structural design of a building after going through the code, it is not expected that a novice can carry out elevatoring design based on NBC 2016. At times architects, MEP consultants, and even general laypersons carry out elevatoring design based on NBC guidelines which results in issues.

8.0 Elevatoring Design – Process and Parameters

The design process is iterative and calls for correct inputs and interpretation of the results. NBC 2016 provides a self-explanatory flow chart for the elevatoring design process.

The flow chart clearly points to the iterative nature of the elevatoring design process and the recognition that the design starts at the conceptualisation of the building.

NBC 2016 also details the formulae for establishing the RTT that forms the basis for traffic analysis.

From RTT, HC and INT can be derived as follows –

HC=300/RTTxPxL expressed as a percentage of Total Design Population for Elevators

INT=RTT/L

Where L denotes the number of elevators in the group and P the average elevator car loading.

Golden Rules:

i. The average car loading is not to exceed 80% of the rated car loading.

ii. L is the number of elevators in a group. If the analysis throws up the need for 8 elevators in a group, it is important that these elevators are in one single group and hoistways are located to facilitate such grouping.

iii. Unless the elevator car is expected to transport stretchers, the elevator cars have to be wider to facilitate ingress and egress. A deeper car is inefficient and this inefficiency requires to be captured in the analysis

4.2.5 *Traffic Analysis Equations*

The classical method to size a lift installation requires the determination of the time, in second, that it takes for a single lift to make a round trip around the building during the up-peak traffic condition. This is called the round trip time and is given by:

$$RTT = 2Ht_v + (S+1)(T - t_v) + 2Pt_p$$

where

N = number of floors above main terminal floors,

H = average highest reversal floor

$$= N - \sum_{i=1}^{N-1} (i/N)^P,$$

S = average no of stops

$$= N\left[1 - \left(1 - \frac{1}{N}\right)^P\right],$$

P = average passengers carried

= 0.8 × maximum actual car capacity,

t_v = single floor transit time = average inter floor distance/rated speed,

T = door operating time (t_c+t_o) + single floor flight time $t_d(1)$, and

t_p = passenger transfer time.

The derivation of the round trip time equation assumes the following:

a) Traffic pattern corresponds to a pure up-peak.
b) Passengers arrive according to a rectangular probability distribution.
c) Lifts, on an average, fill to 80 percent of the actual car capacity by numbers irrespective of the weight of each passenger or the space that maybe occupied
d) All floors are equally populated.
e) Rated speed is achieved in a single floor jump.
f) Interfloor heights are equal.
g) Door dwell time does not exceed the calculated passenger transfer time.

9.0 Conclusion

The viability and sustainability of a building beyond one or two floors is dependent on its elevatoring. For the elevatoring to be effective and adequate, it is essential that the 3 aspects of the life cycle are treated with utmost care. Elevatoring design is a very complex science. It has to commence during the conceptualisation of the building and evolve as the concept moves into the schematic stage and further. Architects, developers, designers, consultants, and the elevator industry have to recognise that a faulty elevatoring design cannot be remedied.

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BIPV - INTEGRATING ENERGY HARVESTING AESTHETICALLY

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BIPV (Building Integrated Photovoltaics) System has emerged as a promising solution which apart from solving the energy-deficit problem also adds to the dimension of aesthetics.

A continuum of PV system designs exists with various levels of integration with building materials and architectural features BIPV offers a number of potential benefits, and there have been efforts to develop cost competitive products for more than 30 years.

The deployment of BIPV systems, however, remains low compared to traditional PV systems. In this report, the status of BIPV is presented, with a focus on and rooftop systems and wall facades and explores key opportunities and challenges in the marketplace.

As a matter of fact, the annual energy output of PV modules based on thin films provides higher energy output than the crystalline PV cell modules.

Table 1. Summary of prevalent PV systems

Scenario	Technology	Form	Efficiency	Module Area (m^2)	Remarks
PV Reference Case	c-Si	Rigid	14.5%	1.28	Lab based
BIPV Derivative Case	c-Si	Rigid	13.8%	0.58	Performance degrades with shading
BIPV Thin- film Case 1	CIGS	Rigid	11.2%	0.58	Currently used for Roof & Wall façade.
BIPV Thin- film Case 2	a-Si	Flexible	5.8%	0.58	

An overview of BIPV

The first installation of BIPV system was realized in 1991 in Aachen, Germany. Since, then the production of photovoltaic module specialized for BIPV is being carried out and the technological advancement in effective utilization of solar energy has further accelerated the process. BIPV is receiving attention since in contrast to the

conventional Building Adopted Photovoltaics (BAPV), which requires an additional superstructure to hold the PV modules, BIPV serves as an integral building component.

Apart from this it offers certain other advantages which are noteworthy:

- BIPV modules act as a functional unit of the finished building and is an active energy producing units,
- Replaces the conventional building materials,
- The BIPV module is a real building element like standard glass panes and can be integrated into every façade or roof structure,
- BIPV modules contribute to the building comforts, namely weather protection, heat insulation, shading modulation, noise protection, thermal isolation and electromagnetic shielding, and
- Avoid cost of land acquisition, fencing, support structures, cost of transmissions and the inherent losses which are necessary for other Solar panels. Studies have also been carried out to test the efficacy of energy solutions provided by the implementation of BIPV in buildings along with the ingenious architectural aesthetics. Some of the appealing examples are given below.

Figure-1: *(a.) Umweltarena Spreitenbach (Switzerland 2012): an example of a 203% Plus Energy building achieved by means of a customized 750 kWp full-roof BIPV skin consisting of c-Si panels with an antireflective glass (b.) Ferdinand-Braun-Institute, Berlin: 732 dark CIS modules designed as a curved façade (Surface: 640 m2, Energy output 39 kWp)*

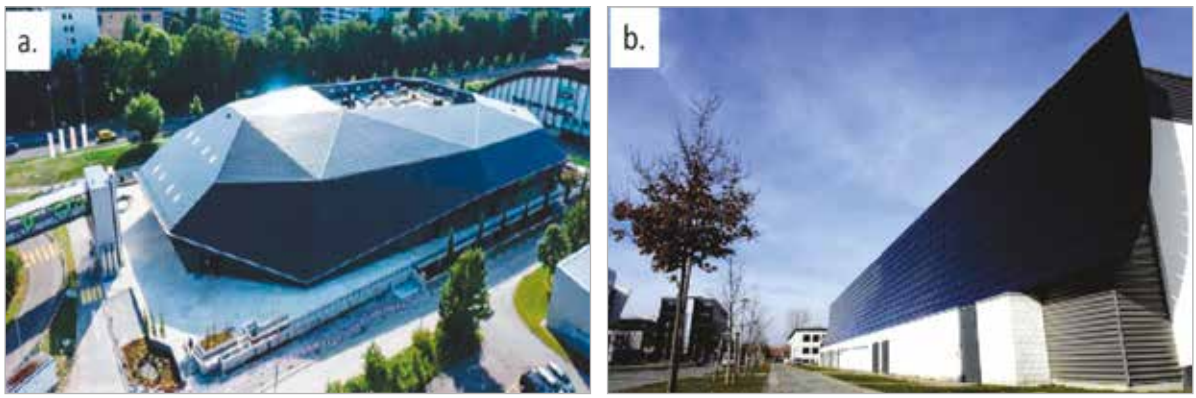

Figure-2: *(a) BIPV module covering complete roof façade (b) BIPV module as a wall façade*

Roof systems – Roofs are considered as an ideal place for BIPV installation. PV modules can completely replace the roof tiles. Besides in-roof installations that cover only a part of the roof, a full-roof covering of PV modules is regarded as a more economic and more elegant alternative choice as maximum surface area guarantees both maximum energy harvesting and a very appealing homogenous rendering, especially when an anti-glazing front glass is applied.

Wall system - The second major field of BIPV application is that of facades where solar panels of all technologies can be integrated as a conventional cladding system for curtain walls and single layer facades.

A COMPLETE BIPV SYSTEM INCLUDES:

- The PV modules (which might be thin-film or crystalline, transparent, semi-transparent, or opaque),
- A charge controller, to regulate the power into and out of the battery storage bank (in stand- alone systems),
- A power storage system, generally comprised of the utility grid in utility-interactive systems or, a number of batteries in stand-alone systems,
- Power conversion equipment including an inverter to convert the PV modules' DC output to AC compatible with the utility grid,
- Backup power supplies such as diesel generators (optional-typically employed in stand-alone systems), and
- Appropriate support and mounting hardware, wiring and safety disconnects.

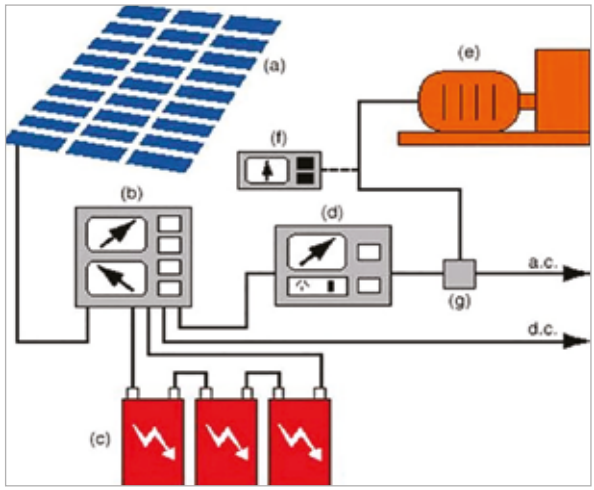

***Figure-3:**. BIPV System diagram (Courtesy-Murdoch University Energy Research and Innovation Group)*

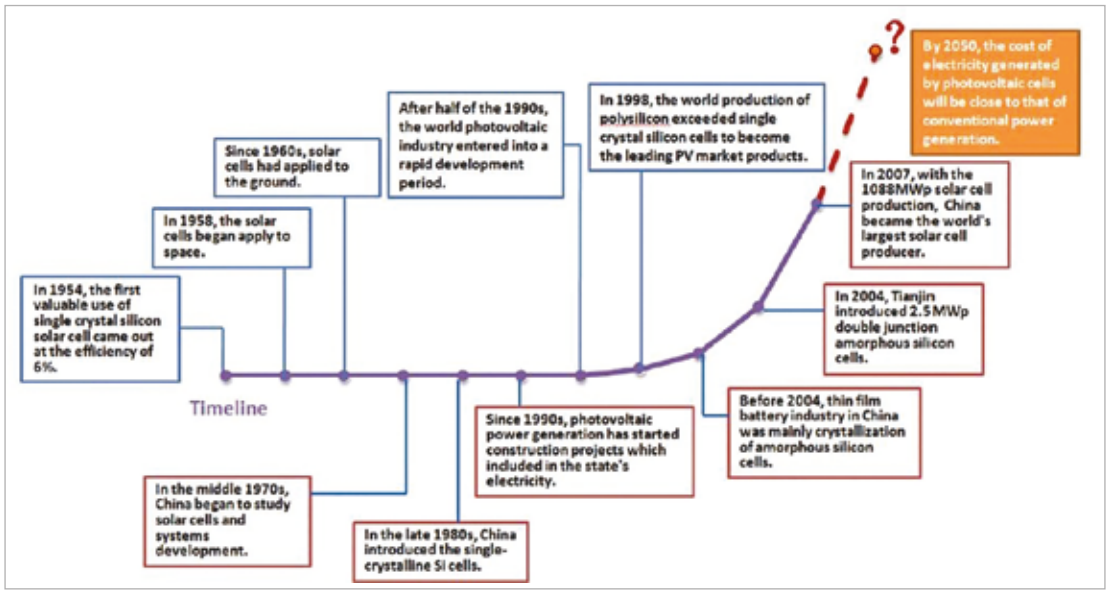

***Figure-4:**. The development of photovoltaic industry in the world*

Building Integrated Photovoltaic (BIPV) technology projects picking up in India

Moser Baer India Ltd. had commissioned a unique building integrated photovoltaic or BIPV technology led solar application in Hyderabad in 2011.

The commissioning of BIPV application in India heralds the arrival of this new age technology which would allow commercial buildings to increase the use of renewable source energy in aesthetic manner.

New solar application, which is based on building integrated photovoltaic (BIPV) technology is now being used in India, and companies like Moser Baer Solar Ltd and Tata BP Solar have commissioned projects based on this technology.

Moser Baer has recently (in 2011) used this technology and converted the exterior façade of the Jubilee Hills shopping complex in Hyderabad into solar panels and erected a 1.8 kWp solar application. The company is leading the Indian BIPV journey because of design team capacity. "These panels will generate electricity to meet the power requirements in the shopping complex," says K N Subramaniam.

Tata BP Solar has also used BIPV technology at the Samudra Institute of Maritime Studies in Pune (in 2007). This satisfies the institute's power requirements internally, mitigating the problems of erratic and poor quality of power supply.

***Figure-5:**. BIPV in Shopping Complex, Hyderabad*

***Figure-6:**. Usage of BIPV panels in Samudra Institute of Maritime Studies in Pune, India*

Figure-7: *TCE Office building, Jamshedpur: BIPV panels*

BIPV panels and solar panels were installed in Tata Consulting Engineers Limited's office building, Jamshedpur in 2009. Both were supplied and installed by TATA BP Solar.

CONCLUSION:

As can be seen from the examples given above BIPV can be blended aesthetically with the façade to provide energy for the building and in the future may even enable freedom from grid power supply.

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WATER DISTRIBUTION IN HIGH RISE BUILDINGS

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INTRODUCTION

The desire to build high into the sky has been a part of human existence for thousands of years. Just think of the pyramids in Egypt, the lighthouse of Alexandria in ancient Greece, or the Angkor Wat temple in Cambodia. High rise buildings/ edifices have also been used to represent political power and affluence; to honor statesmen or religious icons.

Over the last couple of hundred years, however, a more practical aspect has been built into these high-profile projects. High rise buildings reflected the need to make the best possible usage of a relatively small area of land in densely populated urban spaces across the world.

Further with the increase in density of population in Indian cities, there is an exponential vertical development calling for high rise structures marking the city skylines. This poses a huge challenge, so also when it comes to design of efficient water distribution systems. The design of these distribution systems does not stop only with capacity calculation and piping design, but also on the intricacies of booster controls, which also avoids certain operating issues while running a booster system in high rise structures.

WATER DISTRIBUTION IN GENERAL

Pressure boosting can be necessary for one or more reasons as follows:

- Buildings situated on a hilltop where pressure of water supplied from mains is inadequate.
- Tall buildings, where the height of the building prevents the public water from reaching the top floors (Figure-1). For example, a mains pressure of 3.0 bar should, theoretically, be sufficient for a 30-m tall building, but this is not the case. There must be sufficient surplus pressure to cover resistance in riser pipes, single components such as shower heads, toilets and cooling towers.
- The peak load flow might be greater than what is possible to supply from the mains. In these cases, a break tank is installed in the building, from where one or more booster sets take the water and boost it to the required pressure level. The normal specifications are that the pressure on each floor does not fall below 1.5 bar and does not exceed 5 bar.

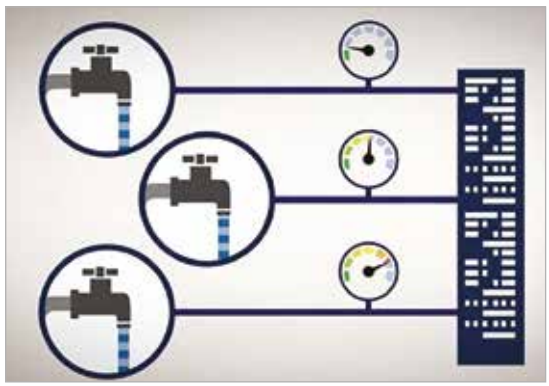


Figure-1: *Water pressure supplied from the mains is not sufficient to cover top floorspanels*

Use of overhead tanks in high rise buildings

The use of overhead tanks to ensure adequate water pressure in buildings, and especially tall buildings, is very common (Figure-2). The alternative to overhead tanks is the use of pressurized systems, where several booster pumps provide the necessary pressure. Overhead tank solutions were originally created more than a century ago, as buildings grew taller and taller. The required water pressure for both fire-fighting and domestic use increased and mains water was insufficient to supply a whole building.

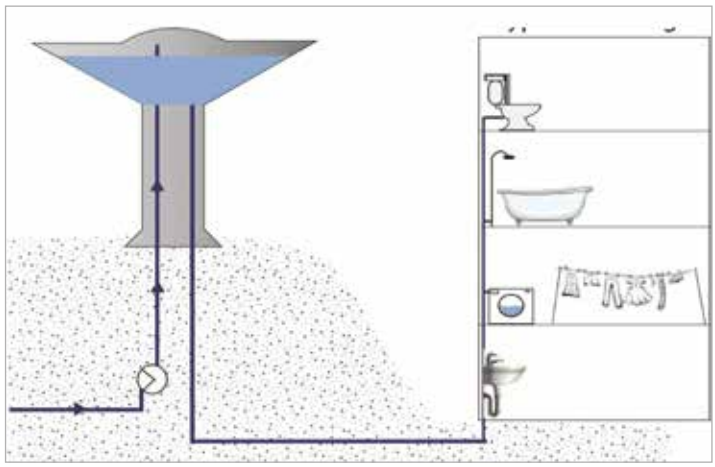


Figure-2: *The principle of an elevated water tower*

Moreover, reliable and efficient pumps for pressurized systems were not available. The immediate solution was to use standard pumps to lift the water to the overhead tank. From the overhead tank, gravity ensured a natural downwards flow and sufficient pressure. Despite improved and energy-efficient pressure booster technology, many buildings still have overhead tanks.

Overhead tanks allow the users to have both water pressure and water supply in situations where there is no electrical power. Overhead tanks vary greatly in size, but common to them all is that they feature “water at the ready”, storing water for domestic purposes and fire-fighting.

The simple construction basically entails a tank, inlet and discharge piping, a float switch, and a pump. When the water level in the tank drops below a certain level, the float switch engages the pump, refilling the tank.

Though from a functional point of view, overhead tanks of today work adequately in many aspects, on the flip side, overhead tanks involve elements that are not always desired. Examples include higher capital costs due to the tank set-up and greater structural requirements, high operating costs, a lack of pressure control, and difficulty in maintaining the overhead tank itself.

In addition to serving as a storage device and creating pressure, roof-top tanks unfortunately can also serve as breeding grounds for bacteria constituting a major health risk (Figure-3). The exceptionally resistant bacteria legionella often appears as an unwelcome guest in water systems. To survive, the habitat for legionella and other microorganisms arises in the biofilm created in the water system. Biofilm is created inside pipes and water tanks, serving as a protective barrier and breeding ground for the bacteria.

Figure-3: *Bacteria inside pipes and water tanks*

System Elements & Layout

System Elements

The booster system is based on several basic hydraulic elements that can be combined in different ways. The most important elements are described briefly - their functionality and role in the booster application in general.

1) Break tanks or Underground tanks

Break tanks are provided in boosting systems in order to supply the system if the mains supply becomes insufficient during peak demand, or if it is unstable. It is also used to ensure that a surge from starting and stopping pumps does not affect the mains distribution. Tanks are also provided in series-connected boosting layouts to create manageable pressure zones. Here, the break tanks supply the taps in the tank's own boosting zone as well as all the zones above it.

A major disadvantage with the break tank is that it is a pressure-neutral tank that absorbs the pressure coming from the public supply, removing any potential inlet pressure. This means that the booster system should supply all the pressure itself, instead of using some of the pressure coming from the inlet. Hygiene is also an issue for break tanks. Because of retention time, the tank should be cleaned regularly and break tanks often feature more than one compartment making it possible to clean the tanks. In some countries, it is not permitted to install booster sets directly on the incoming mains supply. This is primarily to ensure that water cannot be pressed back into the mains supply, thus avoiding the risk of contamination. In those countries, break tanks are a necessity in all booster installations. Normally, the break tank is sized by the consulting engineer and it is generally not regarded as part of the booster system.

Boosting with Break Tank (Figure-4)

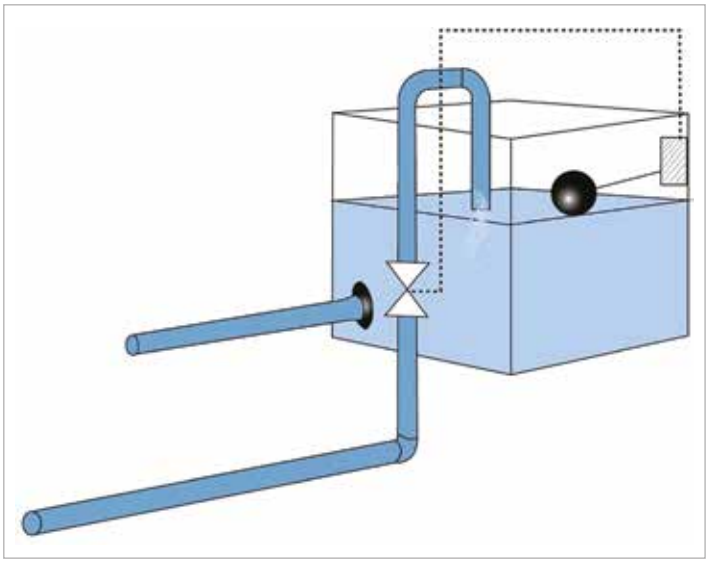


Figure-4: *Break tank with level switch*

Advantages
Water always in stock
Break tanks used on different floors in high rise buildings, makes sizing easier compared to single boosting from basement
Disadvantages
Pressure in mains is not utilized
Space is a scarce resource in modern high rise buildings, making it difficult to have the needed space allocated for break tanks
Break tanks must be kept clean and appropriate cleaning should be a scheduled activity

Table-1: *Advantages of Break Tank*

A water tank is placed before the pump system and filled with water from the mains. This allows the capacity of the mains to be lower than the building's peak demand, ensuring constant pressure even in peak flow situations. The break tank is filled with water during low-consumption periods, always ensuring even water supply to the booster pumps (Refer Table-1).

2) Booster Pumps

Water distribution to buildings is vital. People who live in multi-story buildings always need sufficient water and so do industrial processes. Therefore, high-quality pumps are crucial in booster systems.

What counts for all though, is the way the core of the pump is designed. Multi-stage pumps for boosters are all in-line multi-stage pumps. That means water pressure is gradually built up when the water passes through the different stages. When the final pressure level is met, the water exits the pump at the same level it entered. This is the in-line principle.

3) Risers and branches

Building supply system is normally divided into risers and branches. In the risers, the geodetic height is overcome, and the water is distributed to the different floors. The branches distribute water to each outlet fixture. When using pressure reduction valves (PRV), the branches are often joined into main branches, creating a zone for each PRV to reduce the required number of PRVs. If the buildings are identical and with only one riser, PRVs is provided at each floor. In the example shown to the right, PRVs need to be added on each branch on the building.

4) Pressure Reduction Valves (PRV)

To equalize pressure on all floors, PRVs are often used in multi-story buildings. The pressure is mechanically reduced directly by the spring, making it possible to adjust the pressure precisely for each floor. The PRV can either be used individually with one on each floor or in a branch of a riser supplying 2-3 floors. The PRV is a rather simple way of controlling the pressure throughout a tall building. However,

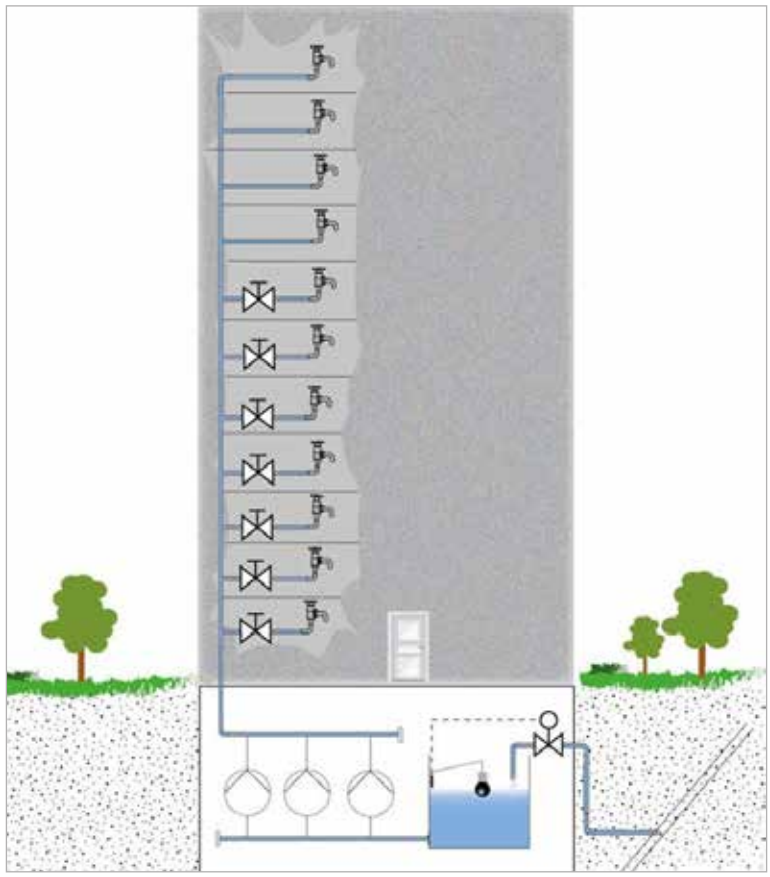
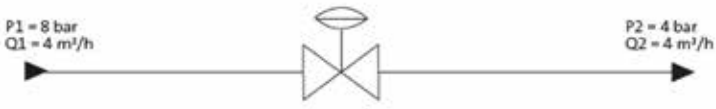


Figure-5: *Building with one branch per floor*

Example: Energy wasted in the pressure relief valve

The presence of PRVs will cause a waste of built-up pressure and thus energy. This is illustrated by a simple example.
A high-rise building needs pressure boosting from the basement floor. In the example, a maximum water tap pressure of 4 bar is allowed. However, due to the system layout, excessive pressure is present in the lower part of the system. This is dealt with by installing PRVs in main branches before the taps. Below it is illustrated how an excess pressure of 8 bar is reduced to the allowed 4 bar. The pipe will supply a water flow of 4 m³/h.



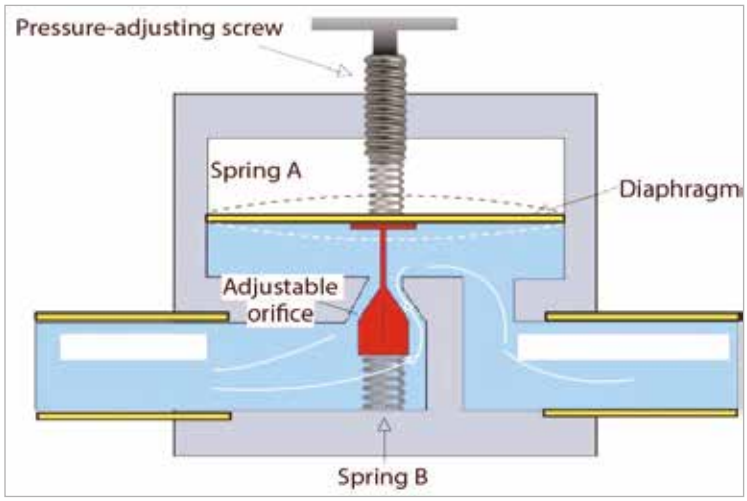
Available hydraulic power before the PRV:
$P1 = q1/3{,}600 \times p1 \times 10^2$
$P1 = 4\ m^3/h\ /\ 3{,}600\ s/h \times 8\ bar \times 102\ kPa/bar = 0.91\ kW$

After the PRV, the pressure is halved from 8 bar to 4 bar, resulting in only half the hydraulic power, P2 = 0.45 kW. As such, the PRV represents a power loss of 0.45 kW. Depending on the number of operating hours, this necessary excess pressure will potentially consume a lot of energy. For, e.g., 4,000 hours of operation per year, this PRV alone will 'consume' 1,800 kWh/year.

Table-2: *Energy wasted in PRV*

there are some disadvantages when using PRVs:

- Each PRV needed in the building layout, the capital cost increases.
- PRVs need maintenance and therefore they need to be placed at an accessible place.
- Each PRV represents a loss, because the energy used for creating higher pressure is wasted.
- Risk of pipe damage and flooding, if a PRV fails and lets high pressure into a lower graded pipe net. This article delves more on the various system layouts that are practically used in water distribution in high rise buildings, indicating its merits and demerits



Booster systems may be designed in several different ways with the elements described above. The layout to be chosen depends on many factors and the specific task in question, e.g. local legislation and traditions, flexibility requirements or the possibility for future expansions, etc. Any one layout system is not ideal for all scenarios.

The advantages and disadvantages of some the most used system layouts are described below.

Single Booster system

A single booster system is perhaps the simplest. It relies on a single set of pumps supplying pressure boosting from the basement to the point farthest away from the booster system. Basically, such systems may be configured with or without initial break tanks.

Single Booster System
Advantages
Only one riser needed (simple design)
No space required on upper floors
Disadvantages
Excess pressure on lower floors in buildings with more than ten floors (PRVs and high pressure graded pipes needed)

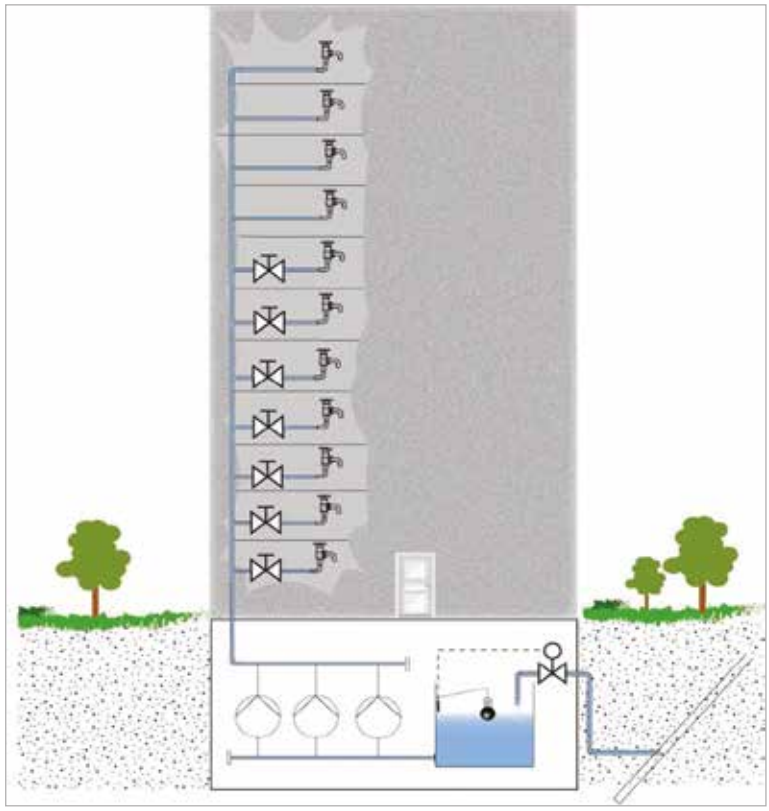


Figure-6: *Single Booster system with one branch per floor*

Zone-divided Booster systems (Figure-7)

The building is divided into pressure zones of ten floors or less with a booster supplying each zone from the basement through dedicated risers.

Advantages
Manageable pressure zones
Increased flexibility and security due to zoning
No space required on upper floors Low-cost operation due to no residual pressure
Disadvantages
Higher initial cost than single-zone systems
Higher static pressure in upper zones (high pressure graded pipes)

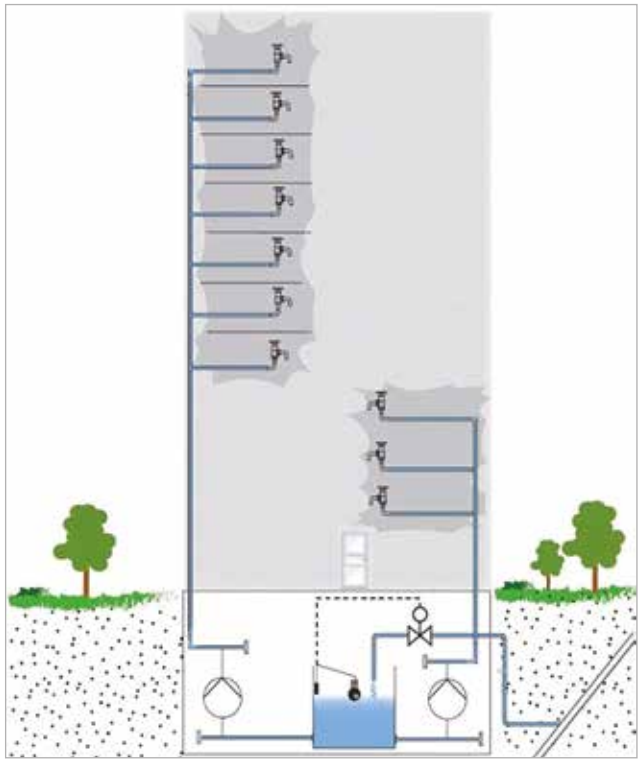


Figure-7: *Zone Divided System*

Overhead tanks with Terrace Booster system (Figure-8)

Overhead tank systems use a transfer pump in the basement to fill the overhead tank by a level switch-operated control. The solution requires pressure reduction valves on each floor if the building exceeds approximately 15 stories, to avoid unwanted high static pressure at the taps in the lower floors. It also requires a terrace booster to provide the top floors with the required pressure, as static pressure there would be too low due to insufficient geodetic height at the overhead tank.

Advantages
Mature Technology
Small booster power due to roof tank working as buffer
Reserve capacity in roof tank
Disadvantages
Higher initial cost than single-zone systems
High static pressure in upper zones (high-pressure graded pipes)

Table-3: *Overhead tanks with terrace booster*

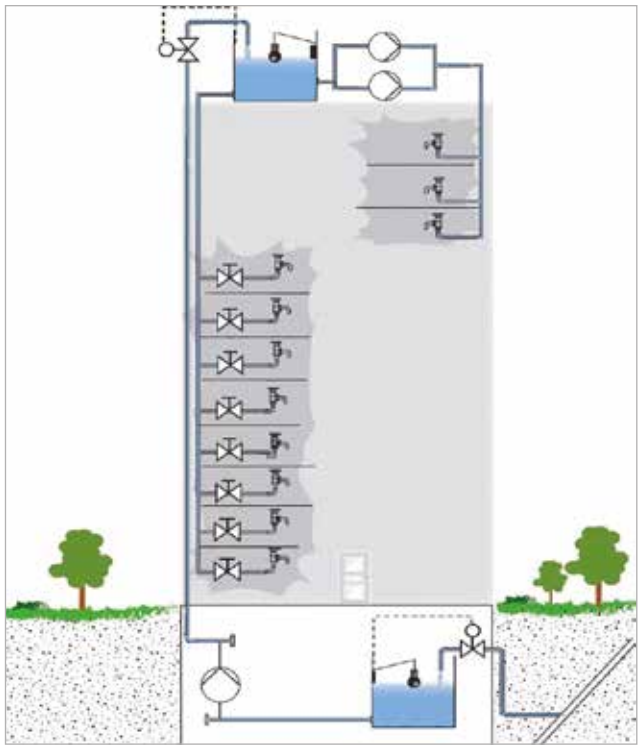


Figure-8: *Overhead tanks with terrace booster system*

Series-connected systems with Intermediate Break Tanks (Figure-9)

Series-connected systems with intermediate break tanks draw on several other systems, utilizing centrally-placed break tanks to supply both the taps, the tank's own boosting zone and all the zones above it. With this system (refer Table-4), a building is divided into smaller and more manageable pressure zones. Every zone is then served by its own booster set.

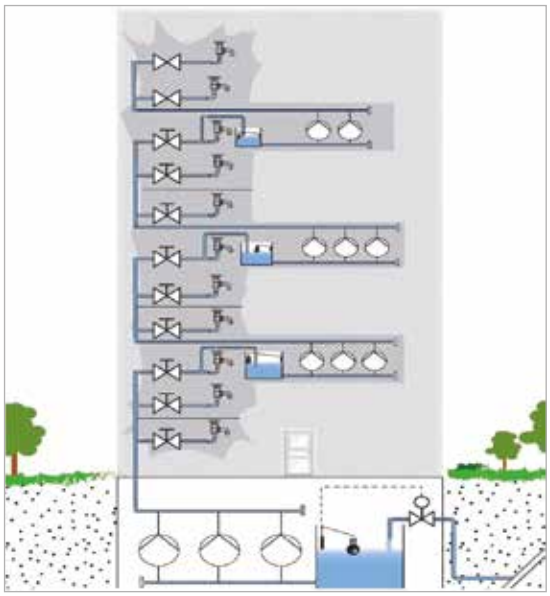


Figure-9: *Series-connected systems with intermediate break tanks. In this example, there are three boost zones.*

Advantages
Low pressure in each zone (no PRVs and less pressure-graded pipes needed)
Manageable pressure zones
Easy to size because each zone has its own supply tank
Disadvantages
Higher initial cost than single-zone systems
Space required for booster sets and tank on service floors
Risk of Microbiological growth in tanks Overhead tanks with terrace booster system

Table-4: *Series-connected systems with intermediate break tanks*

Series-connected systems Without Intermediate Break Tanks (Figure-10)

A series-connected system operates on

Advantages
Low pressure in each zone (no PRVs and less pressure-graded pipes needed)
Manageable pressure zones
No space required for tanks
Less excess boosting (low operation costs)
Disadvantages
Higher initial cost than single-zone systems
Space required for booster sets and tank on service floors
Complex control

Table 5. *Series-connected systems without intermediate break tanks*

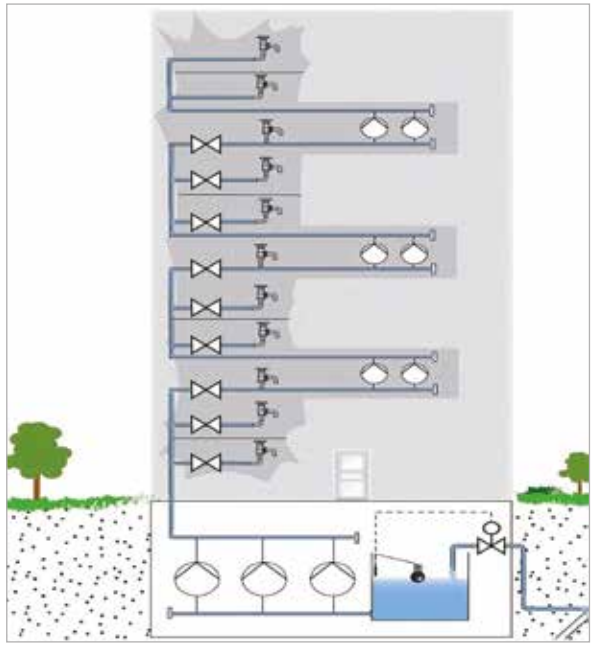


Figure-10: *Series-connected systems without intermediate break tanks*

the same principles as in system mentioned earlier, but without the intermediate break tanks. That enables an effective usage of power as the water is only pumped to the part of the zone where it is used and not past it. However, complete control is very important. When a consumer draws water on the upper floors, the booster systems must be able to deliver the water from the bottom of the building (Refer Table-5).

ILLUSTRATION

To illustrate the differences between the earlier system layouts in terms of the necessary hydraulic power (P4) and energy consumption (E4) for water transport in a high-rise building is given below.

Building Case

The example is an 80 meters tall building, comprising 19 floors and 5 different hydraulic zones as illustrated. The building footprint is 1,600 m2 (40 m x 40 m); Figure-11.

Each of the five hydraulic zones have different users and thereby different consumption profiles, operating hours, peak flow requirements, etc. These conditions are listed below in Table-6.

The zone weight-averaged load profile is shown in the graph which represents the combined water consumption pattern during a typical day (dark blue curve) for the whole building. Arranged as a cumulative load profile (light blue), the number of hours at different duty points are easily interpreted, Figure-12.

The total building peak flow demand is 46.8 m3/h. However, taking the load profile into consideration the peak flow is simultaneously corrected to 36.2 m^3/h.

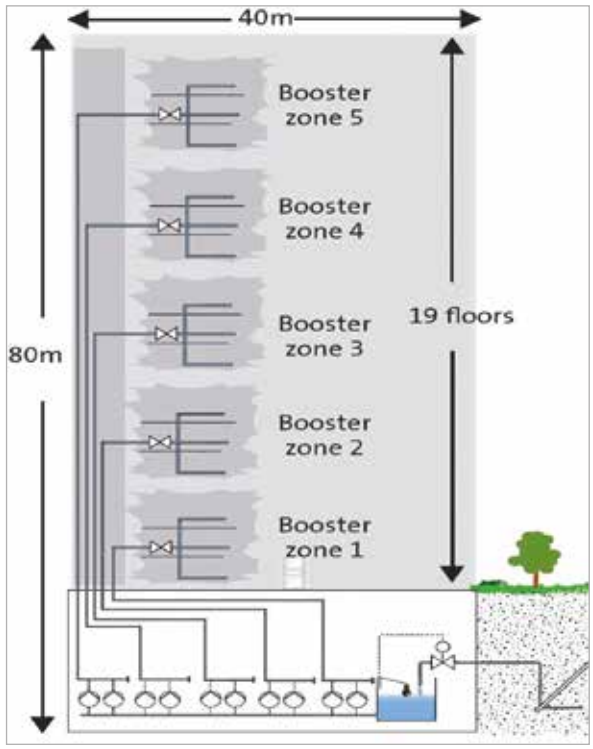


Figure-11: *The Building foot print is 1,600 m2 (40m)*

Evaluated booster layouts

- A: Single-booster system
- B: Zone-divided single booster system
- C: Single-booster system with roof top tank
- D: Series-connected booster system with intermediate break tanks in zones
- E: Series-connected booster system without break tanks

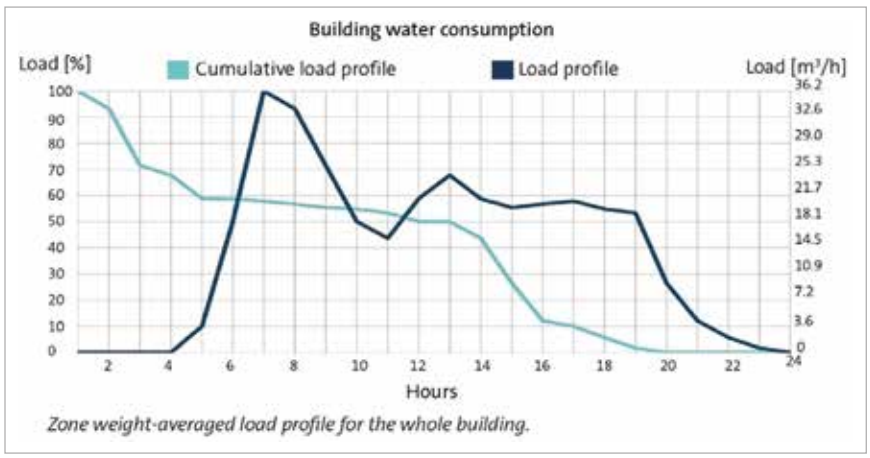


Figure-12: *Building Water Consumption Pattern*

In this example, layouts with tanks (C and D) are designed so that the tank capacity equals 4 hours of peak load. This corresponds to approximately 60% of the daily water consumption.

Booster zone	No. of floors	Zone height	Usage	Persons	Min. tap pressure	Peak flow
Zone 5	1 floor	4 m	Penthouse apartments	16 residents	200 kPa	0.3 m³/h
Zone 4	1 floor	4 m	Restaurant	160 seats	200 kPa	6.0 m³/h
Zone 3	7 floors	30m	Apartments	450 residents	150 kPa	8.3 m³/h
Zone 2	6 floors	25 m	Landscaped offices	640 employees	150 kPa	27.6 m³/h
Zone 1	4 floors	17 m	Shopping centres	100 employees	150 kPa	4.6 m³/h

Table 6: *Zone wise Water Consumption profile*

Hydraulic Booster size and Energy Consumption

The necessary hydraulic booster power (P4) and energy consumption linked to the building case varies per booster system configuration in question.

The result of a rough sizing is shown in diagram above. In this example, series-connected pressure boosting systems with break tanks requires the lowest boosting power and is closely followed by the roof tank solution.

However, choosing a zone-divided system, where each zone is supplied by its own booster system would reduce the annual energy consumption by approximately 10% and only require approximately 15% higher booster capacity. Additional benefits like eliminating the need of intermediate break tank, separation of system in hydraulic zones, etc. could easily make such systems favorable.

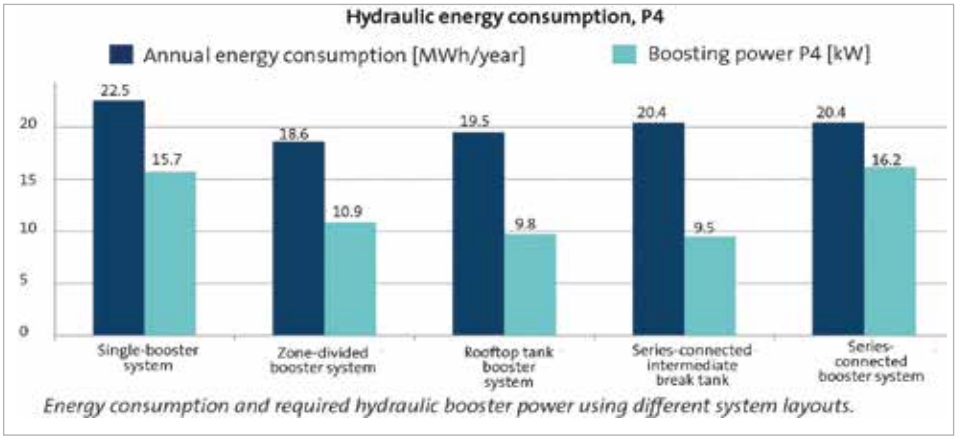


Table 7: *Hydraulic booster size and energy consumption*

Besides, equally important are the booster system controller's capabilities to address certain practical issues in high rise buildings, such as:

1. Avoiding surge in vertical pipe lines/ shafts through Soft fill functionality.
2. Proportional Pressure functionality to reduce higher pressures on pipes and fitting during low flow system conditions, and
3. Low flow stop functionality to avoid churning of pumps during low consumption periods.

Generally, major operating issues occur in high rise structures since these factors are not taken into consideration while designing the booster systems controls.

To conclude, a properly sized, zone divided booster system would be more efficient for the operating life of a high rise building when compared to other systems as discussed.

PRV SELECTION IN HIGH RISE - A BRIEF WALKTHROUGH

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Pressure Reducing Valves have been in use for various applications since the 19th century. The first PRV was about 2m high. Today, they fit right on the palm of a hand.

PRVs have become the heart of a plumbing system and their selection is extremely important. Apart from just the sizing criteria, that is covered later into this article, it's first important to select the right type. PRVs mainly come in 2 types of constructions:

1. Piston Operated, and
2. Diaphragm Operated.

The Piston Operated PRVs consist of the old-school type of construction that primarily has a piston moving vertically up and down to compensate for pressure differential with a spring tension feedback on a metal disc. This type became infamous and was widely used in the past - successfully, but what has changed? The Demand. By Demand here is meant the consumer demand in water systems that has changed greatly since 2010 in the country. With buildings getting higher and wider, the density distribution of apartments or consumption points has become much larger and that result in wide variations in demand through a single day.

As a result of varying demand, 3 main points arise.

1. Variating flow rates on the inlet side (mostly because Hydropneumatic pumps are used)
2. Variating inlet pressures
3. As demand increases and decreases, the pressure drop on the outlet varies.

The above are basic resultants, but they matter a lot to the core functioning of a PRV. To meet the above requirements, a piston PRV has no mechanism to counter or utilise such variations. The Piston PRV manufacturers are aware that variations in inlet flow rates and pressure are going to cause erratic functioning in the PRV. There is also no mechanism for these PRVs to adapt to variating outlet pressures - causing a calamitous dreadful problem - Water Starving.

Another problem, or rather a blind spot that is missed out, is the flow rate capabilities of the PRV. It is therefore firstly vital, that the designer selects the PRV sizing based on the flow rates namely:

1. Minimum flow (During Low demand)
2. Nominal flow (Moderate demand)
3. Maximum flow (High demand).

Each PRV's internal construction varies from manufacturer to manufacturer, but little to no thought is given to check the orifice of different PRVs. This directly relates to problems in water starving due to restricted flows, high pressure drops with varying flows and velocity accelerations - all of which are grave problems in a Water System.

The pointers and comparisons are to create awareness because a problem in PRV design and selection puts the entire Utility Service design at a risk and can cause it to malfunction.

The table gives a comparison with respect to flow rates between both the PRV Models for line sizes of 50mm, 80mm and 100mm. Larger diameter lines are taken for the example, as normally PRVs are installed on the ring main/ riser/ sub-riser

Line Size (mm)	**Piston PRV X**		**Diaphragm PRV**	
	Cv	Kv (cum/hr)	Cv	Kv (cum/hr)
50	20.8	18	52.7	45.6
80	31.25	27	64.1	55.4
100	45.13	39	100.2	86.6

Tble-1: *Piston vs Diaphragm PRV Flow Comparison*

The coefficient of Cv is used by Engineers to size the valves. In layman's terms you need an orifice which is big enough for the water to go through. If the orifice is too small, it can cause a pressure drop that makes the water drop below its vapour pressure. If the water drops below its vapour pressure there would be implosions that damage the valve trims and cause wear on account of Cavitation.

In effect, the actual flow rate begins to deviate from what is predicted using the flow coefficient equation for sizing the Pressure Reducing Valves. That is because the vapour bubbles occupy more volume as the mass of water expands during the phase change (liquid to vapour), creating additional resistance to flow. The vapour bubble formation in the restricted orifice prevents the flow from increasing any further. The effect is called Choked Flow.

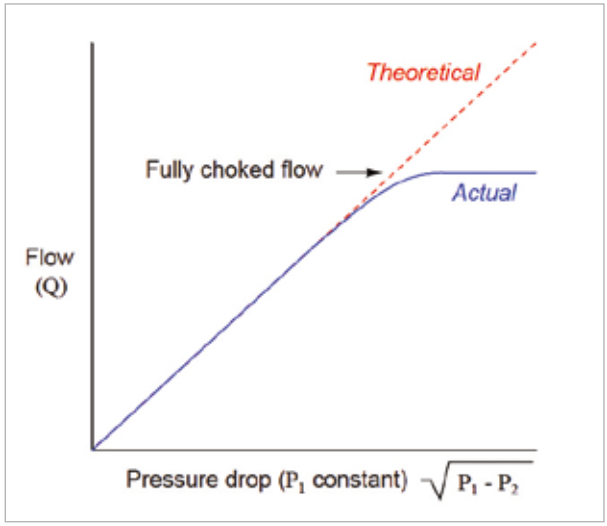


Figure-1: *Flow v Pressure Drop Curve*

The main take away from the above values is that using a PRV (even if the size is the same as the line size) whose functional flow limits are outside the actual consumption flow rates, there would be issues of velocity acceleration and high pressure drop that would result in water not reaching the farthest point, or in case of high demand - causing even more dire problems. The same case can be seen even if a PRV is manufactured with a reduced bore or has a much smaller opening on the inlet side. The cross section details of different types of pressure reducing valves are given in Figures 2, 3, and 4.

Figure-2: *Piston PRV with reduced ports*

Figure-3: *Diaphragm PRV with full bore, open ports and self-cleaning mechanism*

Conclusions & Suggestions

- A PRV's design must be based on the minimum and maximum flow rates.
- Cross-check the cross-sectional areas of the inlet, outlet and body of the PRV.
- The National Building Code of India 2016 Section 2 Part 9, stipulates that Diaphragm operated PRV be always used. The PRV is to be installed on the by-pass line and strainers provided before the PRV.
- For line sizes of 50mm and above, prefer a Pilot operated PRV that has a larger flow area and a feedback line for quicker response time to varying downstream pressures (directly proportional with demand).

Figure-4: *Typical full bore design with no reduced inlet or outlet ports (for sizes including and greater than 40 mm)*

- Consult the manufacturer for head loss-flow curves, cavitation chart and Cv values before incorporating into the design.

SMART WATER METERING FOR RESIDENTIAL COMPLEXES AND GATED COMMUNITIES

Amarendran Kamak
CEO
Micro System Foundations

With Water scarcity a reality, optimal usage of water is a necessity. Water is also turning into a "Pay per Use" commodity with several states making a start by billing consumers for water based on the amount provided. Water meters are being installed at the main inlets for the houses, multi-storeyed buildings and the gated communities. Currently the whole building or community pays for the water through their maintenance fund without any idea about the consumption pattern among the residents, leading to no awareness of water wastage. A smart water monitoring system would show the residents how much they were consuming and also how they were doing with respect to other residents and other societies. People would then definitely become more aware and contribute to optimise usage of water. This paper elaborates on an IOT based Smart Water Metering System using off the shelf available sensors and software.

Figure-1:

Figure-1 shows EQU A which is a structured **information system to** improve the accessibility,management and **water resources** within large urban housing societies and communities.

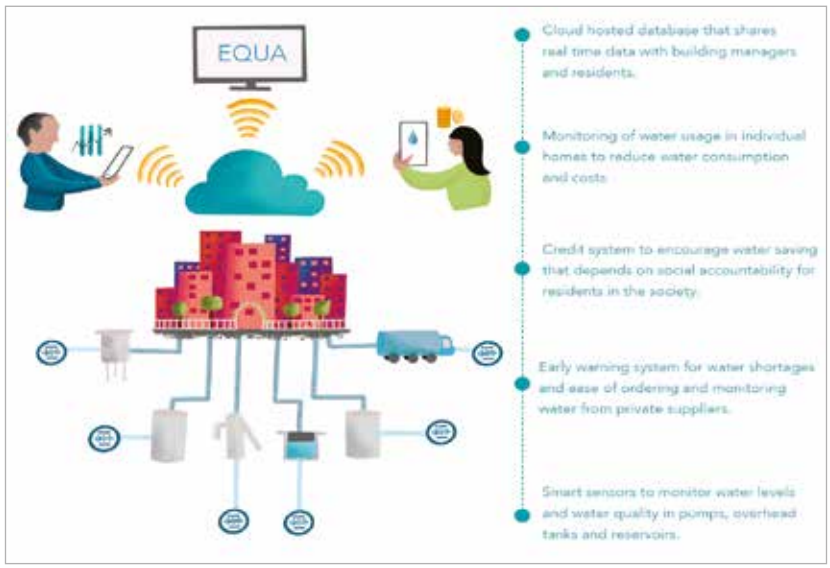


Figure-2: *Advantages of having a Smart Water Meter system in Residential Complexes.*

Figure-3 shows the stakeholders in a Smart Water Metering System. The municipal corporation which provides the water through the pipelines at specified times, the tankers whose water is bought by the community when it requires them, the building manager who manages the water for the community and the resident who consume the water and pay for it.

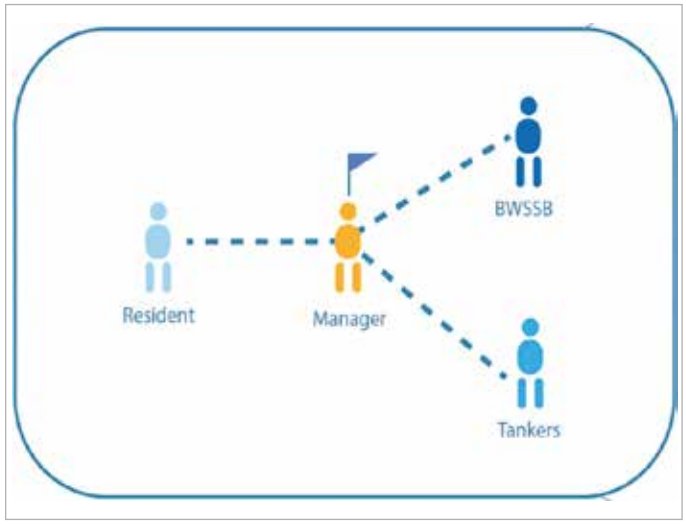


Figure-3: *The stakeholders in a Smart Water Metering System*

The Building Manager is the central figure (Figure-3) who control sall the internal water supply for all the buildings in the complex. The Building Manager needs to know the quantity of water available in the fresh water and the recycled water underground tanks, the water available in the overhead tanks, the quality of the water and along with the average expected consumption over the day along with the current consumption. This would help the Building Manager to plan the pumping operations and also order tankers if and when necessary. Investigation can be done for excessive consumption in the building to see if there are leaks which need to be dealt with. The overall intake can be balanced with the outgo and billing done automatically based on proportionate usage basis at the end of the month by the system.

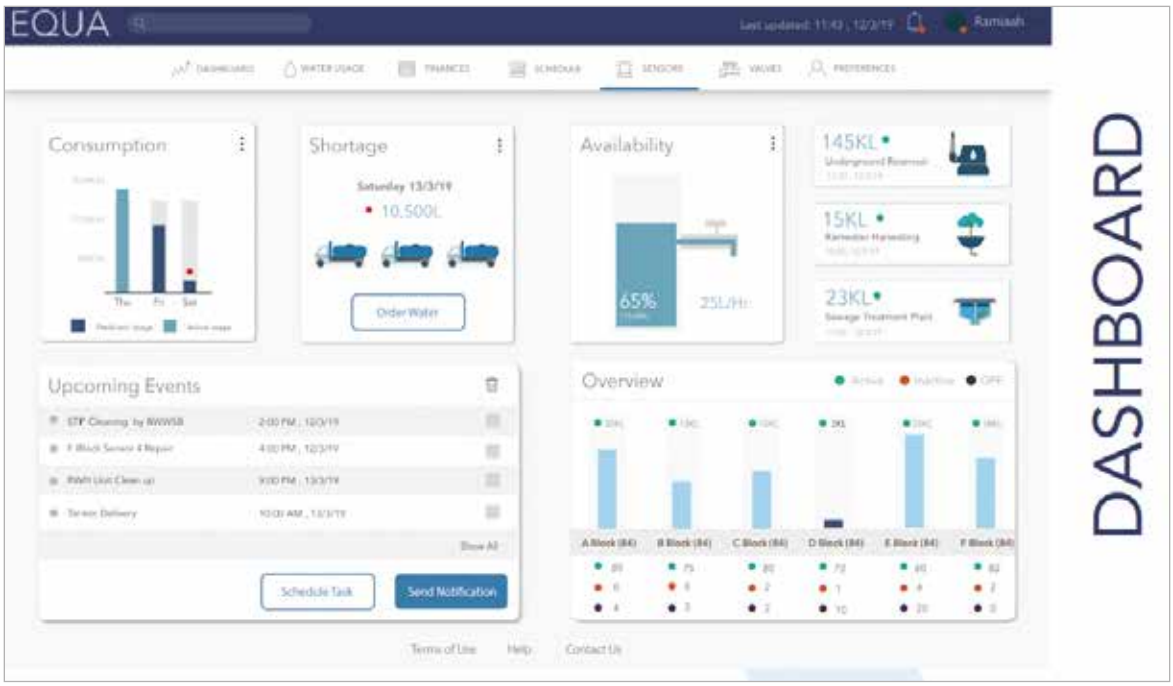


Figure-4: *A Overall Dashboard for the Building Manager providing total accountability for the water*

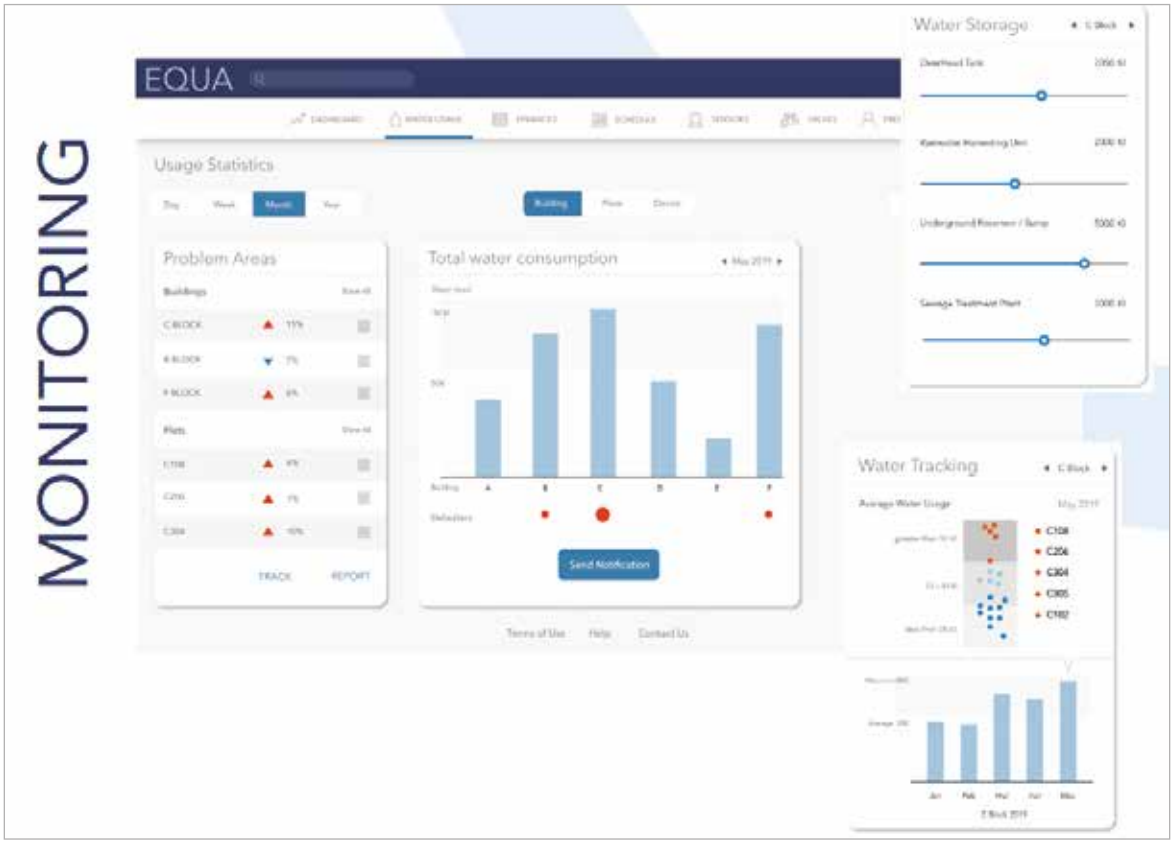


Figure-4: *B Monitoring Dashboard for the Building Manager providing total data for the water*

For the Residents it is essential to understand what is the per person usage of water in their household. They would be provided with an App on their mobile to display a Dashboard for them to track their Water Usage, get Billing, compare themselves against the average usage in their building and other buildings, get incentives for being conservationists. Only the actual consumption shown on day to day and month on month basis would drive home the point of water conservation. Comparisons with neighbours in a building, across buildings, across societies would raise a healthy competitiveness to reduce water consumption. TV's in reception areas of buildings could show the consumption trend, leader board for the flats having lower consumption. Credits can be generated for users consuming less than the average.

Figure-5: *Dashboard for the Residentfor the water*

Sensors & Automation Hardware for Smart Water Metering

Sensors are the heart of an automated system for collecting and feeding data. The data which needs to be monitored are:

Sensor Inputs (Flow & Quality)

- Tanker Output sensor
- Rain Water Harvesting Tank Level Sensing
- SUMP level
- Municipal Corporation Incoming Line Flow
- STP Output
- OH Tank in each Building - Level
- Borewell Water Underground Tank Level
- Apartment Inlet Line Fresh Water – Flow Sensor
- Apartment Inlet Line Recycled Water – Flow Sensor

The type of sensors used for monitoring the above parameters are described below.

Apartment Water Meters: These water meters are very accurate and can be inserted in inlet lines in the water room on each floor for all the flats of that floor. The meter provides a pulse output which is captured by the WiFi based IOT device which can take upto 8 Pulse inputs from the water meters of that floor.

"In multi jet water meters *the principle of operation is to force the passage of the inlet water flow through a series of ducts open in a capsule called distributor, containing the turbine. The dry dial water meter has the reading mechanism hermetically separated from the water flow chamber"*

General Specification

- 1 m^3= 1000 Litres
- Flow Rate: 0.0156 m3/hr – 3.125 m^3/hr
- Working Pressure: 16 bar
- Reading Resolution:
- Output: 10 litres/pulse
- Line Size: 15 – 32 mm dia.

Figure-6: *multi jetwater meters*

Water Meters for Measuring Water from Corporation Water Inlet pipes & Tanker Output

*"Construction principle Similar to **multi-jetmeters, Woltman** meters measure the velocity of the water flowing through with the help of a turbine. The rotation of the turbine is transmitted through a worm gear to the dry dial counter"*

General Specification

- Suitable for all positions (Horizontal, Vertical Inclined)
- MID approved
- Low Head Loss. Good measurement at initial starting.
- Line Size: 65 – 250 mm dia.

Figure-7: *WOLTMAN type Water Meters*

Ultrasonic Sensors for Underground Tank level Measurement

***"Ultrasonic level sensors** work by the "time of flight" principle using the speed of sound. The sensors ends pulses toward the surface and receives echoes pulses back. Basically, the trans mitter divides the time between the pulse and its echo by two, and that is the distance to the surface of the material."*

As this is a non contact kind of measurement it is suitable for underground tank and overhead tank level measurements.

General specifications

- Sensing range 350 - 6000 mm
- Adjustment range 400 - 6000 mm
- Dead band 0 - 350 mm
- Output: 4-20 mA

Figure-8: *Ultrasonic Tank Level Sensor*

Communication of the sensors to Cloud

All the data from the sensors collected from the tanks and apartment inlet lines have to be sent to a cloud over the internet. Considering that all modern complexes and gated communities have WiFi infrastructure, it would make sense for the sensors to be IOT' fied with WiFi devices like the one below for publishing the data to the cloud for display on the Dashboard followed by Analytics.

Specification

- 802.11 n/g/n, WiFi 2.4 GHz , supports WPA/WPA2
- Integrated Low Power 32 bit MCU
- RTC with Battery
- Store & Forward facility when Network Absent
- Built in 11.1 V 1100 mAH Li-ion rechargeable battery (stores consumption when there is no power)
- Configurable upto 8 Pulse Inputs (0 – 3 khz)/ 4 x 4-20 mA
- Suitable for Hall Sensor 3-wire NPN or Reed Switch 2 –wire
- Power: 230 VAC
- Enclosure: ABS, IP65, Wall Mount
- WiFi Antenna: Internal
- Protocol: MQTT

Figure-9: *WiFi Device*

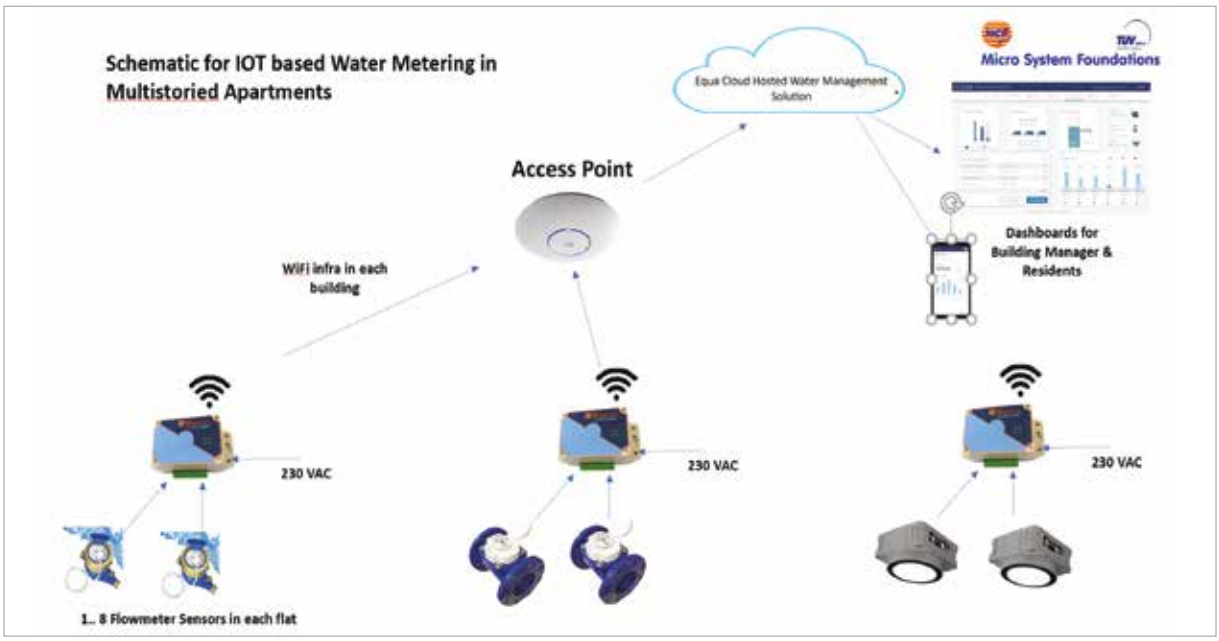


Figure-10: *Schematic for IOT based water metering in multistoried apartments*

The system can be expanded to include STP/ETP data and water quality data like PH, Conductivity, and BOD.

Acknowledgement

Ms. Madhushree Kamak, Masters in Information Design (NID) for the Software Visualisation Designs (Copyright Owner) Mr. Piyush Tewari, Founder of Pyro -Engineers Pvt. Ltd., which specialized in Fire Protection Systems, Plumbing System and Mechanical Systems (Water Treatment Plants , Diesel Storage Systems , Boilers , Compressed Air Systems etc) for the inputs on doing a complete Water monitoring project .

MODELS FOR WATER SUSTAINABILITY

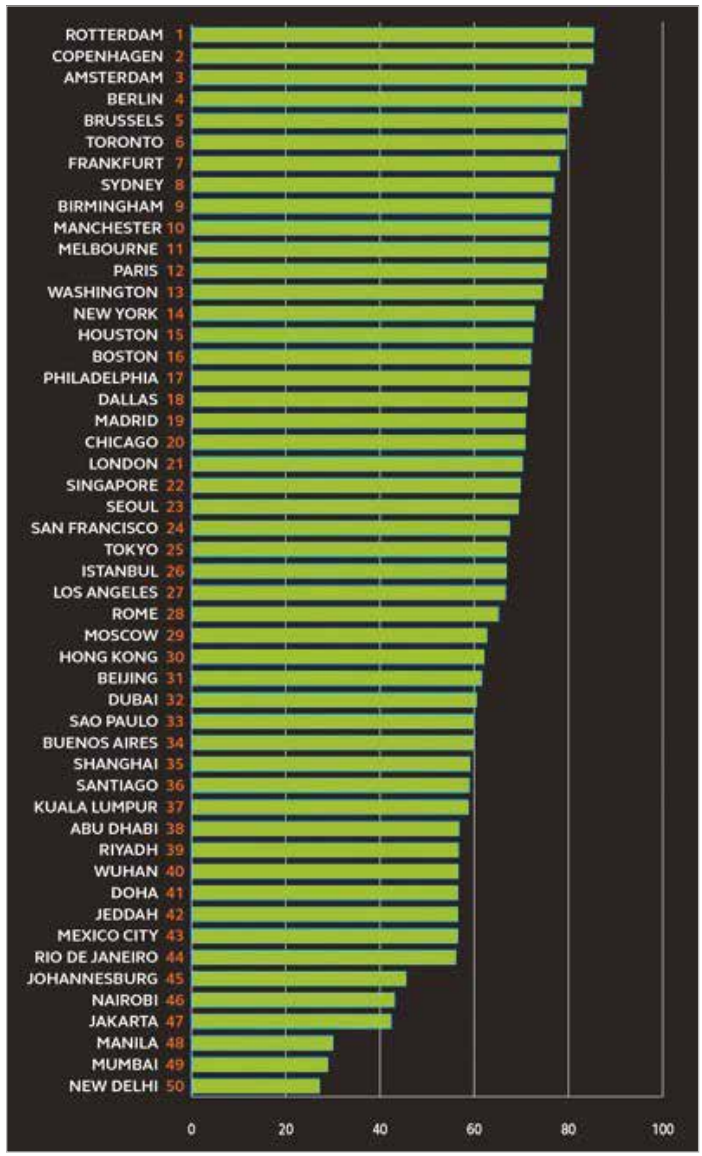
Ajay Kumar Singh
CEO
Enviro (A unit of Vatika Hotels Pvt. Ltd.)

Water sustains life on Earth yet its significance isn't quantifiable. It's the largest natural resource, constituting 71% of the planet's surface. However, only 3% of it is freshwater; of that just 1/3rd is accessible for use in agriculture and cities. The remaining is either in the form of glaciers or it's too deep underground to be extracted.

Aquifers are the main source of water for over 2 billion people. With increase in global fresh water consumption, over half of the world's largest aquifers are depleting. Moreover, the future demand causes a major threat to freshwater reserves needed to ensure basic water, food, and energy security as they are predicted to drop by 40%. According to the Nature Conservancy study, one in four large cities is water-stressed and watersheds are outstretched beyond their physical footprint.

Sustainable Cities Water Index

According to the Brundtland Commission, Sustainable Development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".



The Arcadis Sustainable Cities Water Index (2016) was based on the assessment of 50 cities across the world "by the stewardship of their water across issues impacting their water resiliency, efficiency and quality". Every city included in the index had a distinctive water relationship to shape their urban character and define their commercial identity and market competitiveness. The study highlighted the importance of water as an urban asset critical for long-term success, economic development and overall sustainability. In the Arcadis Report of 2016, Mumbai and New Delhi ranked lowest in the table with their water sustainability as 29% and 27.3% respectively.

Global Scenarios

- More than 1.7 billion people are living in river basins where the water use exceeds recharge, thus leading to toxicity of rivers, attenuation of groundwater and the degradation of ecosystems.
- With rapid development and growing populations, global water demand (in terms of withdrawals) is projected to increase by 55% by 2050. Although by 2025, two-thirds of the world's population could be living in water-stressed countries if the current scenarios persist.
- Inadequate delivery of water and sanitation led to economic loss that was estimated as 1.5 % of Gross Domestic Product of the countries included in a WHO study on meeting the MDGs (Millennium Development Goals).
- More than 80% of wastewater is discharged without treatment.
- The most economically and socially destructive of all natural disasters are water-related natural disasters. Floods, droughts and storms have affected 4.2 billion people (95% of all people affected by disasters) and caused USD 1.3 trillion of damage (63% of all damage) since 1992.

Resilience

Adoption of best Plumbing practices

- Designing and application of Dual Plumbing system.
- Plumbing hardware like pipes and fittings should be applied to prevent recurring breakdown of systems.

Rainwater Harvesting

The collection and storage of raindrops can be done, for future use, instead of allowing them to go waste. Redirection of rainwater collected from rivers, lakes, ponds, roofs or other acceptable sources should be done or could also be collected from dew with nets or other tools. The water collected could be used for several purposes inter alia including potable for humans and livestock with proper treatment where necessary, other domestic use, irrigation, and many more. It can also be used for long-term storage and for groundwater recharge.

The system of rainwater harvesting would help alleviate the adverse effect caused by the flood caused because improper channelling and storage of rainwater.

It would also reduce the depletion of available groundwater.

Plumbing Appliances, Fittings and Fixtures

The plumbing appliances, fittings, and fixtures are now being designed to dispense controlled supply in order to minimise wastage. However, their deployment still needs to be made mandatory in order to derive the maximum savings.

Water Treatment Systems

With continued depletion of groundwater and the sources of raw water reducing, the quality of raw water has also decreased with time. Silt and mud are often found in the raw water sources, which are not only a hazard for human health but also the plumbing systems. Silt, mud and the silica in it causes attrition damage to the pipelines, pumps, filters, and other parts of the water conveying systems and also to other assets installed.

In order to prevent the silt and mud causing harm to the humans and livestock the water is suitably treated before being supplied for consumption or other use. Since treatment of water involves a cost that makes the water precious its use needs to be done judiciously. To adhere to the sustainable approach, water for flushing and other uses is supplied from recycled wastewater, and thereby reduces the load on the freshwater sources.

Water in Cooling Towers

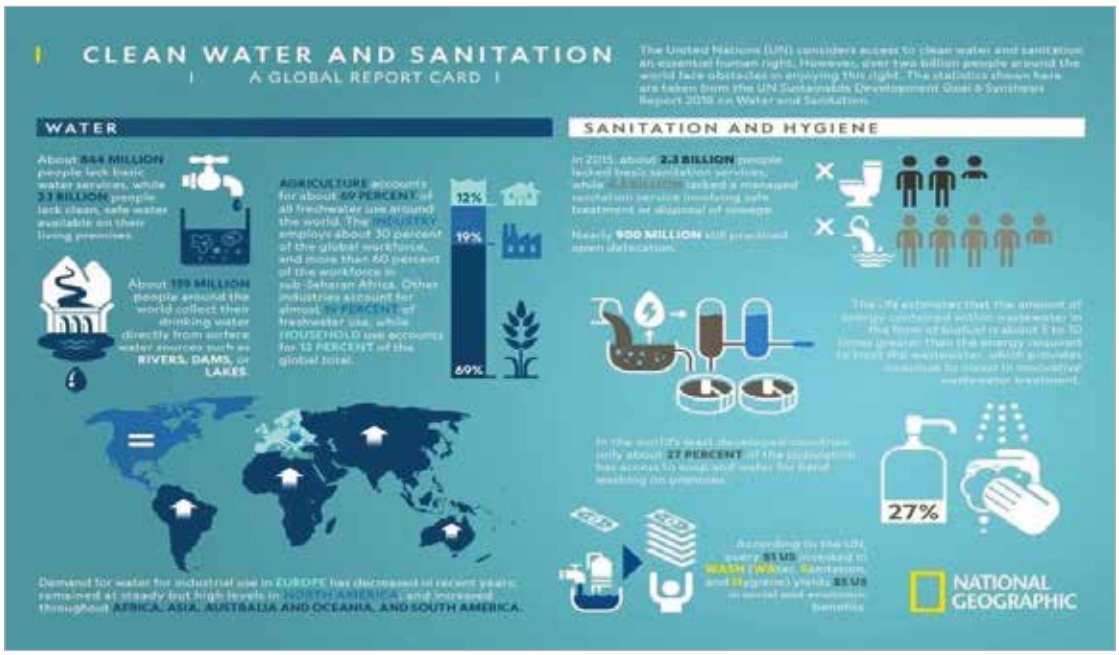
The use of providing conditioned air to habitable buildings is ever increasing and with it the demand for heating or cooling water. Boilers and Cooling towers are thus inevitable and call for more efficient use of water.

For Cooling Towers that could be achieved by:

- Maintenance of optimum Cycles Of Concentrations (COCs)
- Automation of Cooling of water for superior control and reduced water usage
- Proper maintenance of cooling towers

For boilers, water consumption could be reduced by:

- Recovering and recycling the condensate
- Optimizing the cycles of operation



Recycled Water from Sewage Treatment Plant

Most communities have realized that alternate sources of water resources such as treated effluent within their jurisdiction (which may be from their own wastewater recycling plant) have a lower unit cost (present value Rs./kl supplied or saved) and assured availability compared to fresh and raw water.

Apart from the advantage of availability of additional water resource, there are more specific advantages of using recycled water. Research papers show that utilization of treated wastewater cause an increase in the yield of agricultural produce as compared to irrigation with the well water. Similar benefits are also seen on landscape flora. [Erfani et al. (2001)]. These methods are most efficient when wastewater is available near the areas where the demand is the greatest, thus eliminating the high economic, environmental, and energy costs of diverting untapped surface water and transporting it over long distances. The beauty of recycled water is it does not vary much. Thus resulting in a fixed guaranteed water source.

Conclusion

Sustainable Water Management would ensure that all the new water supply comes from existing supplies with the use of technology and sustainable thinking and habits. The purpose of water use should appertain to three ultimate goals of economic feasibility, social responsibility and environmental integrity.

Models should be framed based on conservation, stewardship, and sustainability with efforts on accelerating transformations. Thus, it's imperative that with collaboration we give back to the community and nature altogether.

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5. Sustainable Cities Water Index, 2016, Arcadis

Enviro is managing Sewage Treatment Plants at 25 sites – 13 internal and 12 external sites having a capacity of 7945 kld. The maximum working capacity of each is 1500 kld. The recycled water is used for several purposes such as horticulture and construction purposes.

6 STPs are being installed with 9225 kld capacity. The STPs provide 600 kld of recycled water daily for horticulture and flushing thereby conserving precious natural resources. 404 Rainwater Harvesting Pits have been constructed across all Vatika Sites. With the rainwater harvesting around 502 cum (17,732 cft) of water was fed back to recharge the groundwater table.

RAINWATER HARVESTING FOR STORM WATER MANAGEMENT

A K Sharma
Managing Director

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Director

Empire Tubewells Pvt. Ltd.
Uniquo Infra Pvt. Ltd.

WHAT IS STORM WATER?

Storm Water may be defined as water running off a land surface before it reaches a natural water body. It occurs when the rate of precipitation is greater than what can infiltrate, or soak, into the soil. Runoff also occurs when the soil is saturated. Runoff remains on the surface and flows into streams, rivers, and eventually large bodies such as lakes or the ocean.

What is Storm Water Management?

Storm Water Management is the effort to reduce runoff of rainwater or molten snow into streets, lawns and other sites and the improvement of the water quality. In urban and developed areas, impervious surfaces such as pavement and roofs prevent precipitation from naturally soaking into the ground. Instead, water runs rapidly into storm drains, sewer systems and drainage ditches and can cause flooding, erosion, turbidity (or muddiness), storm and sanitary sewer system overflow, and infrastructure damage. However, stormwater design and "green infrastructure" capture and reuse stormwater to maintain or restore natural hydrology.

Detaining stormwater and removing pollutants are the primary steps involved in storm water management. Previous Surfaces that are porous and allow rainfall and snowmelt to soak into the soil; Grey infrastructure, such as culverts, gutters, storm sewers, conventional piped drainage, soak wells, and Blue/ Green infrastructure that protect, restore, or mimic the natural water cycle, all play a part in storm water management, whose objective is to mitigate impacts on properties, infrastructure, human health, and the environment.

Effects of Urbanisation

Rapid Urbanization has led to increase in runoff rates due to increased impervious areas, and replacement or filling up of natural watercourses and overland flows. This high uncontrolled discharge of storm water can:

- Have a significant impact on water quality and public health: storm water runoff can include a variety of pollutants such as sediments, litter, bacteria, organic nutrients, hydrocarbon, metal, oil and grease, pesticides and acids, and
- Put people at risk, and cause erosion of land and damages to property and infrastructure.

The focus of the storm water strategy in urban areas must be on alleviating existing and preventing future problems through careful design and planning of complementary drainage networks. Successful affordable management of storm water needs a long-term coordinated approach to integrate best practice as well as community and business involvement along with education programmes.

RAINWATER HARVESTING FOR STORM WATER MANAGEMENT

Before jumping onto the concept of rainwater harvesting, it will be fruitful to dwell on the importance of storm water management. Storm water should be understood as a resource. Diversion of storm water has a series of advantages, including financial, over traditional approaches to storm water management, which usually gave priority to costly network constructions. "Water Sensitive Urban Design" or "Low Impact Development" (LID) are approaches to urban planning and design which integrate management of the total water cycle into urban development. The approach also includes methods such as porous pavements, infiltration and rain harvesting systems, swale and wetlands, which should be incorporated in development of new and upgrades of existing infrastructure.

Urban centres in India are facing an ironical situation today. On one hand there is acute water scarcity and on the other, the streets are often flooded during the monsoons. This has led to serious problems with the quality and quantity of groundwater.

This is despite the fact that all the cities receive good rainfall. However, the rainfall occurs during short spells of high intensity. Most of the rain falls in just 100 hours out of the 8,760 hours in a year. Because of such short duration of heavy rain, most of the rain falling on the surface tends to flow away rapidly leaving very little for recharge of groundwater. Most of the traditional water harvesting systems in cities have been neglected and fallen into disuse, worsening the urban water scenario. One of the solutions to the urban water crisis is **rainwater harvesting** - capturing the runoff. This is practiced on a large scale in cities like Chennai, Bangalore, Mumbai and Delhi where rainwater harvesting is a part of the state policy and mandated vide their building regulations.

Why to Harvest Rainwater?
In areas where there is inadequate groundwater supply or surface resources are either lacking or insufficient, rainwater harvesting offers an ideal solution.
Helps in utilising the primary source of water and prevent the runoff from going into sewer or storm drains, thereby reducing the load on treatment plants.
Reduces Urban Flooding
Recharging water into the aquifers help in improving the quality of existing groundwater through dilution.

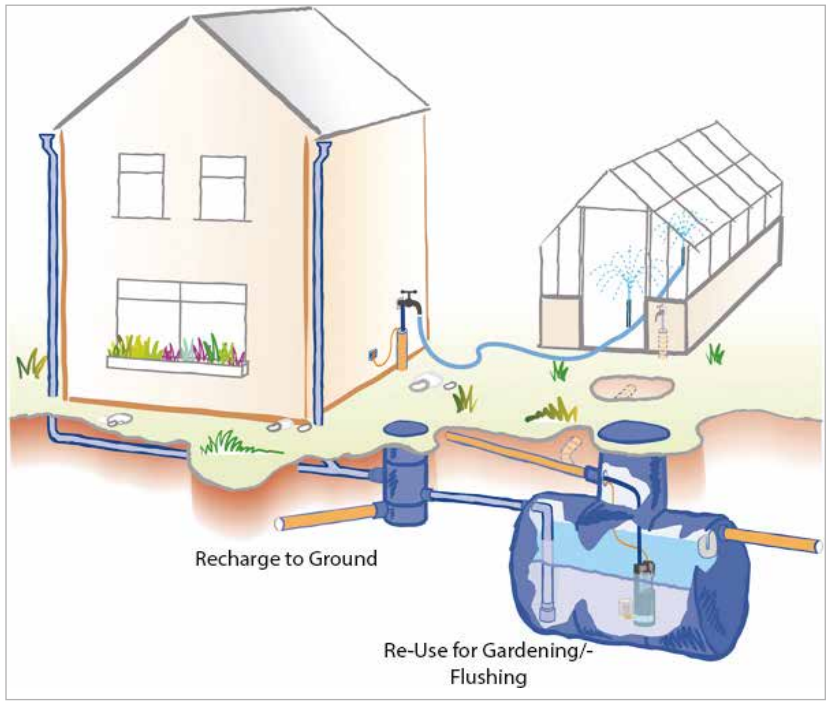
Rainwater Harvesting Systems

Broadly rainwater can be harvested for two purposes:

- Storing rainwater for ready use in containers above or below ground, and
- Charged into the soil for withdrawal later (groundwater recharging).

The water can be harvested from rooftops, paved areas, water bodies and storm water drains. A rainwater harvesting system comprises components of various stages - transporting rainwater through pipes or drains, filtration, and storage in tanks for reuse or recharge. The common components of a rainwater harvesting system involved in these stages are elaborated below.

- **Catchments:** The catchment of a water harvesting system is the surface which directly receives the rainfall and provides water to the system. It can be a paved area like a terrace or courtyard of a building, or an unpaved area like a lawn or open ground. A roof made of reinforced cement concrete (RCC), galvanised iron or corrugated sheets can also be used for water harvesting.



- **Conduits:** Conduits are pipelines or drains that carry rainwater from the catchment or rooftop area to the harvesting system. Conduits can be of any material like polyvinyl chloride (PVC) or galvanized iron (GI); materials that are commonly available.

- **Filtration Systems:** The filter is used to remove suspended pollutants from rainwater collected over roof. A filter unit is a chamber filled with filtering media such as fibre, coarse sand and gravel layers to remove debris and dirt from water before it enters the storage tank or recharge structure. Charcoal can be added for additional filtration.

- **Storage or Recharge Structures:** For the purpose of reusing the rain water or to create a buffer between the filtration system and recharge structures, tanks are built. There are various options available for the construction of these tanks with respect to the shape, size and the material of construction. Whereas, to recharge the water into the ground, recharge structures are constructed.

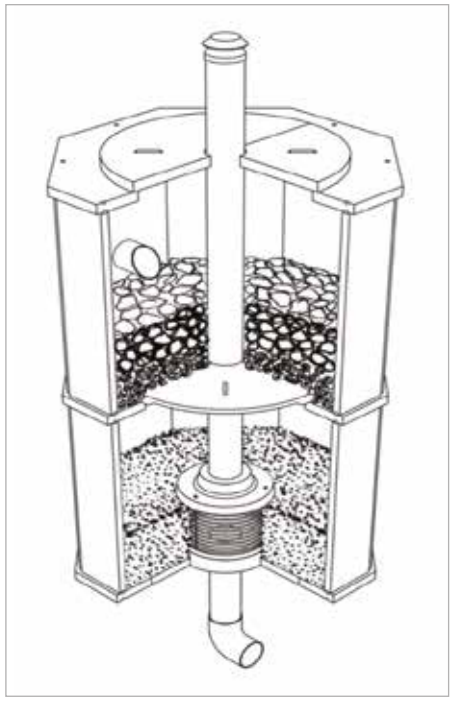


Figure-1: *Patented Rainwater harvesting system from Furaat*

Modern Rainwater Harvesting Systems and Approach

With the rainwater harvesting becoming a necessity with rapid urbanisation, the solutions for it are becoming modern and modular. The conventional filtration pit has now been replaced with modular filters, which help maintain the system filtration degree intact, and help avoid wastage of filtration media. These systems need lesser maintenance in comparison to the known conventional filtration pit designs.

Rainwater Harvesting under CSR Programmes

It is indeed a positive indication that many industries and developers are also concerned regarding natural resources. However, the environment is deteriorating at an alarming rate as its impact is clearly seen on bio-diversity and agriculture on human health.

Issues related to the environment need initiatives not only at policy level but significant action at implementation/ micro level. Every individual/ institution/ organization needs to take up this social responsibility by curbing wastage of all forms of energies. Conservation and sustainable usage of natural resources and renewable energies can take the world out of this grave situation.

One CSR project was for Glaxo Smith Kline, Sonepat (GSK), where surveys were conducted to determine the possibility of harvesting rainwater in neighbouring schools. After the surveys, a rainwater harvesting design was proposed to help the schools in managing storm water flooding.



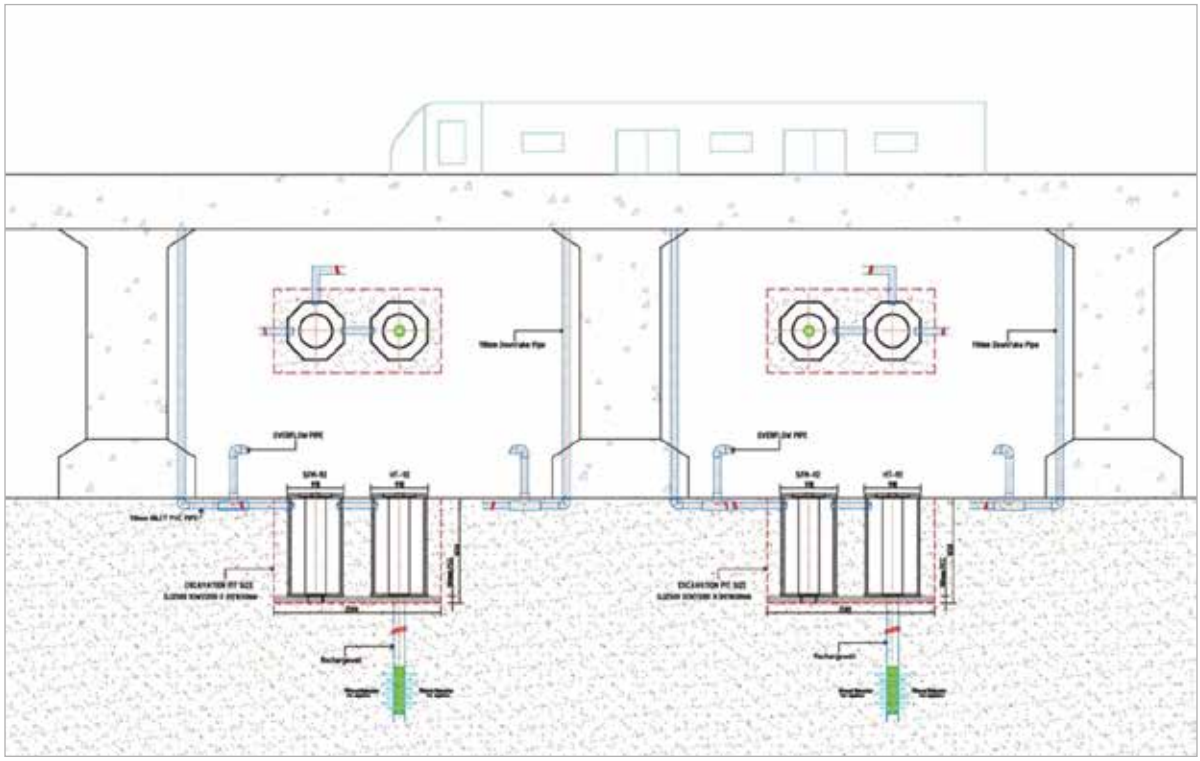

The project was then initiated wherein the rooftop water was diverted via pipe network to a filtration unit, after which was used to recharge to the ground via soakwells. That helped resolve the storm water flooding at schools during the monsoons.

The project also helped create awareness amongst the students which was praised by the school principal. The systems were installed in 2016, and the maintenance work is being done 4 years later as the systems are pretty effective in handling water filtration without chocking.

Ease of Installation/ Management of Modular Systems

Storm water Management in Metro Rail & Stations

Due to the ease of installation, the Fura at Modular System is being widely accepted in Metro Rail installations. The systems are being used to harvest water from the metro lines and also from the stations. Not only are these systems easy to install, but are also easy to maintain.



These systems have been successfully commissioned in Metro developed by Noida Metro Rail Corporation (NMRC). The systems have been installed between every two pillars. Besides, there is an array of systems installed at every Metro Station to take care of the stormwater from the stations. DMRC too has used these systems in their existing stations and has acknowledged the system's success in their internal water policy circulations.

The system is also being considered by Lucknow Metro Rail Corporation (LMRC).

Conclusion

Water, needless to say is an important form of energy in our industrial world. Hence everyone must control its wastage and conserve water in every possible way.

With increase in urbanisation and popularity of Rainwater Harvesting, many companies have started to take up rainwater harvesting as a part of their CSR initiatives. This is a small but noble step in restoring the ground water levels in urban areas. However, there is still a huge gap that needs to be filled when it comes to the design efficiency and maintenance of the installed systems.

IDENTIFICATION OF FIRE HAZARDS OF BUILDING SERVICES

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Fire Adviser DG FS,CD & HG
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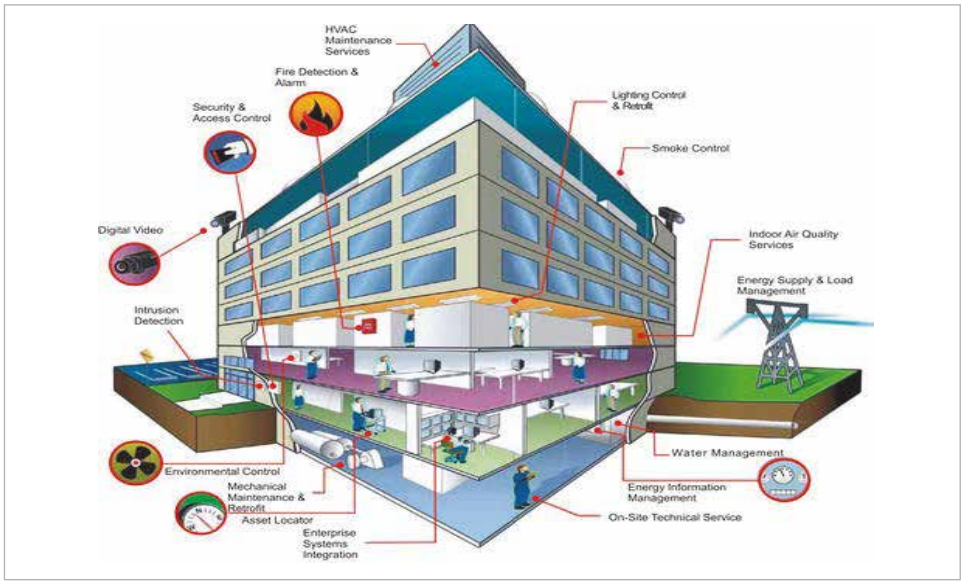
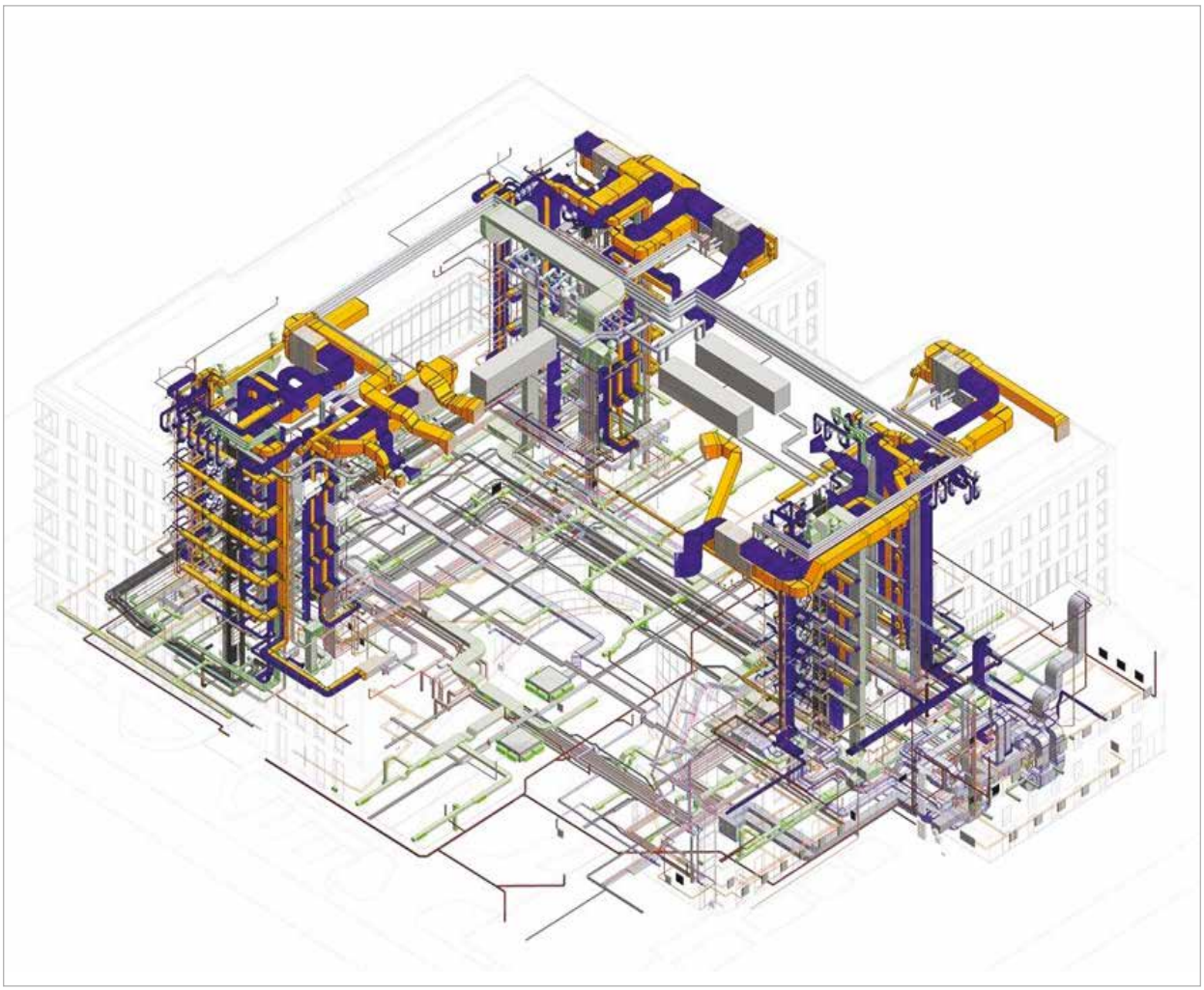
Fire Safety Engineer

1 Introduction

A variety of building services are required to be provided for meeting the functional requirement of buildings and bring it to life. These services include:

a) Electrical system and appliances,
b) Heating systems and appliances,
c) Air-conditioning and ventilation systems,
d) Air moving equipment,
e) Gas supply and appliances,
f) Refuse handling systems and equipment, and
g) Miscellaneous building services, such as lift, escalators, communication, plumbing and service chutes and chases.





It may be necessary to provide one or more of these services for each building or group of buildings, depending upon the occupancy, floor area and height of the buildings. Each one of these services contributes to the overall fire hazards of the building. With a view to mitigating the increase in the potential hazard, it is necessary to assess the fire hazards of the building services. A particular service may or may not cause an outbreak of fire but it may have a capacity to aid the spread of fire, smoke and fire gases.

The hazards that can be caused by each of the building services are briefly discussed below.

2 Electrical Systems and Appliances

Properly designed, installed and maintained electrical systems are convenient and safe. However, any shortcoming in any of these three aspects may lead to a fire or personal injury or fatality. The risks associated with electricity vary from its generation to distribution and actual consumption. All possible safety measures are generally taken at the generation stage. The distributions mains are usually in the open and do not, therefore, present much hazard but trouble starts at small sub-stations where the transformer may get overheated and cause a serious fire due top sub-standard meter for wiring of installation, unsuitable/ sub standard/ defective fittings and appliances.

2.1 Major Electrical Plant & Equipment

A. Transformers and electric sub-stations: – To prevent the fire from spreading, it is essential that:

a) Electric sub stations, transformer and switchgear are housed in detached buildings, but, when housed within the building, must be separated from the rest of the building by fire-resisting enclosures (walls, floor and roofs);

b) no substation or switchgear, with apparatus having more than 2000 litres of oil may be ordinarily located in a basement where proper arrangements for drainage of oil cannot be provided;

c) if the electric substation is housed in the building below ground level, it must be located in the first basement at the periphery;

d) entrance to the electric substation inside a building must be provided with a fire resisting door/ roller shutter;

e) where an electric substation is housed in a basement suitable height must be provided at its entrance on the basement side to prevent the flow of oil from a ruptured transformer into other parts of the basement and must have a direct access from the outside;

f) the transformer should be protected with proper detection and suppression system like Water spray, Nitrogen and Halon based systems and other preventive methods as stipulated in CEA notification;

g) oil filled transformer(s) must not be housed on any floor above the ground floor;

h) no drain should communicate between different compartments of the electric substation and each compartment of the electric substation must be independently ventilated;

i) where a transformer is exempt from protection by automatic fixed fire extinguishing system, a minimum of two CO^2 fire extinguishers of 6.8/7 kg capacity each, on trolley wheels, must be provided for each compartment; and

j) Transformer safety is assured in accordance with accepted standards.

B. Service Entrance Room: It must be independently ventilated. The doors provided for the service room must be smoke-tight and must have a fire resistance rating of not less than two hours.

C. Electrical Service Distribution Lines: The cable ducts must be sealed at every alternate floor with non-combustible materials having the same fire-resistance as that of the duct. Low and medium voltage wiring running in shaft and above the false ceiling must be in separate metal conduits. Water mains, telephone lines, intercom lines, fire alarm lines, gas pipes and any other service line must not be laid in the duct for electric cables. Separate circuits for water pumps, lifts, staircase and corridors lighting and blowers the pressurizing system. Master switches and essential service circuits must be clearly labelled. The false ceiling, including all suspension fittings and fasteners must entirely be of non-combustible materials.

D. Use of correct capacity fuse: it is desirable to protect each circuit breaker so that there is no need for the replacement of blown fuse through appropriate administration measures.

E. Alternate source of power supply: Diesel generators must be fully automatic in action. The generator must be installed in an independent fire resisting compartment of four hours and door of not less than 2 hours fire resistance. If a diesel oil storage tank is also to be located near the standby generator, it must be in a separate fire resistant compartment of 4 hours' rating which must be accessible through a two hours fire rating door. The generator compartment, including the oil tank compartment must be equipped with automatic fixed fire extinguishing systems, High velocity water spray systems/ Carbon-dioxide system/ Halon system. For small standby generator 2 CO^2 fire extinguishers of 6.8/7 kg. capacity each may be provided in lieu of the fixed installation.

i) Electrical Household appliances: Household electrical appliances do not form part of the building services; these are used in conjunction with the electrical installation and contribute substantially to the hazards like Electric Heating Equipment ,Electric Ranges, wall mounted ovens and counter mounted cooking units, Refrigerators, Room Air conditioning Units, Incandescent lamps, Fluorescent lamps, Portable lamps, including portable hand lamps, Smoothing irons, Television and Radio equipment, Washing and Drying Machines, etc.

2.2 Industrial and Commercial Equipment

This class of equipment is much larger and consumes more electricity as compared to electrical domestic appliances.

a) Capacitors: A liquid is used for insulation purposes in capacitors. This may be flammable or non-flammable. Where flammable liquid is used it can be a fire hazard when a fault develops, because of overheating of the liquid. Capacitors containing flammable liquid are, therefore, required to be enclosed in vaults or outdoor fenced enclosures. Capacitors must be equipped with a suitable device for draining off the residue charge after being switched off to avoid shock to the person servicing the equipment and possible damage to the equipment because of a short circuit.

b) Cranes and Hoists: These equipment present a life-hazard due to electric shock unless extreme care is taken in wiring and effective earthing of equipment.

c) Elevators, Dumbwaiters, Escalators and Moving Walkways: The main hazard arising from the use of elevators, dumbwaiters, escalators and moving walk-ways are a life hazard due to electrical shock, and the possibility of spread of fire, smoke and fire gases in the event of a fire. Strict adherence to safety requirements need to be enforced in respect of electrical equipment, such as electric motors, wiring, earthing, etc., with necessary safeguards.

d) Furnaces: Because of the high voltages required for operation of industrial furnaces, transformers are employed with individual furnaces or a group of furnaces. A serious fire hazard in the case of electric arc furnaces arises from the failure of the oil-filled circuit breakers. These circuit-breakers are subjected to measure severe duty and high surge voltages, because of the nature of operations, which may lead to their failure with disastrous results.

e) Machine Tools: A variety of electrically operated machine tools, such as lathes, forges, drills, presses, etc., are used ranging from a single motor drill to a large complicated automatic machine.

f) Motors: Electric motors are used at numerous locations in industry. Mostly a fire is caused by these motors. These fires may be due to any one or more of the following reasons:

i) Short circuiting or grounding of motor winding can produce sparks or arcs which can set alight to the motor insulation or nearby combustible materials.

ii) Bearings may overheat because of inadequate lubrication or due to excessive wear of the bearing resulting in friction between rotor and stator of the motor.

iii) Injury to motor insulation caused by the unsuitable location of the motor or other unsatisfactory conditions, such as corrosive atmosphere. This can also result in short-circuiting and ultimately a fire.

iv) Accumulation of deposits of electrically conductive dust or textile fibre on the motor. The motor insulation provides for normal dissipation of heat but if combustible dust and fibres are present then overheating may ignite them.

v) Lack of preventive maintenance. All motors must be effectively earthed.

g) Motor Control Centre Rooms: Several motor control centres are located in a large room which is known as the "Motor Control Centre Room" and that needs special fire protection.

2.3 Electronic Computer/ Data Processing Equipment (ECDP)

The use of electronic computers and data processing equipment (ECDP) is progressively becoming popular. In most cases, loss of the facility results in irretrievable losses. The entire installation and its operations are of a vital nature and can be temporarily paralyzed due to partial or complete loss of ECDP in a fire.

2.4 Electrical Equipment for Outdoor Use

Electrical equipment for outdoor use include transformer, switchgear, outdoor electrical signs and outline lighting fixtures. All outdoor electrical equipment are subject to the effects of weather, i.e., rain, wind, snow, hail, dust, sunshine, heat and cold. Such equipment can therefore activate and become a hazard at a very fast rate unless adequate steps are taken to counter the effects of weather by designing the equipment and its enclosure for those conditions.

2.5 Causes of Electrical Fires in Buildings

a) Worn-out or 'tired' electrical equipment: One of the main items of equipment in this category is the electrical motor. Worn out wires, television sets, portable lamps, flexible cords, and other household appliances, such as heaters, have also caused many fires.

b) Incorrect or Improper use of Approved Equipment

c) Accidental Fires –Examples are:

i) Clothes left in contact with luminous heaters or in candescent lamps;

ii) Heated electric iron left on clothes being ironed;

iii) Materials dropped accidentally into or on the electric equipment

iv) Heating appliances left 'on' unintentionally.

d) Defective installations: Electrical installations not conforming to the National Electrical Code (NEC) are termed "defective installations".

3. Heating Systems and Appliances

Heating systems and appliances are used for various domestic and commercial industrial applications and responsible for a large number of fires of electrical origin.

3.1 Domestic Heating Appliances

These appliances may be categorised under:

a) Electrically operated domestic appliances

b) Domestic heating appliances that burn fuel- this class of appliances may burn cooking gas, kerosene oil, soft cake, charcoal or fire wood.

i) **Gas burning appliances:** Heating appliance using gas as fuel are liquefied petroleum gas (LPG), natural gas, town gas or bio-gas supplied in LPG cylinder or piped. Gas pipes, for piped supply, must as far as possible, follow a route outside the building and short lengths piping be used for bringing the supply. Gas pipes should not be laid through living rooms or escape routes. Fuel gas is normally odourless - whenever a leakage is suspected, the supply valve must be checked for looseness and lightened, if necessary; the gas inlet valves for the appliance burner(s) must be checked and closed; and the room must be ventilated by opening all doors and windows. Lighting a matchstick for a candle, to detect the leak or operating of an electric switch or a mobile phone, etc. maybe lead to serious consequences in a gas-filled atmosphere and must therefore be strictly avoided. Incorrect operation of a gas-burning appliance can also lead to a serious fire/ explosion hazard while lighting up.

ii) **Kerosene burning appliances:** These appliances include stoves and cooking ranges. The hazards of all such appliances except that the 'pressure-stove' presents extra hazard. For all wick type stoves and cooking ranges precautions must be taken like the burner unit sits squarely in the wick casing and check the level of kerosene oil before lighting the stove. If the oil tank is to be replenished, the flame must be extinguished and the burner allowed to cool before attempting to pour kerosene into the appliance tank. For extinguishing the stove, lower the wick and then below out the flame not try to blow out the flame when the wick is raised.

- » Do not use water for extinguishing the flame.
- » Do not carry a kerosene oil stove from one place to another while its burners are on
- » Do not keep spare kerosene oil near a lighted stove.
- » Do not keep a lighted stove near gas cylinders.

iii) **Appliances burning soft coke or charcoal:** soft coke and charcoal glow during combustion. The flames are mostly invisible. At times, when the glow fuel is covered with ash, it is not readily discernible if it is still burning when the fire is fanned, or in gusty wind, sparks are emitted which alight readily combustible materials if precautions are not taken. Charcoal is comparatively more prone to emission of sparks. Therefore soft cake/ charcoal must be stored away from other combustible or flaming materials and sources of heat. Lighting up a heating appliance must be done in the open and it must be ensured that no combustible or flame material is present nearly. Lighting of such appliances must be avoided in gusty wind or dust storm conditions. Care must be exercised while carrying such appliances, while they are lit, from one place to another.

iv) **Appliances burning fire wood:** Hazards of burning firewood are akin to burning soft cake/ charcoal, except that firewood burns with a flame. However, it also emits sparks in gusty wind or when the fire is tamed. This is mainly due to the layer of charcoal formed on the burning wood. Similar precautions must be taken for this type of appliance as in the case of those burning soft coke/ charcoal as fuel.

3.2 Central Space Heating Systems

These systems are similar to the central air-conditioning systems, except that the air is warmed, instead of being cooled, before circulation. The hazards and the preventive measures for these systems are, therefore, akin to those of the central air-conditioning systems except that the hazards of heating are added. Window type room air-conditioners or fan-coil units are also used for air-condition of individual rooms/ compartments. These units can be and are often equipped with a heating device to warm the air before circulation during cold weather conditions.

3.3 Industrial Heating Appliances

Heating appliances used in industries or for commercial purposes may also be electrically operated or fuel (such as coal, fuel oil or gas) may be used for producing heat. These appliances are much larger in size as compared to domestic appliances. Because of this reason and also to meet special requirements of the industry, these are designed with a view to eliminating the chances of accidental fire and/ or explosion.

4 Air Conditioning and Ventilating Systems

In both systems, most features are common, such as the use of air-blowers/ air handling units and use of ducts for air distribution. These can be partly or wholly responsible for the spread of fire, smoke or other fire throughout the building or area served by them unless care is exercised in the design of these systems to prevent this.

A. **Fresh Air Intakes:** It is natural that the quality of air entering the system depends upon what there outside. Thus, if there is a possibility of fire, smoke and other fire gases being close to the air intakes, these may spread automatically and be drawn in and throughout the building via this system. It is, therefore, important that the locations of the fresh air intakes are carefully selected to prevent this possibility.

B. **Air Filters and Cleaners:** If ignited, the filter/ air cleaner can produce large volumes of smoke and other combustion gases which can spread throughout the spaces served by the system via the air handling equipment. Such a situation may lead to a serious fire hazard. To obviate this situation, the filter media must be of non-combustible nature and be periodically cleaned of all deposited material.

Fire in the air filters or air-cleaning equipment can release smoke and fire which can spread throughout the spaces served by the system via the air handling equipment. It is, therefore, essential that a fire situation be promptly detected and the air handling equipment automatically shut down. It is also essential that fire/ smoke dampers be installed at suitable locations, to close automatically in the event of a fire in the air filters or air cleaners to prevent the spread of fire, smoke and other fire gases. To achieve this objective, detectors are located in the stream of the filters/ air cleaners, in the main supply duct. The detectors have an interlock with air-conditioning system's controls and the fire/ smoke dampers so that the dampers are closed and the entire system shut down automatically in the event of a fire as soon as any detector is activated. In addition to the detectors for shutting down the plant and closing the dampers, an automatic fixed fire extinguishing system, employing water or inert gas or dry chemical powder as the extinguishing medium, must also be installed within the enclosure of the air filtration/cleaning equipment.

C. Air Cooling and Heating Equipment: Defective installation and maintenance of air cooling and heating equipment can lead to fires which can rapidly spread through the air conditioning system to all spaces served by it.

D. Ducts: Ducts may be of concrete or masonry construction or of metal. Metal ducts are required to be insulated to prevent losses or to maintain the cooling efficiency of the system. That is done by an internal lining or applying lagging externally. Openings are provided in the ducts to allow the conditioned air to be supplied to various composed served or for the return air to enter the return air ducts, where provided. In the event of a fire, any or all of the following situations may arise involving ducts.

a) Fire, smoke and other gases of combustion may be drawn into the ducts and conveyed to other parts of the building which may otherwise remaining unaffected by fire.

b) The lining/ lagging on the duct may disintegrate because of the combustible materials used for securing it in position or the combustible materials used in the construction of the false ceiling below the ducts. In such an event, fire can also spread along the surfaces of the ducts.

c) If the space around a duct, where it penetrates a fine resisting wall or floor, is not sealed with non-combustible, fire resistant materials, fire, smoke and other fire gases can spread through that opening and other openings along the duct.

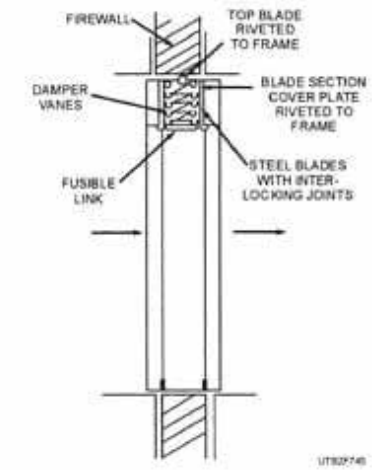
d) The duct itself may disintegrate because of the intensity and duration of the fire.

e) Where the ducts pass over have grills/ openings within the escape route, the escape route may become unusable, resulting in avoidable casualties.

E. Return Air Passages: Staircases, common corridors, lift lobbies and the space above the false ceiling or below a raised floor are often used as the return air passages for the air conditioning system. Whereas some of these can be used as such, subject to certain precautions, those that serve as normal escape routes must not be used as return air passage under any circumstances.

Where the plenum or the space below a raised floor is used for return air passage, the false ceiling and its fixtures or the false floor and all its structural support must entirely be of non-combustible materials.

F. Fire/ Smoke Dampers: Dampers are installed in conditioned air-ducts, return air ducts, passages other locations mentioned earlier to check fire, smoke and combustion gases from spreading to the various spaces served by them.



Fire Damper

Smoke Damper

Combination Fire/Smoke Damper

Fire dampers are located at:

a) each fire separation wall through which the duct/return air passage,

b) the junction of each duct and the central vertical shafts,

c) each location where the duct passes through a floor,

d) the inlet of the supply air duct and return air duct of each compartment on every floor, and

e) For louvers, where extraction system and dust accumulators are used.

i) Fire/ smoke dampers, for smoke extraction shafts, must be provided in building with a height of 24m as follows:

» **For apartment houses:** In non-ventilated lobbies/ corridors. The must be operated by fusible links and alternative arrangements for manual corridors also be provided.

» **For other buildings:** The dampers must be operated by smoke detector and alternative arrangements for manual control must also be provided.

f) Automatic fire/ smoke dampers must be arranged to close by gravity in the direction of air flow and to remain lightly closed upon operating fusible link or other reliable means.

G. Fans, controls, etc.: The fan or air handling unit by itself does not present any unusual hazard, if it is properly installed and firmly supported on a proper foundation. The measures necessary in respect of the fan or air handling unit are:

a) The fan or air handling unit must be readily accessible for cleaning and routine maintenance.

b) Each fan or air handling unit must be provided with an excess vibration switch which must be capable of giving a distinctive audible warning or shutting down the system when failure of bearings is threatened due to excess vibrations.

c) Protective devices must be provided for fan motors installed inside ducts plenums so that the motor get re-energized as soon as the temperature reaches a point at which smoke may be generated. The devices must also sound alarm with thermal overload relays are desirable for fan motors of one horsepower and above.

d) It must be possible to shut down entire system in case of fire or other emergencies. This can be achieved either by heat actuated automatic devices, which must be designed to operate at 10°C above the normal operating temperature in the supply stream and at 57.7°C in the return air stream or by manual shut down controls. The controls for the manual shut off devices must be placed at a convenient location and all concerned must be familiar with the location. It is important that such controls have conspicuous signs posted which unambiguously indicate the function of each.

4.1 Unit Air Conditions: These may include any factory built composite air-conditioning unit serving a single room compartment or enclosure. As far as the hazards of such units are concerned, they are confined to their inherent design, mostly electrical components. A well designed and properly installed 'unit air-conditioner' is comparatively safe. It also does not cause the spread of fire, smoke and other fire gases from floor to floor or from one compartment to another. But, if such equipment is not designed properly and due care is not taken in its installation and maintenance; it may present hazards similar to the larger systems.

4.2. Ventilating System: In the event of a fire, it may be necessary to shut down a mechanical (or forced) ventilation system for reasons similar to those for the air-conditioning systems, because uncontrolled ventilation can fan the fire and cause it to spread rapidly. On the other hand, ventilation can be used as an important aid to fire fighting and rescue operations if applied intelligently. Therefore it is important, that, irrespective of the type of ventilation system employed, it must be possible to control the ventilation of a building when it gets involved in a fire.

Fire hazards of mechanical ventilation system are similar to the air-conditioning system for the common features like air blowers, extractors and ducts. The importance of immediately shutting down the ventilating plant when a fire is seen cannot be over stressed because the supply of fresh air can cause the fire to spread rapidly. On the other hand, ventilation intelligently carried out by those in-charge of the fire fighting operations is a most important aid, because smoke, heat and gases of combustion can be removed and firemen would be able to advance to the zone of the fire. It should not be forgotten that ventilation reduces the risk of a fire starting in many trades and process, particularly where flammable gases, vapours or dust are likely to be present.

4.3. Smoke Control: It has to be accepted that complete confinement of smoke fire gases is seldom successful. But, judicious use of air-conditioning and ventilating system along with the necessary safeguards can assist in smoke control to a considerable extent and thereby reduce the life hazard, particularly in high rise buildings i.e. building over 15 m in height. One way of doing this is through supplementing these by "Pressurization".

Pressurization of stairwell and lift shafts can prevent the migration of smoke from the fire floor to other parts of a high rise building thus ensuring safe evacuation. Another method that can be employed for this purpose is venting the fire floor and simultaneous pressurization of the rest of the building.

5 Air Moving Equipment

Fire/ explosion prone materials, such as dusts, vapours and combustible wastes are generated in several industrial processes or operations. If these are not immediately removed to a safe place, a fire/ explosion may result. The main hazard of this equipment is the possibility of ignition of flammable dusts, vapours or other combustible materials

by sparks caused by fans or foreign material, such as rocks and tramp metals by overheated fan bearings. A fire in the air moving equipment can rapidly spread to other parts of the building served by a common system, through the pneumatic ducting in the same way as in the case of air-conditioning and mechanical ventilation systems.

In spite of the hazards mentioned in the foregoing paragraphs, air-moving equipment plays a positive role in preventing fires/ explosions by promptly removing flammable/ combustible materials and explosive mixtures from location where a disastrous fire/ explosion can occur if such materials/ mixtures are allowed to accumulate.

If the air moving equipment is well designed, installed and maintained it may not be the cause of a fire/ explosion. It must, however, be understood that the air currents in an air-moving system produce the same effect as a 96 kmph gale blowing through a narrow valley and provide all the oxygen required for fanning the flames if, by chance, a spark is generated at any point in the system and finds its way into the pneumatic ducting. In that event, the material being conveyed gets well lit by the time it reaches the discharge outlet. Such a situation may lead to devastating consequences. In certain applications such as in the case of spray booths, dip tanks, etc. a fire in the booth or dip tank can also be drawn into the pneumatic ducting with similar disastrous consequences.

6 Gas Supply and Appliances

Gas supply and appliances have already been covered earlier under the heading “Heating System and Appliances”.

7 Refuse Handing Systems and Equipment

Refuse or waste is generated in almost all occupancies where there is any human activity. If not systematically collected and safely disposed of, it can either cause fire or contribute to the intensity/ spread of a fire, depending upon the nature of the refuse.

8 Miscellaneous Building Services

8.1 Communications: It is essential that adequate protective features are built into their installation design like Fire protection measures for computers, servers, data processing equipment, etc. and the building housing such equipment. All vertical chases/ shafts for telephone and other communications cables must be enclosed in fire resisting enclosures of not less than 2 hours fire resistance rating and be effectively blocked at each floor by fire resisting materials. Communications cables must not be laid in the same shaft as the electrical cables. Each communications room must be fitted with a smoke stop door of not less than one hour fire resistance rating.

8.2 Lifts (Elevators): The purpose of lifts is to provide a convenient means of vertical travel to the occupants of the buildings. But, during a fire emergency, the use of lifts can result in fatalities. All lifts (elevators) are, therefore, required to satisfy certain minimum requirements in the context of life safety. These requirements have been specified in the National Building Code of India.

8.3 Escalators: The following must also be taken into consideration.

a) The drive motor and sprockets must be kept cleaned of oil, grease and dust.

b) It is desirable that maintenance of escalators is entrusted to the firm which installs them.

c) An Escalator must not ordinarily be used as a means of emergency exit.

8.4 Moving Walkways: These are used in limited places. But, wherever these may be installed, similar measures are required for fire protection as in the case of escalators. In the case of moving walk-ways, a combustible belt presents an additional hazard. It has the potential of spreading the fire either by itself getting ignited or because of movement of burning items along its length.

8.5 Dumbwaiters: Although dumbwaiters do not present the same degree of life-hazard as passenger lifts, it is necessary that these must be provided with fire resisting enclosures and lobbies on each floor so that fire, smoke and toxic gases cannot spread through them from floor to floor.

Where large supplies of combustible goods or mail are transported through dumbwaiters and where 'receiving rooms' of considerable size are provided on various floors, consideration must be given to the installation of automatic sprinklers or other appropriate automatic fixed fire extinguishing system for the protection of 'receiving rooms'. In addition, the ceilings, walls and floors of 'receiving rooms' must also be of non-combustible fire resistive construction with a fire resistance rating of not less than 2 hours.

8.6 Boilers: Boilers are usually required to be installed in various industries and in high-rise buildings intended for certain occupancies, such as hotels, hospitals, etc. The following considerations are applicable to all boilers in occupancies other than 'industrial'.

a) Installation, serviceability and operation of boilers are covered by the 'Boiler Act'. Each boiler has to be certified under that Act by the Government Boiler Inspector.

b) Boilers must not be located in a sub-basement.

c) Boilers installed in the first basement must be located in a separate room on the periphery and away from escape routes.

d) The boiler room must be of Type 1 construction where the ceilings walls, and floors have a fire-resistance rating of not less than four hours.

8.7 Plumbing: Metal pipes and fixtures used for plumbing do not present a fire hazard but plastic pipes and fittings do present a hazard whereby these can be destroyed by fire and may also aid the spread of fire to other parts of the building.

8.8 Vertical Chutes, Shafts or Chases: A high-rise building may have one or more vertical chutes, shafts or chases especially constructed for housing essential building services. Those chutes/ shafts/ chases require careful and special design considerations with a view to ensuring that these do not contribute to the spread of fire, smoke and other fire gases from floor to floor. But, more often than not, such considerations are overlooked which result in a serious life hazard. Additionally, the building services housed therein also often get destroyed/ damaged due to exposure to fire and heat.

9. Conclusions

All the building services must be planned, designed, installed and maintained so that they are safe to use/ operate and do not become a safety liability. For that all the possible and even probable hazards must be identified and provided for.

COMPLIANCES -NOT A GUARANTEE OF FIRE SAFETY

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Abstract: Fire is one the fundamental constituent of the universe. The fire is akin to God, given its utility quotient and hence it is one of the most revered elements. One of the most important things regarding fire is it is devastating when it goes out-of-control.

The present article talks about the measures to control fire (Fire Safety) and lists some of the fire accidents that took place in India in the recent past.

Introduction: Humans are made with five elements and fire is one of them. Children are taught in school as to how fire was discovered and created. Fire forms an essential part of life from birth to cremation. Fire has been worshipped as one of the Gods. It is broadly known that fire needs three elements to occur and hence during training the persons are taught how not to allow the three elements to combine so as to obviate the chances of fire. However, that does not imply that fire should not be used where necessary. For, without fire to create heat how can bread be baked? However, fire accidents need to be avoided. This gives rise to another element – negligence. This is an element that needs to be learnt, taught and discussed.

Very few persons are serious or committed to safety. Persons are mostly concerned with obtaining a Not Objection Certificate (NOC) or to meet requirements of essential compliances. This document gives the basic need or guideline to meet the minimum criteria to stay safe but just those are not insurance or guarantee of 100% safety from fire accidents. Based on increasing awareness and experience, an attempt has been made to gather and present some facts which can be shared.

Fire Safety: stems from a set of practices and procedures intended to reduce the chances of fire or if it does occur, to minimise the destruction caused by a fire. Fire safety measures include those that are intended to prevent ignition of an uncontrolled fire, and those that are used to limit the development and effects of a fire after it starts.

Fire safety measures are extremely important to protect property and prevent loss of life. Fires have the potential to spread and they generate heat and smoke throughout the building, thus affecting the safety of all the occupants.

People must Prepare Themselves for a Fire Emergency. The measures given below should be adopted for fireproof buildings in an upcoming project. Measures for existing buildings are also discussed.

1. **Install and Maintain Proper Smoke Alarms:** Smoke alarms should be installed on every level of occupied areas and also those areas which are in use even for part time. Smoke Alarm fixtures should be regularly cleaned of dust by vacuuming over and around them. The batteries in smoke alarms should be replaced at least once or

twice a year (as per manual). The entire unit must be replaced after ten years of service. Creating awareness of any incidence through an audio alarm by means of hooters is a prime requirement to save the habitants, whether it's for fighting the fire or for timely evacuation.

2. **Install and Maintain Fire Hydrant System:** Fire Hydrant should be installed at each floor to cover the entire floor plate area. It is necessary to maintain these equipment after installation. It has been observed that in some premises the installations are not maintained – refer the pictures below which show poorly maintained Hose Boxes or those that are made inaccessible.

(a) Empty Hose Box - No Hose & Nozzle.

(b) Hose Box - With a Hose but No Nozzle

Area & Approach to Fire Hydrant Obstructed (can't be accessed when needed)

3. **Building Evacuation Plan and Signages:** All the Occupants, Residents or End user MUST be familiar with the building's layout.

Evacuation plan: The directions of Safety Exit and the Fire Escape should be clearly and properly marked on each floor. It should be ensured that there are at least two exit routes – a primary and a secondary route in case exit through primary route is not possible. All emergency routes should be clear of any sort of blockage or obstacle, which could trap a person. They should also not be locked. The Building Manager must post evacuation plans in high traffic areas, such as lobbies in addition to other occupied places.

Proper Signage should be installed at required locations for ease of persons to evacuate during a fire.

Exit Signages

Exit Signage marked in a premises

4. **Fire Extinguisher in Every Occupied Area and in Lobbies:** Each occupied area, such as flats or family apartment, commercial premises, other use areas, other properties must have the requisite fire extinguisher and each adult occupant must know how to use them. Common Floor Asset Maintenance Tracker should be used to setup reminders for refilling of the fire extinguishers, since they are the first line of defense to extinguish fire.

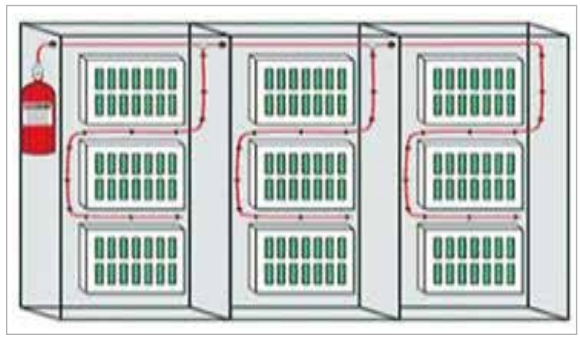
5. **Regular Fire Drills:** Regular Fire Drills must be orgainsed to train all adult occupants for handling fire emergencies by being aware of a fire alarm and evacuation plans once a fire alarm is audible.

6. **Building Design:** The complete layout should be vetted and thereafter the Fire Alarm, Fire Suppression and other allied systems should also be designed by an experienced Fire Designer/ Consultant.

7. **Fire Systems Equipment:** All the plant and equipment installed in a building should be of good quality conforming to the relevant IS Standards.

8. **Maintenance of Plant & Equipment:** All the fire safety plant & equipment must be retained in good working condition. Third-Party Auditing must also be done twice in a year to cross check their proper functioning. The figure below shows a badly maintained electrical panel which could cause a fire on account of short circuit. The other figure shows an Automatic Gas Suppression system for areas with electrical panels, servers, etc. where water cannot be used for dousing a fire.

Unkempt Electrical Panel



Automatic Gas Suppression System

9. **Smoke Extraction:** A Smoke Extraction system should be provided in a building to enable safe evacuation of the occupants and also to facilitate access by Fire Fighters. It is a well known fact that most people suffer on account of smoke rather than fire per se. Compartmentation should be done in buildings to segregate one zone from another to avoid smoke travelling from one zone to another. Compartmentation can be achieved by means of Water Curtains, Physical Barriers, Fire Curtains, etc.

Response/ Action to be taken in case of Fire: If a fire occurs inspite of taking all precautions it must be borne in mind that a fire can spread quickly and fill the area or major part or the entire building with smoke. Once an area is filled with smoke, it is hard to see and also to breathe. Hence all occupants must be made aware of how to respond and what action to take by means of proper training in case of a fire. Such pre-planning increases chances of mimimising casualties and loss of goods and property on account of a fire.

Sl. No	Emergency Response/ Activity	Explanation
1	Identify All Exits	Every occupant must be made aware of the closest exit and also the alternate exit.
2	Get out fast	Advise every occupant not to stop to get dressed or grab any belongings. If a person smells smoke or see flames, they need to move quickly except those who are trained how to fight fire. While the trained persons fight the fire the others must evacuate the premises.
3	Check the doors for heat before opening	If the door is hot, DO NOT OPEN, find another exit. The fire may be right on the other side and opening the door could give it the oxygen it needs to spread.
4	Stay low to the ground to avoid breathing smoke	The leading cause of death or injury in fires is lack of oxygen caused by smoke. Since smoke rises during a fire, so staying close to the ground when exiting (either crawling or crouching) makes it easier to see and breathe.
5	If anything on your person catches fire, STOP, DROP and ROLL	The fastest way to put out a fire is to deprive it of what it needs - oxygen. If the hair or clothing starts to smoke or get aflame, immediately STOP, DROP to the ground and ROLL
6	**Don't use elevators during a fire**	Elevators can stop or break during fires, trapping a person inside. All buildings with elevators are required to have separate exits by stairs.
7	**Physically Challenged persons**	If a physically challenged person lives or works in a building with an elevator, the owners, managers and the Fire Department must be informed about the person's emergency needs. An emergency escape partner, someone who is willing and physically able to help must be pre-identified, so that if the building is being evacuated, the escape partner helps the physically challenged person to exit. All floors must have evacuation chairs and bags.

Sl. No	Emergency Response/ Activity	Explanation
8	**If you can't get out, secure your room and yourself**	Place wet towels, blankets or clothing under the door to keep out the smoke. If possible, move to the bathroom and fill the bathtub with water.
9	**Assembly Point**	Set up a safe, easy-to-remember and easy to reach place to meet others once you have escaped. Pick a place outside the home or office (that's far enough away from the building) to meet up with everyone else.
10	**Attendance Check at Assembly Point**	A designated person must do a systematic attendance check. That way that person would be able to tell the Fire Department if any family members or coworkers are still inside. Tragedies have happened when people have not "reported in" and others have re-entered buildings to look for the so-called missing persons. Make sure that everyone operates under a buddy system, so this does not happen to either you or fire fighters!
11	**Inform Fire Department**	After you get out, immediately call the Fire Department
12	Don't Go Back Inside!	Once you have escaped a burning building, don't go back in for anything. Even if the fire doesn't seem bad from outside, the smoke and heat inside may be overwhelming.

With 27,027 deaths, every fifth fire-related death in the world in 2017 took place in India. Around 9 million Fire incidents and 1.2 Lakh deaths were recorded across the Globe that year. Of these incidents, India recorded 1.6 million fires and 27,027 deaths, according to a 195-nation analysis by Global Diseases Burden Published in the BMJ Injury Prevention Journal recently. The Indian death were 2.5 times the figures in China, where 10,836 people died in fire in 2017. India along with seven Countries, including Pakistan, accounted for over half the deaths due to fire. The study said kids under five and adults above 60 are the biggest Fire victims. (Source: Times of India, 22, December, 2019)

Some cases of the fire that have occurred in India in last few years are given below. They serve to show that no safety aspect or requirement should be discounted.

1. **Carlton Towers, Bengaluru (Feb 3, 2010):** Due to electrically induced heating and ignition of power cables in the electrical shaft at Carlton Towers near Old Airport Road in Bengaluru, fire of high intensity broke out. The severity of fire can be understood from the single fact that it took the lives of nine people, injured 16 severely and left many others affected. The Carlton Towers reopened after seven years in 2017.

2. **Kamala Mills, Mumbai (Dec 29, 2017):** A fire broke out in the Kamala Mills compound in Lower Parel, Mumbai, which claimed 14 lives and injured 21. Flying embers from lighted charcoal segree engulfed the cloth material used for curtains in "Mojo's Bistro" restaurant and destroyed the thatched roof of "1 Above" restaurant.

3. **Explosion in Cracker Factory, Warangal (July 4, 2018):** A cracker factory situated in Warangal; Telangana witnessed a serious outbreak of fire which caused the death of 10 workers who were working inside the factory at the time of incident.

4. **Bawana, Delhi (January 20, 2018):** This was one of the worst fire accidents of 2018. An illegal firecracker manufacturing factory was set up in lieu of a plastic manufacturing factory in the Bawana district, on the outskirts of Delhi. On January 20, 2018, around 6 pm the illegal unit caught fire, trapping labourers inside due to the exit being blocked by construction activity going around in the vicinity. The accident claimed the lives of 17 people. Two months later, an 800-page charge sheet was filed by the police and the owners were booked under IPC sections 304, 377 and the Explosives Act.

5. **Viraat Hotel, Lucknow (June 19, 2018):** A massive fire broke out at Viraat Hotel located in the Charbagh area of Lucknow. The accident claimed the lives of five people and injured another five.

6. **BPCL Plant, Mumbai (Aug 9, 2018):** At least 43 people were severely injured in a boiler blast at Bharat Petroleum Refinery in Chembur area of Mumbai. The accident took place on August 9, 2018, at the state-run BPCL refinery.

7. **ESIC Hospital, Mumbai (Dec 17, 2018):** A dastardly fire accident took place at ESIC Kamgar Hospital, Marol, Mumbai claiming the lives of 10 people on December 17, 2018.

8. **Karol Bagh, Delhi (Feb 12, 2019):** A hotel in Karol Bagh, Delhi caught fire late in the night killing 17 guests. Some guests were sleeping when the fire broke out. The fire was ignited due to an electrical shortcircuit.

9. **Bandipur forest (Feb 21, 2019):** The Bandipur Tiger Reserve was ravaged due to a massive forest fire that occurred. The fire destroyed more than 1,000 hectares of the forest land. It was one of the major ecological disasters. Karnataka's top forest official confirmed that an "act of sabotage" had caused the blaze.

10. **Aero India (Feb 23, 2019):** A massive fire broke out in the parking lot outside the Aero India 2019 show in Bengaluru. Around 300 vehicles were gutted in the fire.The fire started in the parking lot, which was fortunately quite away from the Aero India Venue. Dry grass fire aided by heavy winds has been cited as a possible cause.

11. **Surat Commercial Complex (May24, 2019):** An academic coaching housed in a commercial complex in Surat was gutted by fire. The building's terrace caught fire due to electrical short circuit on the ground floor. 22 students lost their lives, while 19 sustained non-fatal injuries.

12. **Building on Malabar Hill (Feb 6, 2020):** A fire broke out in a building near Hanging Gardens at Malabar Hill on 6th Feb 2020. The fire was confined on the fifth floor of the 14 story residential building.The fire broke out in Flat Number 52 on the fifth floor of the building and gradually started spreading to the staircase lobby and the upper floors.

Conclusions: There were the times, when fire at a place was regarded as the fury of nature (destruction of so many thatched houses, especially in summer months, forest fire, fire in a building, etc.). However, today means are fortunately available to contain it, with knowledge and awareness. If proper care, precaution and knowledge are exercised, Fire would not be a Furious element to contend with.

FIRE PROTECTION STRATEGIES – CREATING AN OPTIMUM BALANCE BETWEEN ACTIVE AND PASSIVE FIRE PROTECTION

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Synopsis

Vertical growth of urban areas, traffic snarls and congested roads make timely access difficult for the fire fighting team to the areas where people are trapped. This brings to the fore the importance of effective fire escapes routes and the need to provide fire and smoke compartmentation which would effectively prevent spread of smoke and heat till the arrival of fire fighting teams. It is a well-known fact that most of the lives lost in in a fire accident are due to suffocation. The smoke and the fumes lead to victims being disoriented, suffering breathlessness which finally results in the death of the victims. People trapped in fire find it difficult to make their way to safe zones which could help them to be rescued by the fire teams. The active fire protection measures are many times compromised either by non-maintenance or unauthorized actions. Implementation of proper fire protection measures at the design stage and regular maintenance would not only save the precious lives during fire accidents but also protect the building assets. The aim of this paper is to highlight the active and passive protection measures in buildings and the technological advances in both the type of protection measures in buildings. The National Building Code of India has laid emphasis on various aspects of fire protection and has made some significant additions in its 2016 edition. These have been brought out in this paper.

Introduction

Statistics available indicate that a staggering figure of more than one hundred and thirteen thousand people lost their lives in fire accidents between years 2010 to 2015. This works out to an average 62 deaths per day. A careful review and analysis of some of the major fire accidents indicate the following.

1. Lack of proper exits, failure of PA system, blocked corridors, obstructions caused by unauthorized constructions – e.g. the Uphaar tragedy.
2. Fire caused by electrical short circuit, rapid spread of fire by storage of inflammable materials, spread of smoke through ducts of central AC of a building resulting in asphyxiation. Late intimation and consequent delay in arrival of fire tenders and lack of proper blue print of the building plan e.g. the AMRI Hospital tragedy.
3. Unplanned construction, unauthorised additions/ alterations, change in usage, provision of single exit and lack of basic fire fighting facilities, congested locality hindering the fire tender movement – e.g. the Multi-storeyed market complex, Kolkata.
4. Non maintenance of fire detection system, defunct sprinkler systems, defective PA system, locking of fire exit doors, absence of fire safety plan e.g. the Carlton Towers, Bengaluru.

The cases listed above point to the fact that a majority of fire accidents are due to closure of exit routes, failure of working condition of fire equipment and failure of the deployed fire protection measures.

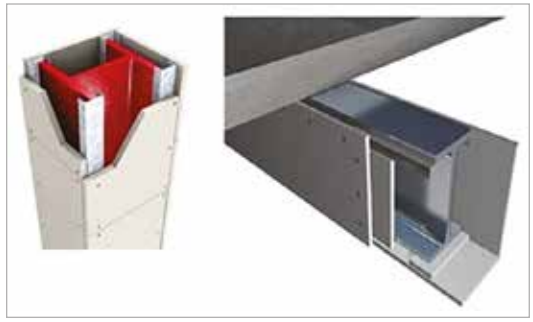
The efficient working of Active Fire Protection systems requires initiation of some amount of action, either manual or automated. Manual action comprises use of fire extinguishers. Automated systems on the other hand involve a chain of events such as alerting the occupants by means of alarm, triggering the sprinkler systems, shut down AHU's and fans, activate fire dampers, start smoke extraction system, stopping lifts at predefined levels, pressurisation of the lift well and staircase system, etc. Thus, active fire protection includes systems that are activated in response to a fire. There are likely chances that there could be a failure/ slow response in any of the AFPs. The reasons could be when there is a delay in human response in triggering the alarm/ inability to use the fire extinguisher or sprinkler failure due to lack of maintenance, limited capacity of extinguishers. On the other hand, Passive Fire Protection is a fire safety provision which is dormant in normal conditions but would become active in case of a fire. Passive Fire Protection aims at dividing the building into a series of small fire tight compartments which would inhibit rapid spread of fire and smoke throughout the building, thus giving occupants more time for evacuation. Another aim of Passive Fire Protection is to protect damage to the critical structural members. Compartmentation also aids in quick extraction of smoke by ventilators by creating upward draft for the hot smoke. To effectively minimize the hazards of a fire, there needs to be collaboration of both Active and Passive Fire Protection measures. There are various factors such as availability of required quantity of water, evacuation time, duration of protection, type of structure or equipment with which fire protection is being planned and the type of fire as these would have a bearing on the choice of systems and their right combination.

The most common constituents and methods of fire protection include:

Active Fire Protection System

- Fire detection systems which locate smoke, flame or heat and sound an alarm for enabling emergency evacuation and notifying the local fire authorities,
- Portable fire extinguishers,
- Dry/ Wet riser systems, and
- Automatic sprinklers.

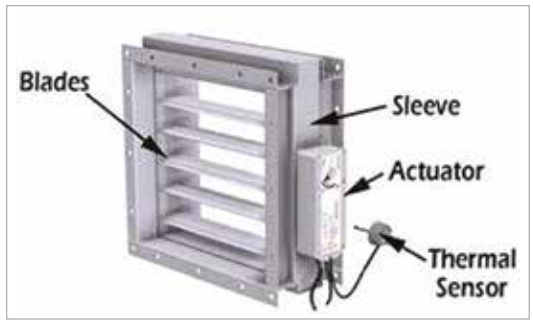
The above systems should work in tandem either by manual or automatic intervention and inhibit the spread of fire as planned.



Structural Protection

Passive Fire Protection System

- Fire resistance rated construction such as walls, floors, ceiling/ roof,
- Fire-resistance rating of critical structural elements,
- Movement related opening protection measures mainly the Fire Doors,
- Fire stopping methods where services penetrate walls/ ceilings and shafts
- Protection of Air transfer and duct openings, and
- Smoke control systems.



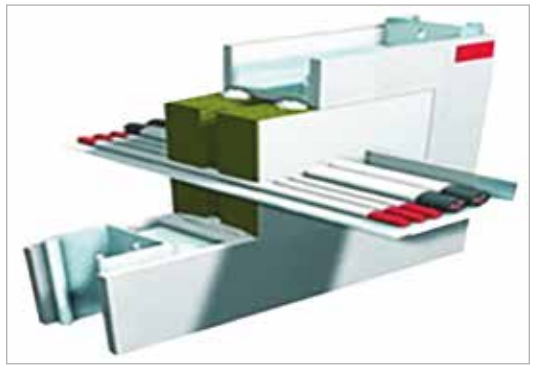
Damper

Fire Stopping for Openings

Intumescent seal

Fire pillow

Fire Stop Sealant for individual pipes, etc.



Mineral fiber or RTV Foam for bunch of Pipes or Cables

Advancements in Technology

There have been technological advancements in the sphere of fire protection which make the components of the system function more efficiently. Some of these are:

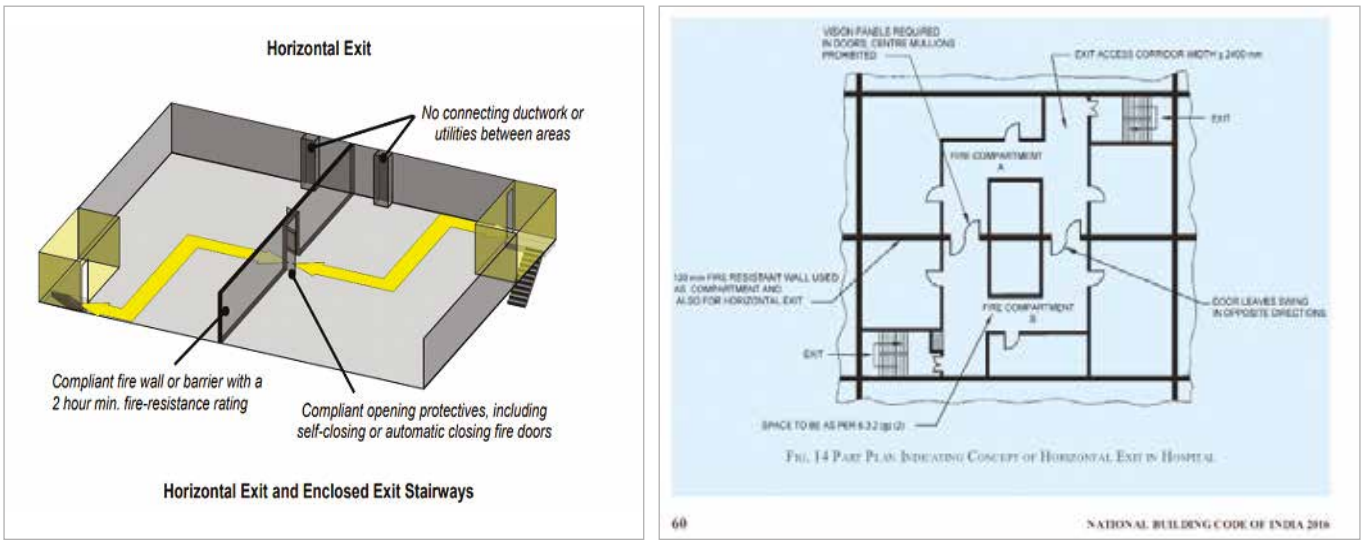
- Sound wave fire extinguishers which would bring down dependency on the water and a non-destructive technology.
- Water mist systems which deploy fine mist of water quenching the fire in a shorter time as opposed to conventional sprinklers. They also reduce damages caused by the conventional water sprinklers.
- Early suppression fast response fire sprinkler systems which are ceiling mounted high pressure heads with superior efficiency.
- Inert gas fire suppression systems for electrical rooms, IT systems and the like.
- Integrated voice evacuation and messaging systems which not only serves as alarm but custom built for particular locations which have pre-recorded messages on escape routes and fire evacuation plans.
- Fire and carbon monoxide detectors which work on technology of air quality monitoring which can sense and send alerts on the smart phones or land lines.

- Video image smoke detection systems which can pin point the origin of smoke or flame useful in large indoor facilities with high ceilings. These are linked to the BMC and show up in the Control Room.

There has been innovation in the passive fire protection industry and the industry is in a constant growth mode. The advancement in the intumescent coating industry has not only made the products cheaper but also lighter in comparison to the earlier practices of cementitious coating resulting in reduction of costs. Further advancement in technology and constant product innovations including sliding and flush glazed products is driving the fire door markets.

Fire Evacuation Strategies

For a good passive fire protection strategy it is essential that proper emphasis is laid on the conceptualization at the design stage to ensure that governance of the system is effectively served in the hour of the need. A strategy which is based on assessment of all the likely fire



Horizontal exit/ compartmentation

risks and an evacuation plan which would address the identified risks is of paramount importance to be integrated in the design stage itself. This aspect is now getting all the importance and due attention from all the designers. Type of occupancy, density of occupancy, height and number of floors in a building have a major role to play in the type of strategy to be adopted and the Passive fire protection measures to be implemented. Vertical growth entails a longer travel time from the upper locations to the ground level in addition to the horizontal distance to be traversed to the staircase lobbies/ Emergency staircases. While a total evacuation strategy of vacating all occupants through the stair case can be adopted in low rise buildings, tall buildings need a partial evacuation strategy considering the likely backup of persons at the stair cases. Phased evacuation is essential in all cases. It is essential that for the success of phased evacuation, fire compartmentation is essential. In case of people with mobility impairments a defend-in-place strategy or a delayed evacuation needs to be adopted whereby occupants can remain in a refuge area in relative safety before being evacuated. The PFP measures also include ensuring proper sealing of opening, efficient smoke extract systems to aide in quick evacuation of the residents.

Hospital buildings house patients with various degrees of immobility and disability and hence ensuring safety of such vulnerable persons in case of a fire is a huge challenge. Modern day hospitals and care centres in addition to being large, house various complex facilities thus presenting challenges in complete evacuation of the building in situation of a fire. Thus the concept of progressive horizontal evacuation is adopted in hospitals. As a part of this strategy the occupants are moved from the fire-affected area to the adjoining area, through a fire-resisting barrier which is designed to protect the occupants from the twin dangers of fire and smoke. The occupants would then remain in a fire safe area and situation is assessed even as the fire is being extinguished. If at any point, there is a necessity for further evacuation then the same would be carried out by shifting the occupants to another safe zone or down by the closest stair case. Fire protection approach for hospitals needs to address any emergency situation which requires additional/ special provisions which must be integrated into the building design.

An office would have higher occupancy and may rely upon phased evacuation which would put greater reliance on the passive fire protection measures. A hotel would need well specified PFP measures with appropriate fire resistance construction along with active fire protection measures.

The National Building Code of India 2016 in the Fire and Life Safety part, has extensively dealt with various passive fire protection measures. The fire safety aspects have been described under three classifications of Fire Prevention, Life Safety and Fire Protection. Extract pertaining to these revisions in NBC 2016 are given below.

*1. **Fire prevention:** Covers aspects of fire prevention pertaining to design and construction of buildings related to passive fire protection measures, various types of building materials and their fire rating. Some significant revisions are as follows.*

a) Fire resistance ratings of structural and non-structural elements, provisions relating to fire separating walls, fire separating floors and fire partitions have been updated. b) Provisions of fire safety requirements of services shafts have been updated. c) A separate comprehensive clause on electrical power supply distribution for fire and life safety systes has been included. d) Detailed clauses on air conditioning systems towards safety and smoke control integration have been provided. e) Glass facade requirements have been detailed considering the fire protection and smoke exhaust aspects. f) A separate comprehensive clause on Fire Command Centre (FCC) has been introduced covering various requirements

2. Life safety: Covers life safety provisions in the event of fire addressing construction and occupancy features that are necessary to minimise danger to life from fire, smoke, fumes or panic. The revisions include:

a) The components of means of egress have been comprehensively brought out covering specific aspects relating to exit access, exit and exit discharge. The relationship of occupant load, exit width requirements and travel distances have been detailed enabling efficient planning for enhanced life safety provisions. The table on capacity factors has been modified based on aspect of width per person approach used globally. b) The concept of fire fighting shaft for safe and efficient use by the fire fighters to access the floor on fire and also allow egress/evacuation of the occupants with simultaneous use of refuge area used as staging of the occupants, have been well integrated, including in the annex for high rise buildings. c) Aspects of compartmentation with fire barrier and its passive fire safety requirements have been detailed for respective occupancies. d) Pressurization of exits and smoke extraction requirements for respective areas including car parking have been updated. e) The clause on fire detection and alarm system has been completely reviewed and updated as per the latest practices.

3. Fire protection: Covers significant appurtenances and the related components. Further, it enumerates guidelines for selecting the correct type of equipment and installation meant for fire protection of the building, depending upon the classification and type of the building. The revisions include:

a) The table on minimum requirements for fire fighting installations has been updated. Detailed provisions have been included on fire water storage, fire pump room, sprinkler system and various alternative fire suppression systems.

b) Additional Occupancy-wise Requirements –

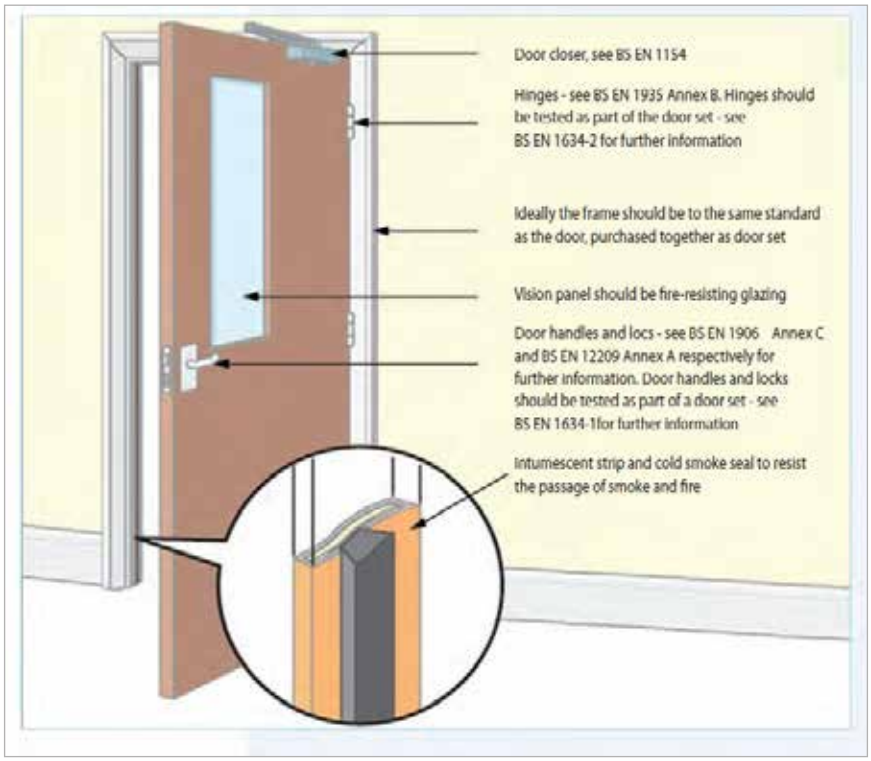
- *Concept of progressive evacuation in case of hospital buildings has been included in detail to ensure life safety Provisions relating to requirement of refuge area have been updated including for D-6 occupancy and introduced for apartment buildings of height 60 m and above.*
- *Separate provisions on atrium have been included*
- *Detailed separate provisions have been included on commercial kitchens*
- *Detailed separate provisions have been included on car parking facilities.*
- *Separate provisions on fire and life safety requirements for metro stations have been included*

Maintenance and Testing

Investigations, post some of the major fire accidents, indicate that loss of lives and damage to the property could have been minimized if the basic fire fighting facilities installed were regularly maintained and tested for their working. It is absolutely essential that all multi-storeyed office, commercial and residential complexes stick to the specified fire drills and testing of equipment. The passive fire protection products used must have passed rigorous testing under extreme fire conditions to serve the intended purpose of ensuring sufficient time for occupants by inhibiting spread of fire. Selection of the right kind of fire protection products should ensure that they have been tested to the relevant and current standards. BIS has formulated more than 150 standards on fire safety in buildings and firefighting equipment & systems. Another way of assuring the quality and reliability of products is to use products which are certified by independent third party organizations recognized by the regulatory authorities. This would ensure that selection of a product meets the required performance criteria and generate confidence amongst the customers and end users.

Conclusion

Active and Passive Fire Protection Systems though of different nature, are equally important for fire safety of a building, the life of the occupants and the assets housed in it. Both the systems are compliment to each other and when installed and deployed properly would ensure the intended purpose of safety of the occupants and the assets. Advancement in technology and constant innovation would ensure that the methods deployed are just not to inhibit the spread of fire and smoke but in the first place to prevent occurrence of a fire itself. It is important to realize that each of the fire protection systems is not an alternative to the other one and both the systems are complimentary to each other.



Standards for Fire Door[2]

Rapid vertical growth due to dwindling land mass has resulted in large scale projects with a mixed use and reduced time of construction. Hence, the emphasis should be to integrate passive fire protection measures at the design stage. This brings to the fore importance of a multi-disciplinary approach and coordination at the design stage since all the disciplines have an important role to play. Adoption of fire resistance construction to aid fire compartmentation, increasing of fire resistance of critical structural members, adhering to occupancy and safety related clauses for all electrical and air-conditioning systems, communication, fire detection, alarm and PA systems by respective engineers and locating strategically planned fire proof doors in the escape routes and creation of effective fire barriers integrated into the overall efficient planning of the building would result in a safe building.

REFERENCES

1. National Crime Records Bureau – Ministry of Home Affairs

2. ASFP Guide to Inspecting Passive Fire Protection for Fire Risk Assessor

3. National Building Code of India 2016

HIGH PRESSURE WATER MIST SYSTEM - SAFE PROTECTION FOR MUSEUMS, ARCHIVES & LIBRARIES

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INTRODUCTION

Conventional fire fighting technologies continue to have disadvantages in terms of resulting water damages, environmental compatibility, toxicity, or refilling costs. Often, the consequential damages caused by the extinguishing agent are greater than the potential loss by the fire.

The benefits of fire fighting with water in the form of smallest droplets have been known since the 1930s but only have been identified for protection of historical buildings, archives, libraries and museums during the last decades. For many applications, high pressure water mist technology is a good alternative which avoids the disadvantages of other fire fighting agents.

The high-pressure water mist fire protection system uses very fine water sprays (i.e. water mist). The small water droplets allow the high-pressure water mist to control, suppress or extinguish fires by:

- cooling by heat absorbtion by creating a larger surface area,
- displacement of oxygen by local inerting effect, and
- attenuating radiant heat by cooling.

The effectiveness of a water mist system in fire suppression depends on its spray characteristics, which include the droplet size distribution, flux density and spray dynamics, with respect to the fire risk. For many applications, high pressure water mist technology is used as an alternative, reducing and avoiding the disadvantages occurring with other fire fighting methods.

PRINCIPLE

Water is the most effective cooling agent to fight fires. Conventional water-based systems require large quantities of water to control or extinguish fires, mainly making use of the cooling effect. The primary reason for the large water amounts required is that the majority of the water is not effectively used to fight the fire, resulting in large water runoff. This is due to the limited surface area of the water droplets getting into contact with the heat from the fire.

If water is atomized into very fine droplets, as it is in the high pressure water mist technology, a substantially larger surface area comes in contact with the fine droplets to absorb energy and consequently fight the fire. The fine droplets convert into steam in the vicinity of the fire. Due to vaporization, the energy and the combustion rate of the fire are effectively reduced.

Once the fire has been suppressed or extinguished, the droplets being discharged continue the effect by removing heat from the fuel source i.e. plastics, fabrics, wood, paper, etc. and prevent re-growth or re-ignition of the fire.

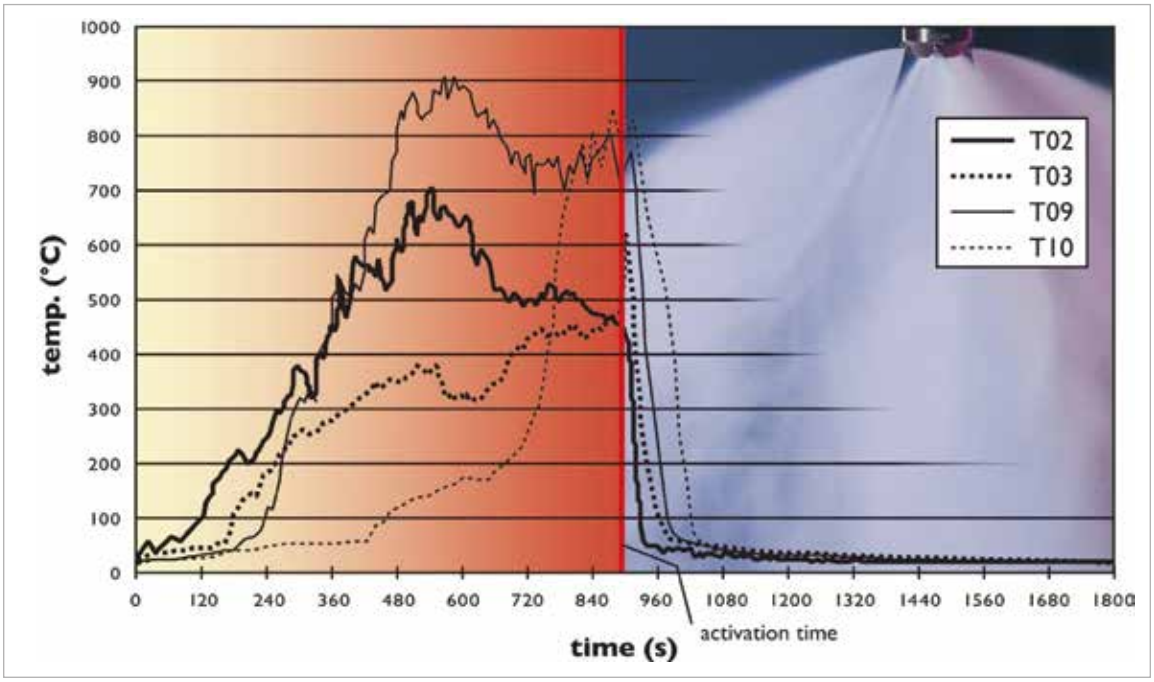


Illustration of cooling effect of a High-Pressure Water Mist System

In addition, to the cooling effect, the fast vaporization results into a local inerting effect caused by volume increase of water resulting in depletion of oxygen in the direct vicinity of the fire. The difference with respect to other inerting agents is the local effect at the fire source and not reducing the oxygen concentration in the entire space.

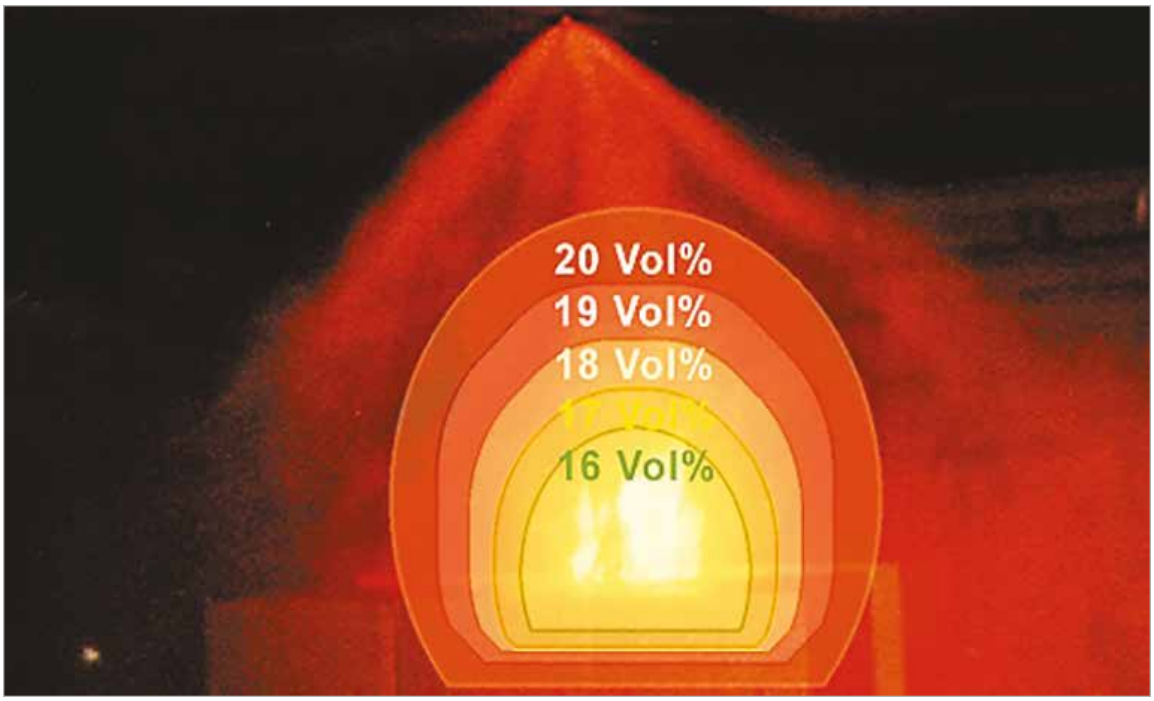


Illustration of cooling effect of a High-Pressure Water Mist System

FIRE TESTS

Water mist is not a gaseous agent and therefore cannot be designed and approved like a gaseous agent. Likewise, water mist cannot be directly compared with conventional sprinkler systems where the design is based on two-dimensional water calculations.

For each application the required nozzle type, droplet distribution, flow rate and discharge time have to be individually determined to provide the optimum protection of the relevant risk.

There are established guidelines and protocols for light and ordinary hazard risk application for the approval and design for water mist systems used in various applications such as Libraries, Museums & Archives. The protocols for light and ordinary hazard risk applications on land have been established by VdS 3188 standard (Verband der Sachversicherer), FM5560 standard (Factory Mutual) and CEN (EN TS 14972 standard). The International Maritime Organization also have established guidelines and protocols in accommodation areas on board ships. There are some independent fire tests which have been carried out according to these guidelines also.

Today, these standards and guidelines are applied to generate design parameters and to approve system components. For some applications like Ordinary Hazard risks, the standards prescribe fire test scenarios to verify the system technology. For the fire load and risk that are not covered by these standards, Individual Fire Test protocols and scenarios have to be developed with fire experts to test the technology and to generate layout parameters.

The fire test for these applications have yielded the following results:

- All the fire tests have shown a rapid control and suppression of the fire as soon as the system was activated.
- No fire spread occurred on the adjacent shelf.
- All temperatures in the area were rapidly reduced to a safe level, most below 50^{O} C.
- The damages to the fire load mainly resulted from the time before system activation. All documents and goods were analyzed for damages after the test duration of 30 minutes. It was found that they were damp on the surface but dry inside.

SYSTEM SET UP

High-pressure water mist systems mainly consist of a pressure generating device, a high-pressure pipe work and special nozzles.

The required operating pressure is generated by means of high-pressure pumps or pressure cylinder systems. The selection depends on the type of risk and the area to be protected. Larger risk areas such as archives, libraries and museums are normally protected by pump systems. The main design features of high-pressure pump units are similar to conventional sprinkler pumps, whereby positive displacement pumps are used due to the higher-pressure levels required. A difference with respect to the conventional sprinklers is the storage tank requirements.

Due to the substantially lower water consumptions the water storage tanks are only 10% of the capacity required for conventional sprinkler systems. In some cases the high-pressure pump units are directly supplied by the public water main (where the mains are pressurized for 24 hours supply) via a small intermediate tank. Maintenance requirements are comparable to the conventional fire fighting systems.

The low water consumption also has a positive effect on the pipe dimensions required. Not only the flow rates are much lower than the conventional sprinklers, but the allowable hydraulic pressure losses of up to 80 bar allow installation of systems with pipe diameters of 10 mm to 50 mm. These properties permit installations in confined locations and easy retrofits in historical buildings.

The system can be triggered either by a separate detection system or by thermally activated glass bulbs. All system designs as for conventional systems, e. g. deluge and wet systems, dry and pre-actions system can be applied for the water mist technology. Room with heights up to five meters have ceiling mounted nozzles. Higher areas, e.g. such as an atrium, can be protected by installing nozzles at different levels or nozzles approved to be mounted at ceiling level. Beyond that, it is possible to install wall cabinets with water mist extinguishing guns. They offer the possibility of rapidly suppressing initial fires, using the lowest possible consumption of water.

ADVANTAGES OVER CONVENTIONAL SYSTEMS

Historical buildings, those housing archives, libraries or museums usually contain large quantities of valuable documents and goods. Hence all such risks have special requirements for the extinguishing systems. On one hand the earliest possible activation is considered to be necessary; on the other hand, a false alarm must not result in unacceptable damages to the goods protected.

Sprinklers are not the optimal solution for such risks because of the extreme water damage in case of an activation which easily can surmount the damage caused by the fire itself, not to mention a false alarm situation. During retrofitting the large pipework of conventional sprinklers is a disadvantage, rendering the use of sprinklers technology unfeasible in these cases.

Besides, the large water storage tanks for sprinklers system take up valuable space that could more appropriately be used for documents or goods storage areas.

Gas extinguishing systems do not damage the protected goods or documents, but usually require very large storage areas for the gas cylinders. The effectiveness of these systems depends on the effective sealing of the enclosed area. Historical buildings, libraries and museums normally have wide open spaces, hence in most cases it is not possible to use gas systems without large investments for creating partitions for enclosures. Most gas systems can only be activated after a pre-warning time, allowing for growth of the fire during that time. They also are an environmental concern.

High pressure water mist systems use such little amount of water that the resulting water damage usually is negligible. That makes it possible to use early detection systems without a fear of a false alarm. Detectors can be used for activation as well as automatic nozzles with low temperature rated glass bulbs. Water mist systems for archives, museums, and libraries can be designed as total flooding or selectively activated systems with minimal water storage requirements. In some cases the systems are directly supplied from the municipal water supply (where the mains are pressurized for 24 hours supply) using small intermediate tanks.

The fine water mist also reaches hidden spaces like in shelves to a much larger extent than the sprinkler water. At the same time the temperature in the protected area is reduced more efficiently compared to the use of gas extinguishing systems and sprinklers. The latter effect is of particular importance to prevent spreading of the fire to nearby goods or documents and to allow trained personnel to rescue people caught in the area.

Smoke particles are partly washed by water mist systems, reducing the spread of smoke to valuable goods near the fire. Taking into consideration that smoke usually causes the most damage, the reduction of the smoke spread is an important aspect to be considered. Retrofits can more easily be carried out even in buildings with open ceiling structure and special requirements with regards to the architecture due to small pipes sizes required by these systems.

CONCLUSION

The water mist systems initially were mainly seen as an alternative to gas extinguishing systems for machinery and special risk protection, however, now more and more applications in areas that traditionally had been protected by conventional sprinklers are being identified for provision of water mist system.

Due to partly higher initial investment cost and the lack of general design parameters, water mist systems do not substitute sprinklers in the most traditional sprinkler applications, but today there are certain applications, like historical buildings housing archives, libraries and museums for which the benefits of water mist systems over sprinklers are recognized by owners, users, architects and consultants and makes it worth to investigate design parameters and protection concepts for valuable areas where water damage is not acceptable.

REPORT - CONFERENCE ON NEW & EMERGING TECHNOLOGIES IN ROAD CONSTRUCTION

Prof. Mainak Ghosal
Consultant
Banking & Construction Industry

The road construction industry is dynamic and presents several opportunities driven by innovative solutions. Through the program it was intended to deliberate upon the emergence of newer technologies for road construction which are durable, sustainable and environmental-friendly. The members of the industry, policy makers, international organization and technological providers united to deliberate on the emerging technologies for road construction. At an apt time when India's GDP and its demand is plummeting in every passing quarters, the Federation of Indian Chambers of Commerce and Industry (FICCI) had organized a "Conference on New and Emerging Technologies in Road Construction" on 06 December 2019 at FICCI, New Delhi. General (Retd.) V K Singh, Hon'ble Union Minister of State for Road Transport & Highways, Government of India delivered the Inaugural Address at the conference. The FICCI-CRISIL Report on 'Paving Future Roads for India' was released at the Conference.

Figure 1: *Releasing of the FICCI-CRISIL Report on 'Paving Future Roads for India'*

General (Retd.) V. K. Singh mentioned that road development in India really started off during the Second World War in 1930s when road construction facilitated the development of other industries. Prime Minister Modi's vision of trying to achieve a 5 trillion dollar economy by 2024-25 was challenging but achievable by promoting our road networking at a rapid scale. Now, with the prevailing GDP rate it was almost impossible as India needs to grow at a rate of 9% and with the present rate of road construction at 30km/day, major improvements in construction were needed. Gen. Singh said that nearly 65% of all goods in the country were being transported through roads, while 90% of the total passenger traffic used road network to commute. He said the Government was committed to building quality roads and highways in the country.

He referred to the *Bharatmala Pariyojana,* which aims at building over 66,000 km of economic corridors, border and coastal roads, and expressways to boost the highway network.

The Pariyojana envisages providing 4-lane connectivity to 550 districts, increasing vehicular speed by 20-25%, and reducing the supply chain cost by 5-6%, said Gen. Singh.

"Government is open to adopt and try newer and innovative technologies for road construction by various technology promoters to improve the economic and environment viability of the projects as it is necessary to cut down construction costs by employing new materials, innovative technology, and by fast tracking decision making to avoid associated cost escalation," the Minister said.

The highways construction industry should develop innovative and eco-friendly materials as well as use recovered and recycled materials to develop green transport infrastructure, he added.

The highways sector has the potential to revive growth and cited how the US survived economic depression during 1930s because it built road infrastructure, which spurred growth in steel, cement, automotive sectors and labour market.

The Minister stated that "There is also urgent need to streamline the Detailed Project Reports (DPR) preparing process, as in most cases the project reports are delayed, ill-conceived and not based on ground realities, which is causing undue delays in project execution and one of the main reasons for cost escalations. There is an urgent need to develop a positive, transparent, corruption free working system by adopting newer technologies ...Delayed decisions are totally unacceptable as they lead to colossal loss of time."

Mr. R K Pandey, Member Projects, NHAI informed that to promote green construction, NHAI would be bringing out a new document on use of waste plastic in road construction within a month.

The government should have provision on use of local construction materials in the Detailed Project Reports (DPR) so that local natural resources can be used for constructing eco-friendly sustainable roads as per Mr. K K Kapila Co-chairperson, FICCI Infra Committee on Transport.

Distinguished Speakers for the conference were:

- Mr. Sandip Somany, President, FICCI & Vice Chairman & Managing Director, HSIL Ltd.
- Mr. R K Pandey, Director Projects, National Highways Authority of India.
- Mr. K K Kapila, Co-Chairman, FICCI Committee on Infrastructure and Chairman & Managing Director, Intercontinental Consultants and Technocrats Pvt. Ltd.
- Mr. Thanes Prajapati, Regional General Manager, Bitumen Asia-Shell
- Mr. Satish Chandra, Director, Central Road Research Institute
- Mr. B C Pradhan, Director, Pradhan Mantri Gram Sadak Yojana (PMGSY)

During the sessions, the speakers pointed out the following:

- Mr. B C Pradhan deliberated that nanotechnologies were now implemented in road construction citing the examples of Zycosil, with IRC recommending it.
- Mr. D. P. Gupta, Director (Roads & Highways), Asian Institute of Transport Development & Formerly Director General (Road Development) & Additional Secretary, Government of India – spoke on the security of Indian roads with 70% of road accidents occurring in the District & Other roads.
- Mr. Nagabhusana M N, Senior Principal Scientist, CSIR- Central Road Research Institute – Application of new technologies like soil stabilization has been possible on roads.
- Dr. Arvind K Swamy, Associate Professor-Civil Engineering, Indian Institute of Technology, Delhi – dearth of good engineers is felt as no one wants to be a beginner, all want to be a follower.
- Mr. B. K. Arora, General Manager, Afcons Infrastructure – process innovation in road construction taking record time to complete a bridge say 6 hrs (Rail) or 18 months(DMRC Projects). Use of sheet piling to prevent soil obstruction instead of removing the underlying layers.
- Mr. Girish Ahuja, Deputy General Manager, Nitto Demko India Pvt. Ltd. - safety and security of Indian roads with 1.5 lakhs dying in accidents in the last years and the rate being 400 fatalities in 24 hrs.
- Mr. Jeyan Vasudevan, Regional Manager, Bitumen Technology, Shell – talked on various challenges that road construction is facing today, starting from the technology aspects to management issues.
- Mr. Satish Chandra, Director, Central Road Research Institute – mentioning that high volume of fly ash was used in road construction in Delhi way back in 1990s and said though some progress has been achieved much needed to be done on technological fronts. He also said that when IRC launches or modifies a code it should do so with seminar/ conference/ workshops as an awareness development programme.
- Dr. B Krishna Prapoorna, Associate Professor, Indian Institute of Technology, Tirupati – said that industry and academia should work together and industry should come to the academia to kick start a technological process instead of vice-versa.
- Ms. Atasi Das, Senior General Manager-Design, GR Infraprojects Limited – lamented that contractors don't have the knowledge in using what sort of waste to be used for recycling as pan-parag/ gutkha plastics have different melting point than do not suit the required M P compatible with bitumen. She also said that when new materials/ technologies are incorporated the client should rely on its asset management and performance management and both the parties should rely on information management through SMS's .The audience added that time management is also very relevant apart from these two.
- Mr. Bidur Kant Jha, General Manager (Pavement & Materials), LEA Associates – pointed out various case studies as how contractors were blamed for poor quality modified bitumen they purchased to be used in the 1st part of the Golden Quadrilateral project. Also when the GOI changed its plan of using modified bitumen to the conventional ones the seller when asked for invoices (of Indian Oil) plainly refused to comply.

Figure 1: *Report in Indus Dictum, dated 7th December, 2019*

PRESS COVERAGE OF THE CONFERENCE:

The media was very enthusiastic about the event and nearly all of them made sure that the conference appeared in their headlines.

1. Centre looks to cut down costs in construction sector, The Hans India, Dec 07, 2019
2. India now world's 2nd largest road network at 5.8 million km: Gen V K Singh, Indus Dictum, Dec 07, 2019
3. Govt open to adopt new tech, eco-friendly material in construction sector: Singh, Business Insider, Dec 06, 2019
4. Govt open to adopt new tech, eco-friendly material in construction sector: Singh, The Economic Times, Dec 06, 2019
5. Govt open to adopt new tech, eco-friendly material in construction sector: Singh, The Times of India, Dec 06, 2019
6. Gen V K Singh says, government focussed on aligning national standards for design, construction, maintenance and operation of roads, Orissadiary.com, Dec 06, 2019
7. Gen V K Singh hails participation of private sector in road development, Devdiscourse, Dec 06, 2019

CEAI NEWS

GENESIS OF A PARTNERSHIP WITH SEPC, MINISTRY OF COMMERCE AND INDUSTRY, GOI ... NOW ON A FIRM FOOTING

Report by Sayona Philip
Past President CEAI & Chairperson Presidents' Council

1. Meeting with Ministry of Commerce

CEAI first met with officials of the **Ministry of Commerce and Industry (MoCI), Government of India (GOI) in February 2018** and put forth all the concerns about various issues pertaining to development and growth of the consulting engineering services in the country. They informed them that formal support from the Government would go a long way in the growth of the services in the face of growing competition from International consulting engineers and suggested that a Mentor Ministry of GOI could fill that gap. The official conveyed that it was something that could definitely be taken up.

CEAI expressed its members' interest in participation as part of Trade delegations so that Indian Consultants could be more active in the overseas markets. The MoCI mentioned that the Engineering Services business, whether for export of services from India or by service providers from other countries operating in India, is governed by the Trade Agreements under WTO, to which India is a signatory. CEAI must build its business strategy based on GATS of WTO. (GATS – General Agreement on Trade in Services)

Further, it was suggested that for a level playing field under GATS, India could create some rules to be followed by Indian, as well as, International Service Providers. Those rules could be based on Standards created by the Bureau of Indian Standards (BIS), who would be empowered to suggest how benchmarking could be done. Indian, as well as, international engineering consulting service providers could be regulated by having to comply with those standards for doing business in India, through a certification or registration process for which a regulatory mechanism would need to be put in place. CEAI could prepare documents on short term regulations and long term standardization for providing services of consulting engineering.

Around that time, MoCI was in the process of identifying Champion Sectors for the Government to focus on and suggested that CEAI also holds a dialogue with SEPC.

2. Meetings with SEPC

In March 2018, CEAI met with the **SERVICES EXPORT PROMOTION COUNCIL (SEPC)**, MoCI.

The DG mentioned that there was no representation of engineering consulting organisations at SEPC and that SEPC would be happy to support their cause to address the needs of the sector for the export of services. Various suggestions were given by SEPC for participation in MoCI events like "Global Exhibition on Services" and setting up Buyer-Seller meets, supporting participation in Trade Shows and trade delegations to potential market destinations.

In May 2018, the President of India Shri Ram Nath Kovind launched ***12 Champion Service Sectors*** during the inauguration of the 4th edition of the ***"Global Exhibition on Services"*** in Mumbai, called it a bold new step that would contribute to both India's economy as well as the global economy and create jobs. They were to be the focused priority sectors of the Government of India and comprised IT & ITeS, Tourism and Hospitality, Medical Value Travel, Transport and Logistics, Accounting and Finance, Audio Visual, Legal, Communication, Construction and Related **Engineering**, Environmental, Financial and Education.

Thus, Engineering Services were given their due importance, when 'Construction and Related Engineering' was identified as one of the Champion Sectors by MoCI. The Press report on the event could be viewed on the link given below.

https://economictimes.indiatimes.com/news/economy/policy/working-with-ministries-to-develop-plans-for-12-champion-services-sector-com-secy/articleshow/64099292.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

3. BIS Industry Interaction

The Service Sector is one of the key drivers of the Indian economy with a huge potential to grow into one of the largest markets of the world. Standards play a major facilitative role in this regard. Since the standardization needs and priorities of the sector are determined through consultation with the industry, and standards developed with their involvement and participation, BIS planned an interaction as a follow up to the identification of Champion Sectors.

In August 2018, the MANAGEMENT SYSTEMS DEPARTMENT of the Bureau of Indian Standards invited representatives from all Champion Sectors, for **BIS Industry Interaction** at BIS HQ, New Delhi. They included Associations and companies from various service sectors. CEAI was invited to attend the Interaction. The President, CEAI attended the same.

Director General, BIS along with the ADG and two DDGs of BIS attended. Presentations were given by representatives from CII, Assocham, service sectors like telecom, healthcare, etc. BIS mentioned that they would be forming Sectoral Committees for the Champion Sectors to take it forward. This is still a work in progress and CEAI has brought it up with the Ministry subsequently.

4. Dialogue with SEPC

Around that time, the Consulting Engineers Association of India, as the apex body of consulting engineers in India and a Member Association of FIDIC ***(Fédération Internationale Des Ingénieurs Conseils)***, which is the International Federation of Consulting Engineers, was planning the FIDIC ASPAC International Conference on the theme ***'Quality Infrastructure for Clean and Sustainable Development'***.

Through the latter part of **2018**, CEAI started a dialogue with SEPC to partner it for the conference. Regular meetings took place in connection with their partnership for the Conference and how the opportunity could be used to showcase the Engineering Services sector.

Around **January 2019**, SEPC agreed to the partnership and in **March 2019** confirmed that the Ministry of Commerce and Industry, GOI had approved SEPC's proposal for **EnggIN,** a Reverse Buyer Seller Meet or B2B meet which would be held in parallel with the Conference. There would be a combined Inauguration, where the endeavour would be to request the Minister to be Chief Guest.

SEPC also suggested that there be a Panel Discussion on creation of 'Criteria for providing Engineering Services' by Domestic/ International personnel/ firms in India. However, CEAI suggested that a separate 'Workshop on Engineering Services for Benchmarking/ Setting up Criteria' be held. SEPC agreed and said they could hold it in IHC with about 25 to 30 persons attending. It could be scheduled at a later date.

5. FIDIC ASPAC CONFERENCE & EnggIN 2019

The FIDIC ASPAC Conference was held on 08-09 July 2019 at Le Meridien in New Delhi in partnership with SEPC, Ministry of Commerce and Industry, GOI.

SEPC is instrumental in promoting the efforts of the Indian services exporting community, hence, it launched **EnggIN 2019**, the first edition of the Reverse Buyer Seller Meet or B2B meet, on the first day of the FIDIC ASPAC Conference, held in parallel at Le Meridien. It was sponsored by SEPC in partnership with CEAI and was quite successful with about fifty buyers attending.

A true market place in India, EnggIN2019 brought together the entire spectrum of International Buyers including Government Agencies, Consulting and Contracting companies from USA, Africa, ASEAN Countries, Japan, China, Taiwan, Korea, France, Romania, et al. and Indian Sellers of Consultancy, Contracting, Engineering and other services under one umbrella to explore service offerings from India. The objective was to handhold International Buyers, through the process of collaborating with independent Indian Sellers, to develop and enhance their overseas business as well as boost India's services potential.

SEPC intends for EnggIN to be a regular event and India's biggest collaborating ground for Engineering Consulting Service Providers and Overseas Buyers.

6. Participation in GES 2019

In **November 2019**, CEAI participated in the ***'Global Exhibition of Services (GES) 2019'*** in Bangalore, organised by SEPC of MOCI, Government of India. Multiple parallel sessions in champion sectors were held as a part of the event that included a Panel Discussion on Engineering & Construction Services, the theme being 'Engineering & Construction Services - *Next Growth Engine for Indian Exports'*.

Key issues were discussed viz., the export potential and India's performance in the sector, its key markets & segments, Digitalization, Emerging Technologies, Innovation, etc., skill sets and training capabilities. It was felt that a focussed discussion on the issues of Consultants was necessary and a full day session should be held for that.

7. Budget Proposals

In December 2019, SEPC requested for CEAI to give their proposals for the budget for FY 2020-2021, even if it was to be represented to the Ministry of Finance, GOI. Based on inputs from several members, the gist of the proposals conveyed is given below, mostly pertaining to severe cash flows experienced by companies.

- 15% income tax for manufacturing companies set up after 1st October 2019, should be applicable to new SERVICE COMPANIES also.
- TDS is at 10 %, but actual income tax component comes to 4 to 5 percent. This impacts cash flows as 5% excess gets deducted. For Contractors it is 2%, in case of companies and 1% for individual listed contractors. Therefore, similar TDS rates should be applicable to consulting companies also.
- It would be fair to make consulting firms liable to pay GST only on receipt of payment and delays in payment of certified bills from public sector clients should attract penal interest.

GST CONCERNS:

- The "place of supply" for any service relating to an Immovable Property is the place where the Immovable Property is located. In case the customer is not registered where the immovable property is located then entire input tax credit is not available. It was suggested that the place of provisions should be amended. In case of Immovable property "place of supply" should depend on the customer's GST state.
- Issues related to export proceeds not received within a year: Exports can be made without payment of taxes in case LUT has been obtained by the Company. Further, the Company can claim refund of unutilised credit as per relevant rules. As per Rule 96A of the CGST Rules, 2017, the Company needs to obtain the export proceeds within one year of the invoice date. GST liability is to be paid along with interest from Invoice date in case the said proceeds are not received within the prescribed timelines. Currently, the Law is silent on mechanism and procedure to be adopted for refund of tax in such a case. Also, refund needs to be provided both for tax and interest paid by the assessee. Another suggestion is that tax should be payable after 1 year or post timeline which is allowed by RBI whichever is later.
- Allow Input Tax Credit (ITC) balance utilisation between Inter State: Input Tax Credit (ITC) is not allowed to be utilised between Inter State even though there is balance available in one state. This results in blockage of working capital (Cash) .It was suggested that the Government should allow utilisation of Input Tax Credit (ITC) between states.
- Incentives for export of consultancy services need to be provided as it has a domino effect on construction and supply industries, like exempting earnings from taxes in India.

CEAI ALSO PROPOSED THAT:

- SEPC should provide for financial assistance to the engineering consulting Industry to upskill Indian Consultants to make them more competent and competitive.
- SEPC sponsor or subsidise trade delegations (of Consultants) to potential user countries to enable marketing of experience and capabilities.

8. Meeting with Ministry of Commerce

In the latter part of **December 2019**, as a follow up of the interaction at the SEPC - AGM, a meeting was held by CEAI with the Additional Secretary, MoCI to discuss the concerns of the Consulting Engineering Business in India, including matters related to the need for a level playing field, the restrictive criteria for Indian companies in the participation for large bids, unremunerative prices for Consultancy and the need for fair terms and conditions for engineering consulting contracts. It was decided to hold a joint SEPC-CEAI Workshop to discuss various issues in January 2020, with participation from all stakeholders.

9. CEAI - SEPC Workshop

The Service Export Promotion Council (SEPC), MoCI, GOI and the Consulting Engineers Association of India (CEAI) jointly organized **'A Workshop on GLOBAL VISION 2030 - ENGINEERING AND CONSTRUCTION SERVICES – Challenges and the Way Forward'** on 28th January 2020 at the Royal Plaza Hotel, New Delhi.

The Workshop had participation from companies and individual experts from the engineering and construction service sectors and important stakeholders from the MoCI, SEPC, Ministry of External Affairs, EXIMBANK, et al.

The MoCI requested the organisers to send the Workshop proceedings with recommendations for further suitable action, by the Government of India.

The proceedings included the points made at the presentations, interactions from stakeholders/ participants and the recommendations for action to be taken by the Government of India. The summary of the recommendations are:

a) Engineers Bill – why legislation is essential for the Engineering profession

Engineers Bill would provide a framework for Indian Engineering & Design Consulting (EDC) and Project Management Consulting (PMC) with due focus on professionalizing this sector. It would ensure that:

- Professional consultancy services are rendered by qualified and competent personnel ensuring safety and welfare of the society.
- Only registered consultants are able to provide consulting services.
- Foreign consultants also need to be registered (equal treatment for Indians trying to work abroad).
- Licences are issued to individuals and companies.

IT WAS RECOMMENDED THAT:

- Legislation is required in the country to regulate the profession of engineering and create a cadre of engineers of high calibre in all the disciplines in a sustained manner.
- The Engineers bill which is under process be finalised by the Ministry of Human Resources Development (MHRD) at an early date.

b) Goods and Services Tax (GST), Income Tax, Payment Delays, Remunerative Compensation and Micro, Small and Medium Enterprises Development (MSMED)

GST: IT WAS SUGGESTED THAT:

(i) Revisions should be made in the GST deposit process. Instead of paying GST by the month following raising of invoice, the options are:

- ➢ GST on the payments by the Service receiver must be deducted at source.
- ➢ GST by the public sector be paid on Reverse Charge basis.
- ➢ GST to be paid by the Suppliers on receipt of payment and not after mere raising of invoices for services rendered.

(ii) GST for Consultants be reduced to 10%.

- **Income Tax and Payment Delays:** To improve the cash flow of companies in the sector, it was recommended that:

(i) a single rate of TDS for everyone who has PAN may be retained, at 1% or 2% of turnover.

(ii) Section 194J of the Income Tax Act be amended to limit TDS to 4% (or maximum 5%, as prevailed till 2007).

(iii) Government and Public Sector undertakings mandatorily pay dues to the service provider within 45 days of receipt of services, and modify payment terms suitably.

(iv) Government bodies to have competent technical staff to review and approve consultant's work and for counterpart staff to work with the Consulting and Contracting teams till project completion.

(v) As projects get delayed, it may be worthwhile to consider T&M (time and material) approach foraward of engineering services contracts.

- **Remunerative Compensation:** It was recommended that:

(i) Quality and Cost based selection of Consultants be done for project execution, even more so when the projects are large or complex.

(ii) The weightage for quality and cost should preferably be 90:10 (as done for most funded projects) or atleast 80:20, with a provision of reviewing those whose quote fall beyond the threshold of+/- 15% of the average financial bid amount in the project.

(iii) The Works should be awarded at Lowest Workable Rates and not at Least Cost, as is at present.

- **MSMED Act:** It was recommended that:

(i) Upper limit of Rs.250 crores for annual turnover for Medium Enterprises may be increased.

(ii) Include the Medium/ Professional Enterprises in the definition of 'Supplier' u/s 2 (n) of the Act.

(iii) In the interim period, direct Government & Public Sector Undertakings (PSU) to pay dues to Medium Enterprises within 45 days of receipt of invoices, as being followed for MSMEs.

c) Contractual Matters

Important Contract clauses need to be modified and the Ministry of Commerce may recommend that key contractual guidance be provided by Ministry of Finance for Consultants with respect to Indemnity, Liability Limit, Payment milestones; for contracts involving India's national security, usage of Indian Arbitration & Conciliation Act, 1996; release of BG/ Retention Money in agreed timeline, need to ensure 5% recoverable profit in all PSU/Indian government contracts as per FIDIC guidelines, Extension of Time for concurrent delay, Joint and Several responsibility of all parties forming the JV, delegation of powers to appropriate decision making authorities, Omnibus Bank Guarantee system, promoting Professional Liability Insurance, Prioritised Finalisation of Arbitral Awards. Further, the need for an empowered National Regulator or Approving Authority should be established by the Government with regional presence like the NCLT to approve/disapprove such actions.

d) Engineering Services Provider Definition and Qualification

The recommendations were:

- In order to ensure the quality of deliverables on engineering projects, it is recommended that the award of consulting works be limited to pure play engineering consulting companies only.
- Indian consulting companies should be provided equal opportunities in first time projects based on their pedigree and credentials.
- Indian companies need to upskill in new areas and acquire expertise in new technologies and by partnering with International firms, but with significant participation.
- The process of benchmarking and setting of standards by the BIS could enable a certification process for doing business in India.
- Prequalification criteria for firms should be fair and public sector contracts do away with restrictive clauses to ensure a level playing field.

e) The Domestic Construction (EPC) Industry

It was recommended that:

- Award of projects on L1 basis be made obsolete and bidders be technically evaluated on the previous track records, innovations adapted, etc. and thereafter by price quoted with suitable weightages provided.
- Evaluation be done or the Key Performance Index (KPI) be evaluated and reviewed on a quarterly basis. And shortfalls to be dealt with strictly.
- New technology be accepted and old and obsolete standards be revised and only the concerned and relevant authorities be responsible for approvals.
- An agency to provide the accreditation/certification of competency be established, a common talent pool be prepared wherein the skill set requirement be identified, etc.
- Government Clients should be empowered to take decisions and Project Timelines should be fixed and monitoring should be done for both the Client & the Contractor.
- The stakeholders should come together and resolve the challenges of the skill ecosystem.
- Motivation is required for the Core Engineering Graduates to pursue career in construction.
- Gig Economy to be encouraged where assignment based employment is encouraged.
- Manual dependencies have to be decreased and mechanization has to be encouraged, so as to free up resources for higher value work.

f) Technology Transfer, Capacity and Capability build-up

It was recommended that:

- The Government help build capacity and capability of its resources and its companies, enabling them to expand their knowledge base and upskill their engineering talent.
- It is recommended that India sets up Design Institutes or Design Organisations to build comprehensive expertise in domestic companies and foster a culture of innovation in the country.
- As a first step it needs to establish the parameters and identify area wise Design Institutes or Design Organisations from both the Public and Private sector.

g) Technology Infusion

It was recommended that:

- the Government take the lead in implementation and technology infusion. Digital databases of communities and cities must be planned with 3D digital models of assets for regulatory approvals and management of assets.
- Command and control centres with digital connectivity would help in better governance and knowledge sharing during project execution and help create reference databases for future projects, better delivery, etc.
- the government must take initiatives to mandate delivery of engineering using BIM or equivalent for all large and complex projects.

OVERSEAS BUSINESS

h) EXIMBANK funded Projects

Some major recommendations were for:

- Clear definition of the term 'Indian Consultant'.
- Parameters be set out for the recipient Country to facilitate their internal budget preparation in consonance with the LOC requirement.
- EXIMBANK to carry out a thorough review of RFP documents to ensure provision of adequate staffing and Contract conditions.
- Hand-holding and strict monitoring to confirm readiness of the recipient Country to deliver the Project/s, after approvals and process payments in a timely manner.

- EXIMBANK to issue Guidelines for exercising flexibility in addressing time extension and variation issues.

i) EPC experience in Export Markets

It was recommended that:

- the Government of India follows the Principle of Reciprocity when dealing with other countries.
- Indian EXIMBANK should reconsider its own terms on Buyer's Credit to make it more lucrative by considering appropriate interest rates and loan durations, currency of funding and loan amounts disbursed.
- More visible support be provided by Indian Embassies in other countries, discourage unfair practices and for business delegations from India to present a united front overseas.

j) Government Support

If the Indian Engineering and Construction Services Industry have to contribute its mite for India to become a USD 5 Trillion economy, it needs to have a renewed focus on the export market and the Government of India would have to,

- Help in hand holding Indian Consulting and EPC Companies through the SEPC of MOCI, the respective Indian Missions overseas through the Ministry of External Affairs, and the EXIMBANK.
- Invite Indian Companies to be part of trade delegations/ Road Shows in countries where India is providing soft loans and grants.
- Engage with foreign Governments overseas to help Indian private sector companies compete in a transparent manner on sector basis for EXIMBANK LOC projects.
- Support Indian Consulting Companies in capacity building to enable small companies to be able to go out and do business in the International Market.

10. Services Exports from India Scheme (SEIS)

In March 2020, CEAI made a representation to MoCI on the need to continue with the Service Exports from India Scheme (SEIS). The SEIS in its current form was introduced in 2015 to incentivise export of services from India to organisations outside India. It aimed at promoting exports by providing duty scrip credit for eligible exports. The SEIS was earlier termed as Served from India Scheme (SFIS).

CEAI emphasised that in the Engineering Services sector, presently, domestic projects yield very little profit due to various reasons, and those companies that have ventured overseas are dependent on international projects for profitability. Several companies are in distress due to GST, large payment outstandings, most often brought about by Contract conditions which tend to be one sided. This was especially so, for those working on large Government and Infrastructure projects, with outstanding to the tune of almost 2/3 of their revenues.

Therefore, withdrawal of the scheme would aggravate further the hardship of those companies who had also invested considerable capital in International business which required continued investment till the business reaches a certain level of maturity, quality benchmarks attained and begins to pay for itself. CEAI has requested for an interaction with the Ministry on this.

WORKSHOP ON GLOBAL VISION 2030 – ENGINEERING & CONSTRUCTION SERVICES

CEAI has been expanding its outreach for interactions with Government departments to convey the problems that the fraternity face and also to persuade authorities to initiate long term corrective actions for redressal of the contentious issues. An opportunity came in the wake of the seminar held during the GES conference held in Bengaluru in November 2019 which has been reported in the December 2019 issue.

The Service Export Promotion Council (SEPC), of the Ministry of Commerce and Industry (MOCI), Government of India (GOI) and the Consulting Engineers Association of India (CEAI), had jointly organised the '***Workshop on Global Vision 2030 – Engineering & Construction Services'*** on 28th January 2020 at the Royal Plaza Hotel, New Delhi.

The workshop was held in two focus sessions. *The first session was on the topic of 'The Domestic Scenario – Challenges and Need for Capacity Building'*. Mr. Sudanshu Pandey, Additional Secretary, Ministry of Commerce, chaired the Session.

Ms. Sangeeta Godbole, Director General of SEPC delivered welcome address. She briefed about SEPC and that SEPC has just started promoting the export of Engineering Services. She said that after the B2B meeting organised jointly by CEAI and SEPC in July 2019 at New Delhi, SEPC and the Ministry of Commerce & Industry, GOI, had organized the 'Global Exhibition of Services' (GES) in November 2019 at Bangalore. This workshop was a follow up of those events.

Mr. Amitabha Ghoshal, President CEAI briefed about the objectives of the workshop. He explained that CEAI is the mouthpiece of Consulting Engineering industry and was aiming to strengthen the sector, such that Indian capability can be exported to the entire world. As a Member organization of FIDIC, CEAI was authorized to conduct training on FIDIC Contract documents in India. He also stressed the need for statutory recognition for Indian Engineers like other professions, i.e., medical, legal, etc.

Thereafter five speakers presented their views in the first session:

1. Mr. V N Heggade of STUP Consultants Pvt. Ltd.
2. Mr. A K Singh, Vice President, Larsen & Toubro Ltd.
3. Dr. Rajashekhar Malur, Chief Technology Officer, Tata Consulting Engineers Ltd.
4. Mr. K K Kapila, Chairman & Managing Director, ICT Pvt Ltd.
5. Mr. Amit Sharma, Managing Director, Tata Consulting Engineers Ltd.

At the end of the first session, M. Sudanshu Pandey, Additional Secretary, MOC, presented his views on the topic and the support being provided by MOC. He suggested that a detailed study be conducted to compare with the global market. Thereafter a focus session should be conducted which can address some of these issues. On request of Mr. Amitabha Ghoshal, President CEAI, Mr. Pandey invited CEAI to approach MOC at any time with a specific agenda which would be beneficial for the consulting profession. Mr. Pandey informed that Mr Amit Sharma, MD of TATA Consulting Engineers Ltd. had been elected to the Governing Council of SEPC.

The second focus session was on the topic of *'VISION 2030 – How Aspirational India can Compete Globally'*. This session was chaired by Mr. Darpan Jain, Joint Secretary, Ministry of Commerce & Industry, Government of India.

The speakers for the session were:

1. Dr. Ajay Pradhan, President & CEO, Cetus Consulting Solution Services Pvt Ltd
2. Dr. Dhaval Parikh, Director (International Business), Aarvee Associates Engineers & Consultants Pvt Ltd
3. Mr. Abhik Pal, Former Executive Vice President & SSUB Head (T&D), Tata Projects Ltd
4. Mr. Pankaj Kumar Singh, Advisor (Infra), Ministry of External Affairs
5. Mr. S Prabhalathan, CGM, EXIM Bank

Mr. Darpan Jain, Joint Secretary, MOCI, GOI offered the ministry's support to CEAI for discussing the issues being faced by the engineering profession in India.

As a follow-up CEAI submitted consolidated proposals on different issues to the Ministry of Commerce.

The entire proceedings went off satisfactorily in an atmosphere of positive vibes.

Mr. Amitabha Ghoshal, President CEAI addressing the participants

Ms. Sayona Philip, Past President CEAI and Ms Sangeeta Godbole, DG SEPC

Mr. Darpan Jain, Joint Secretary, addressing the participants

Mr. Sudanshu Pandey, Additional Secretary, Ministry of Commerce, Government of India sharing his views with the participants

Dr. R Malur,COO Tata Consulting Engineers Ltd. presenting his views

Mr. Amit Sharma, Managing Director, Tata Consulting Engineers Ltd. presenting his views

Mr. K K Kapila, CMD ICT Pvt. Ltd.presenting his views

NATIONAL CONFERENCE 'WATER INFRASTRUCTURE FOR URBAN AREAS AND INDUSTRIES'

Dr. S Chatterjee & Dr. Ajay Pradhan

"Water, water everywhere, Nor any drop to drink."

The famous quote from the late eighteenth century poet Samuel Taylor Coleridge, virtually sums up the future that would stare at the mankind, if water is continued to be used as callously and recklessly as has been and is being used. People would be stranded amidst the oceans of water, starving for usable water, like the *Ancient Mariner.* As Benjamin Franklin said *"When the well is dry, we know the worth of water."*

India faces a turbulent water future, even though it has one of the world's largest fresh water reserves. Unless water management practices and water infrastructure are updated, India would surely face a severe water crisis within the next two decades. India would have neither the cash reserves to build huge new infrastructure nor the water needed by its increasing population and expanding economy. In this context, the role of water related infrastructure is inseparably linked to good sourcing of water, extracting the water, treating the water, transporting and consuming water, treating the waste water and recycling, in the most sustainable manner.

Based on the above objectives, CEAI organized the two-day National Conference on *'Water Infrastructure for Urban Areas and Industries'* in partnership with the Kalinga Institute of Industrial Technology (KIIT), deemed to be University, on 13th and 14th February 2020 at the KIIT Convention Centre, Bhubaneswar, Odisha. The conference was supported by engineering consultants, water infrastructure owners and operators, technology providers, regulators, water infrastructure construction companies, et al.

A total of 24 renowned and experienced national and international speakers including Keynote speakers presented their views and shared experiences with participants. The conference was well attended

Dr. Ajay Pradhan, Chairman of the conference delivering the Welcome Address. Mr. Amitabha Ghoshal, President, CEAI, Mr. Priya Darshi Mishra, Chairman, OSHB who was Chief Guest, Prof. H Mohanty, VC, KIIT University, Prof. R K Khandal, President, India Glycols and Dr. S Chatterjee, Past President and Governing Council Member, CEAI

with over 120 participants from urban local bodies, regulators, industry, government agencies, technology providers, construction companies, consulting fraternity, academicians and students.

There were six technical sessions including the plenary and finally the panel discussion on the conference themes and the way forward.

Dr. Ajay Pradhan, briefing Dr. Achyuta Samanta, MP (Lok Sabha) & Founder KIIT & KISS and Chief Guest Mr. Priya Darshi Mishra, Chairman of Odisha State Housing Board

The Chief Guest of the conference Mr. Priya Darshi Mishra, Chairman of the Odisha State Housing Corporation highlighted that making the source of water available for new urban development and expanding housing infrastructure poses one of the biggest challenges in cities like Bhubaneswar in spite of being the capital of the most water rich state of India. It was also discussed that sustainable and good quality of potable water supply to cities must ensure a right water tariff to recover part of capital expenses as well as the operation and maintenance costs. That would need to be done through proper stakeholder management as demonstrated in urban local bodies of Maharashtra as stated by Dr. Malini Vijayshankar, Director IL&FS Group and ex Addl. Secretary (Water) Government of Maharashtra. It was widely discussed and felt that technological, institutional, financial and social aspects are key factors that, must be considered for any successful operation of Urban Water System.

Dr. Ajay Pradhan, Mr. Amitabha Ghoshal, Dr. Malini Vijayshankar, Dr. Arun Ghosh and Prof. Arun Kumar

While there is a great challenge in making available essential water related infrastructure towards urban sanitation facilities in cities, the regulators imposed a very heavy penalty for failure to check the urban waste water load into the rivers or other water bodies. The Vice Chairman and Member Secretary of Odisha Water Supply and Sewage Board, Mr. Dwaipayan Pattanaik, presented experiences of a unique method of managing faecal sludge from septic tanks by collecting through a mobile vehicle and treating at a centralized facilities. It was a very unique approach for a short-term measure, before proper sanitary networks are implemented, connecting each household to waste water treatment plants. At the same time, it was discussed that there must be proper policy for reuse and recycling of treated waste water and sludge towards building up resilient urban water status, through circular economy concept. New technologies with smaller footprint of land and lesser energy consumption were presented to ensure the future sustainability of urban water infrastructure.

Some of the real challenges in regards to preparation of Detailed Project Report and execution of Urban Water Supply & Sewage Systems of old cities of Odisha were presented by consulting engineers and agencies managing and overseeing their execution. It had indeed opened up the new vistas as the persons present learnt lessons and gained knowledge from them in terms of the innovative ways of approaching the problem with a strong stakeholder's participation, and using new methods of construction to overcome the challenges at the implementation stage. The Odisha Government had taken the lead in terms of ensuring 100% metered water supply system with over 90% collection of tariffs through *Jal Sathi* through women's self-help groups. That was shared by the Project Director JICA Project and the Project Manager for Cuttack and Bhubaneshwar with financial support from JICA since 2012.

Since the majority of Indian cities are being supplied with ground water as the source of drinking water, it was discussed that the ground water sources are depleting at a very fast pace. That is further aggravated by increased surface run-off, lesser rainy days and not adequate recharging to improve the ground water table. It was believed to be the result of climate change and rapid urbanization with high spatial-temporal variations of rainfall. Hence, cities must ensure a mandatory plan for rain water harvesting, storm water management for water supply, etc. for any new housing infrastructure.

CEAI Members with Faculty and Students of KIIT University

Mining and Industrial Water Supply and Effluent Treatment were discussed in one of the focus sessions with implementation of Zero Liquid Discharge concept and policies including government support for better value and incentivization. Similarly, a stringent and process oriented mechanism should be put in place for all open cast mining activities with monitoring of afforestation work. A research study presentation was made on the rate of increased deforestation and barren land due to mining activities in the state of Jharkhand.

The last session was on making available finances to support the creation of urban water infrastructure through flexible PPP methods by ensuring viable gap arrangements and support in revenue recovery realization for the operators to minimize their risks. It was clearly brought out that there is a huge shortfall in making available finances for urban local bodies to build to meet the growing need of water requirements in terms of distribution and collection systems. During the session, experiences of JICA financing for water and waste water of Cuttack and Bhubaneswar cities cases were shared by the Project Manager. Both the cities have adopted an unique mechanism of women self-help group *Jal Nidhi and Jal Sathi* on ward wise basis for collection of tariffs for all metered connection with incentivization scheme. The AP Urban Infrastructures Ltd, a special purpose vehicle shared their experiences of private financing for water infrastructure through revenue realization model on a strict timeline basis of execution. It was very educative to learn of the novel methods of financing schemes that are currently underway in several places in India. Therefore, it is concluded that a PPP should be flexible and should not be based on the same approach or one size fit all models for every project.

Mr. Chinmay Tripathy, Project Manager, JICA sharing experiences on projects

Finally, the panel discussed amongst many aspects thee issues and challenges deliberated during the two days conference on water infrastructure for urban areas and industries. The key aspects that emerged were:

a) Involvement of all Key Stakeholders right from the beginning of the project to ensure timely completion.

b) Cities need to have revenue collection mechanism to ensure smooth operation and maintenance; Bhubaneswar City being an example.

c) PPP schemes should be based on realistic cost and flexible model for successful operation.

d) Technology should be the key enabler in bringing down the cost of operation and overall infrastructure cost, in the face of restricted availability of land.

GOODBYE L1! A ROUTE TO SUSTAINABLE ENGINEERING DEVELOPMENT

Report by Prashant Kapila & Somenath Ghosh

Considering the global awareness and understanding of the role of engineering in modern life, United Nations Educational Scientific and Cultural Organisation (UNESCO) had declared 4th March 2020 as *World Engineering Day for Sustainable Development. As a part of the World Engineering Day celebrations, CEAI organised a seminar on "Goodbye L1 -A Route to Sustainable Engineering Development"* at the India International Centre, New Delhi. CEAI was amply supported by IEEMA (Indian Electrical and Electronics Manufacturers' Association) in the conduct of this seminar along with MoRTH, NHAI, CPWD, ECI, IEI, CIDC and FIDIC.

The Seminar was inaugurated by Shri Nitin Gadkari, Hon'ble Minister for MoRTH & Shipping, and Dr. Rajiv Kumar, Vice Chairman, NITI Aayog joined the session as the Guest of Honour. The Inaugural Session was preceded and followed by a number of technical presentations from key government agencies engaged in procurement. The event was well attended by delegates from NITI Aayog, Central Vigilance Commission (CVC), Department of Expenditure (Ministry of Finance), large user organisations from Government (CPWD, MES, MoC& I, NHAI, Power grid, RVNL) and the Private Sector (L&T, Tata Projects, Sterlite, Siemens, KEC International, Crompton Greaves, Bajaj Infra) and multiple Consulting Engineering Firms.

During the Seminar, CEAI addressed the inadequacies in the current method of selection of consultants and contractors on the Least Cost Basis which results in substandard quality of construction with time and/or cost overruns, innumerable legal cases as well as poor quality DPRs, etc. There was a general consensus on the need for a more equitable method of selection based on Lowest Workable Rates.

In an effort to accord due importance to this topical subject, CEAI would be covering it in two parts. In the first part, a brief summary of the proceedings with views of the Speakers are being shared in the following paragraphs to give an idea about the existing thought process in the minds of the key Stakeholders, critical for the progress of the objective. In the second part, the Seminar recommendations would be finalised along with NITI Aayog and would be presented in due course for the benefit of all.

In his inaugural address, the Hon'ble Minister Gadkari ji remarked, *"I am fully aligned with the spirit of elimination of L1 .... There is a need for fast track decision making process with complete transparency, corruption free system and a qualitative approach to work. .... To make this happen, NITI Aayog should take leadership and I will fully support NITI Aayog. .... We want to encourage Indian Contractors, Engineers and Consultants."*To elucidate his point, he cited the example of the Mumbai-Pune Expressway Project undertaken on PMC mode with full responsibility, the project was completed in Rs. 1,650 crores as against the budgeted expenditure of Rs. 3,600 crores. He opined that to ensure Quality, the system of credit rating of Consultants and Contractors by reputed third-party agencies for unbiased and fair assessment, should be quickly introduced by NITI Aayog. Besides, he also suggested the need to reshape the public perception on the rationale to change L1 to alternate options, which

would ultimately benefit the country. He reiterated the need for time bound decision-making process and on time delivery of works.

Dr. Rajiv Kumar, Vice Chairman, NITI Aayog opined that though achieving the stated goal was not going to be easy, there was a silver lining with the Central Vigilance Commission clearly in favour of exploring alternatives to L1 system. Driving home the point, he said there was a need to correct the misnomer that giving up L1 system and adoption of alternative methods would result in cost escalation or corruption in the system. The change from L1 System has to be backed up with extensive public awareness to the proposed alternative procurement system, its benefits and efficacy.

The FIDIC document on alternative mechanisms serves as a good reference. The other aspects in the bidding process could be the credit rating of the bidder as is done by The World Bank for the international tenders, an explicit price preference could be extended to home grown companies in construction, contracting and consulting. He concluded his address by suggesting the way forward when NITI Aayog would prepare Seminar recommendations, engage with the Department of Expenditure, Ministry of Finance and put it up to the Cabinet with a view to amend the General Financial Rules (GFR).

Mr. K. K. Kapila, Past President, CEAI and Mentor of the programme, elucidated in detail how Good-bye to L1 would not result in increase in the overall Project Cost. He highlighted on the need to influence public opinion by writing articles on the theme of Goodbye L1 in newspapers, social media, conduct of public debates and use of whatever tools that are available to try and build an eco-system whereby it is rightly understood that this change was for the benefit of the nation.

Mr. Amitabha Ghoshal, President, CEAI, acknowledged that it was fortuitous to celebrate the World Engineers Day on the theme of "Goodbye L1" which is of relevance to the entire business and the professional services community. Though the Seminar elicited good participation from the Government Authorities, Owners of Contracts, Engineering Consultants, he remarked that the presence of manufacturers, producers, suppliers and sub-contractors, who are equally affected by this current system of procurement of goods and services could have been better.

The Inaugural Session concluded with a vote of thanks from Ms. Sayona Philip, Past President, CEAI who pledged the support of the Consulting Engineers' fraternity to the cause of equitable and fair evaluation and award of works.

The Technical Session had some interesting and intense deliberations between the speakers from various government departments on the pros and cons of L1. Mr. R. K. Pandey, Member (Projects), NHAI mentioned that he was unable to find ready made justifications for changing from L1 for Selection of Contractors, as against the Selection of Consultants where it was rather simpler to justify with sufficient data, the QCBS approach with 80:20 weightage. He presumed that the same would be the case for manufacturers or suppliers. He was of the opinion that capable organisations should be awarded the contracts, which could be facilitated by the process of credit rating. He urged that while making recommendations from this Seminar, the need for change should be lucidly brought out along with alternative options, to facilitate its broader acceptance.

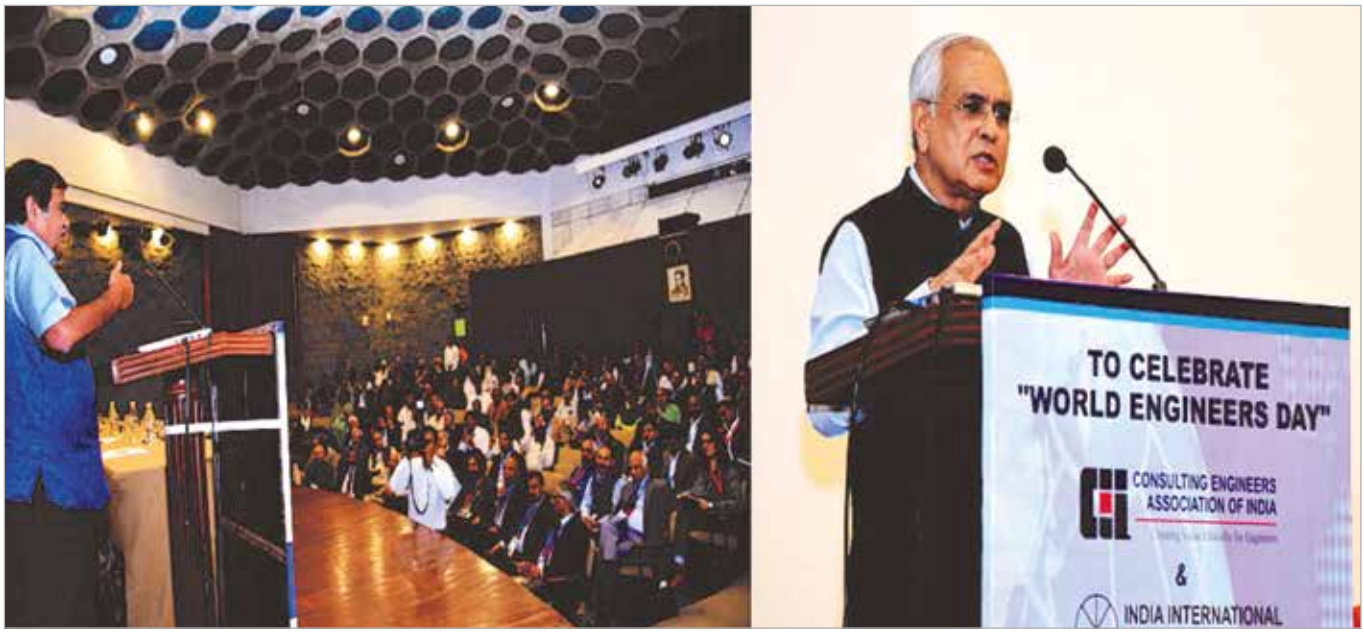
A presentation on Alternative Procurement Mechanisms as proposed by FIDIC – on Lowest Workable Cost approach, Cost and Quality approach and Quality approach was made by Lt. Gen S. Ravi Shankar (Retd.), Former DG (Border Roads) and President, ICT, who very lucidly described them with suitable data and explanations. The methods could be reviewed and considered for adoption for procurement of Contract, Services and Goods by a Nation, as deemed fit.

In summarising the deliberations during the day, Dr. S.K. Saha, Advisor, NITI Aayog whole-heartedly supported the initiative and was committed to making the recommendations foolproof. He stated that, while acknowledging that procurement was a complex process, the end user or the common man was not interested in knowing how the contract was awarded or at what price, butwhat was important was the quality of services/ goods and the common man becomes price conscious, only when the goods/services were not up to the mark.

Mr. Shailendra Singh, CTO, Central Vigilance Commission (CVC), one of the proponent organisations

of the change from the L1 system mentioned that it was time to look beyond the prescribed method, i.e., Least Cost Selection method or the L1. He added that as presented by many during the day, there could be instances where L1 system was justified and it could be continued for routine procurement cases which do not have much impact. However, in cases of procurement of services and works for specialized/ complex projects or goods, whose outcomes have a large bearing on the Society, cost alone should not be a consideration for such procurement.

For Consultancy Contracts, the GFR allows procurement strategy besides L1, and Quality cum Cost Based Selection method has already been recognized as a valid method of procurement of consultancy services. However,non-consultancy services, i.e., goods and works still rely on the age-old practices of Least Cost Selection method. Taking cognizance of the need for better solutions, the CVC in October 2019 had prepared a Concept Paper which is currently under consideration by the Government.



CEAI LECTURE SERIES

In continuation of the first Lecture series held from August 2018 to January 2019, CEAI is organising a series of six monthly lectures at the Indian International Centre, Lodhi Road New Delhi from January 2020.

The first Lecture was held on 22nd January 2020 on 'Role of Standards and Certification for Quality'.

Dignitaries on the dais: (L-R) Mr. Sanjay Pant, Mr. H S Dogra, Mr. Anil Jauhri, Mr. Somenath Ghosh

The lecture was chaired by Mr. H S Dogra, Former DG, CPWD and Chairman Civil Engineering Division Council, BIS. Presentations were made by Mr. Anil Jauhri, Former CEO, National Accreditation Board for Certification Bodies (NABCB) and Mr Sanjay Pant, Scientist F, Head Civil Engineering Dept., Bureau of Indian Standard (BIS).

Mr. Anil Jauhri making his presentation

Mr Sanjay Pant making his presentation

CEAI MEMBERS' NEWS

India Economic Conclave

The Bengal Chamber of Commerce & Industry (BCC&I) organised the second edition of 'India Economic Conclave' on 15th January 2020 at the Park, Kolkata.

Mr. Amitabha Ghoshal, President CEAI was invited for chairing the session on '*Infrastructure Development and its Influence on Economy'*.

Mr. Amitabha Ghoshal, President CEAI, addressing the participants during the conclave

BUSINESS SPHERE MAGAZINE'S AWARD

Mr. Arvinder S Brara, Vice President, CEAI and Chairman & Managing Director, Mantec Consultants Pvt. Ltd. received the Business Sphere Magazine award for ***Excellence in the Field of Technical and Environment Consultancy*** at a function held on 16th January, 2020.

Left to right: *Mr. Deepak Khattar, Editor, Business Sphere, HE Mr. Juan Cortez Rojas, CDA & Head of Mission of the Plurinational State of Bolivia, Mr. Arvinder S Brara, Dr. Anil Agarwal, Member of Parliament, Rajya Sabha, Mr. K. L. Malhotra, Advisor, HE Mr. Ricardo A. Berna, CDA & Head of Mission of the Republic of Panama*

ANNUAL CONVENTION OF BUILDERS ASSOCIATION OF INDIA

BAI held their annual convention this year at the Vedic village near Kolkata on 5th January, 2020. Mr. Amitabha Ghoshal chaired the session on *'Future of Construction'* and updated the audience on what to expect in the future.

AWARD FOR BEST PROJECT MANAGEMENT CONSULTANCY & BUILDING DESIGN SERVICES IN INDIA

Mr. Vineet Lochan Gupta, Life Member of CEAI and CEO of Techno Engineers received the award for the Best Project Management Consultancy & Building Design Services in India. The Award 2019 was organised by Blindwind.

Mr. Vineet Lochan Gupta receiving the award

MR. ALOK BHOWMICK ELECTED AS A FELLOW OF INAE

In recognition of the commendable work and invaluable contribution in the field of bridge and structural engineering, the Council of the Indian National Academy of Engineering (INAE) elected Mr. Alok Bhowmick as a Fellow of INAE with effect from 1st November 2019.

FIDIC NEWS

FIDIC INTERNATIONAL INFRASTRUCTURE CONFERENCE 2020

With the current uncertainty and the pace of developments concerning COVID-19 the FIDIC International Infrastructure Conference scheduled to be held in September 2020 in Geneva has been postponed

CEAI REPRESENTATION TO FIDIC COMMITTEES

FIDIC has invited nomination from CEAI for their committees. CEAI nominated the following members in various committees of FIDIC:

	Committees	Nominated members
1	Business Practice	Mr. K K Kapila Dr. Ajay Pradhan
2	Capacity Building	Ms. Sayona Philip
3	Contracts	Dr. Dhaval Parikh
4	Future Leaders	Mr. Jitendra Singh
5	Integrity Management	Dr. S Chatterjee
6	International Financial Insitutions	Dr. Dhaval Parikh
7	Membership	Mr. K K Kapila
8	Sustainable Development	Mr. Sudhir Dhawan

FIDIC COVID-19 WEBINAR SERIES

FIDIC has started webinar series for FIDIC member associations and their member firms.

This webinar session is targeted at FIDIC member associations (MAs) and their members to better understand how MAs and firms are responding to the current crisis and how they are adapting their activities going forward given the ramifications and implications of COVID-19. This webinar will discuss responses from the global level down to national market examples.

Speakers will include leading professionals from FIDIC global member associations who will address the key issues being faced by their business associations and their members. COVID-19 is raising issues that associations have not had to deal with before and given that the entire industry is affected by the COVID crisis, the challenges faced by association professionals are acute and demand a careful and thought through response.

By sharing experiences from across the world, this webinar will offer help and guidance to member associations facing the challenge of dealing with the current crisis.

The first webinar of the series was held on 7th April 2020. The following experts were presented their views:

- **John Gamble**
  President and CEO, ACEC Canada
- **Linda Bauer-Darr**
  President and CEO, ACEC USA
- **Hannah Vickers**
  CEO, ACE UK
- **Chituwa Sinkala**
  Chief Executive, ACE Zambia
- **Nicola Grayson**
  CEO, Consult Australia
- **Maurizio Boi / Marco Ragusa**
  President/CEO, OICE Italy
- **Prashant Kapila, Chief Operating Officer**
  Intercontinental Consultants & Technocrats Pvt Ltd, India

OTHER NEWS, VIEWS & NOTES

VIEW POINT

The themes for the next three issues of Viewpoint spread over nine months would be:

(a). **New Materials & Systems for Buildings**
(June 2020)

(b). **Stakeholder Management in Public Infrastructure Projects** (September 2020)

(c). **Digital Engineering** (December 2020)

Considering the experience of CEAI members and various stakeholders in the subjects, CEAI would be happy to receive articles on the above themes.

Authors could share their knowledge and experience by providing case studies of the works executed or in execution, first-hand accounts of the challenges faced, practical issues experienced and the solutions to those, etc. Photographs, charts, diagrams, drawings, etc. would benefit our readers for better appreciation of the issues encountered and addressed.

The articles for an issue need to reach CEAI at least 6 weeks prior to the end of the month of the View Point issue.

Articles need to be in Times New Roman 12 with single line spacing with before and after 6 pt and normal margin on A4 size. A recent clear and bright passport size photograph of the author is to be sent along with the article.

Advertisement in View Point

VIEW POINT is circulated to all CEAI Members, FIDIC, Ministries of the Government of India, Public & Private Sector Undertakings, Construction Firms, Contractors, Consultants, Foreign Missions and Funding Institutions in India and other organisations related to or dealing with the engineering profession.

Advertising in the VIEW POINT gives the Advertiser wide exposure and visibility.

Support from CEAI members and stakeholders are sought in increasing the number of advertisements, so that View Point gains in stature as an unique Technical Publication.

The rates for advertisements in VIEWPOINT are given below. This is excluding GST @ 5% or as prescribed, which will be extra:

Item	Rate Per issue* (Rs)	Discounted rate at 20% for 4 consecutive issues* (Rs)
Back Cover **	25,000/-	80,000/-
Inside Front Cover***	15,000/-	48,000/-
Inside Back Cover***	15,000/-	48,000/-
Full Page	10,000/-	32,000/-

**GST @ 5% or as prescribed will be added to the above rates.*
*** Back Cover booked till Sept 2020 / **Inside Front Cover booked till June 2021*

Tech Quiz

1. **When were Cast Iron pipe first used for water supply?**
   a. 1510
   b. 1680
   c. 1412
   d. 1313
   e. 1411

2. **Which is the oldest habitation with a sanitation system?**
   a. Egypt
   b. China
   c. Mesopotamia
   d. Greece
   e. Indus Valley Civilization

3. **What is the major cause of fires in residential buildings?**
   a. Electrical Defaults
   b. Cooking
   c. Crackers
   d. Gas
   e. Matchsticks & Candles

4. **How many cities in India have continuous water supply?**
   a. One
   b. Six
   c. Three
   d. Two
   e. Eight

5. **In which city in India was an Elevator first installed?**
   a. Kolkata
   b. Mumbai
   c. Delhi
   d. Chennai
   e. Baroda

6. **Who started biometrics?**
   a. Alphonse Bertillon
   b. Woody Bledsoe
   c. John Daugman
   d. Helen Chan
   e. Joao De Barros

7. **When was room air conditioning introduced in India?**
   a. 1925
   b. 1954
   c. 1970
   d. 1962
   e. 1950

8. **Which was the first city in India to get electric supply?**
   a. Darjeeling
   b. Bangalore
   c. Calcutta
   d. Bombay
   e. Madras

9. **In which Indian city was the fire brigade started?**
   a. Bombay
   b. Madras
   c. Delhi
   d. Calcutta
   e. Surat

10. **Who created the modern AC unit?**
    a. Stuart Cramer
    b. Charles Gate
    c. Michael Faraday
    d. Willis Carrier
    e. John Hadley

The first person who mails the correct answers to ***CEAI info@ceai.org.in*** will get a congratulatory mail and will be acknowledged by publishing the persons photograph in the next issue.

Contributed by A P Mull

Answers to Tech Quiz December 2019 issue

1(d), 2(b), 3(e), 4(c), 5(e), 6(d), 7(a), 8(b), 9(c), 10(a)

Prof. Mainak Ghosal, Consultant is the winner of the Tech Quiz with full/ maximum marks.

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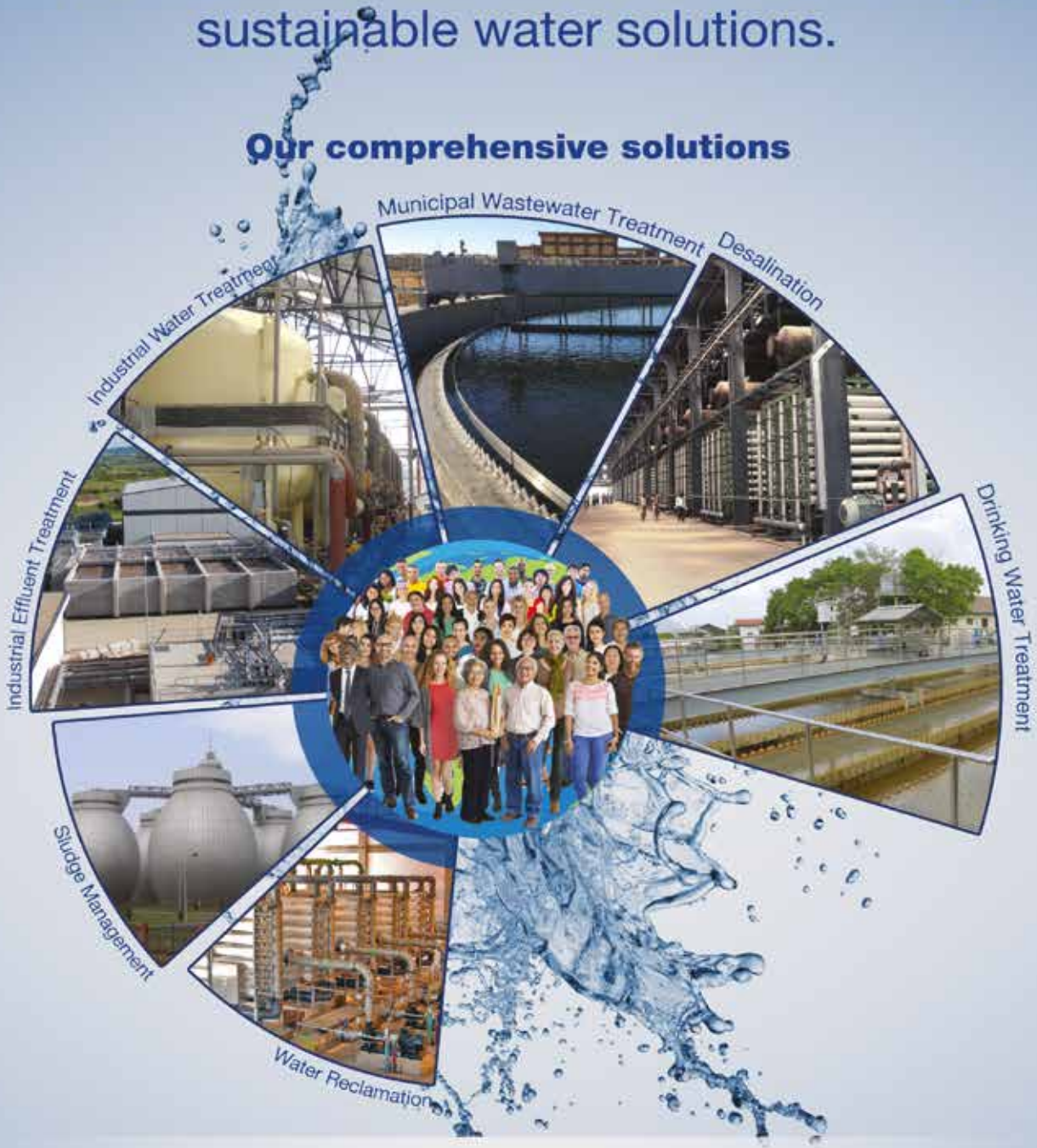

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Innovative, Creative & Technologically Sustainable Infrastructure Solutions

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- Over 22,000 km of Road Construction Supervision and Project Management
- Design of over 4,100 Bridges, Tunnels and other Structures
- Construction Supervision of over 1600 Bridges, Tunnels and other Structures
- Over 60 Airport Projects Involving Planning, Design & Supervision
- Over 45 Projects of Railways and Metro Rails
- Transaction & Financial Advisory for Projects of Capital Value over USD 7 Billion
- Road Safety Audit/ Black Spots Improvement/ Awareness Campaigns in over 100 Assignments
- Master Plan and Development Plans for over 75 Cities/Towns
- EIA / SIA for over 500 Projects
- Water Supply Schemes for over 500 Towns and Villages
- Irrigation Planning & Design of over 8,00,000 ha. Gross Command Area

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NAF®S 125, NAF®S 227 and the NAF®S 1230 fire extinguishing systems are recommended for facilities and areas that have a high fire risk, high value property and high cost of downtime. All these extinguishing agents are non-conductive, non-corrosive and approved for use in occupied spaces by the US EPA.

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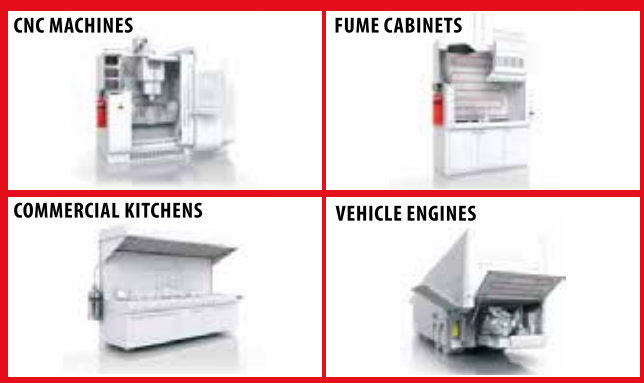

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LIVE STUDIO Invitation
Lehry Valves has launched for the first time in Asia, a State-of-the-art, AI enabled Valve Experience Studio targeted primarily to educate the consumer on all things-plumbing. Plumbing in India has become fast paced owing to the steep economic rise, but as we all know, anything that is not gradual will not have a bell shaped learning curve. It is up to the industry manufacturers to play the catch-up game, rather smartly, to aid the industry in solving problems that arise due to system advancements and inconsistent demand of the consumer.

Utility Management Solutions
At the LIVE Experience Studio, design consultants, builders and even the end user can learn about the various methods on how a valve - the heart of a Water Supply system - when rightly selected and used, can in a grave magnitude, help to curb consumption patterns and reduce passive wastage. One could also visually see the effect of Water Hammering, cavitation in Pressure Reducing Valves, how to select PRVs so that water starvation during peak demand does not occur, functioning of a WiFi based metering system, Smart Automatic tank & pump controlling systems, Mechanical ACV Float tank level control systems.

The experience studio also deploys Amazon's Alexa that answers questions and carries out set of operations to 1. Demonstrate various effects and Show how a particular plumbing problem can be solved. Lehry hopes this innovation will generate interests in aspiring engineers to move to this industry and continue innovation through young minds. As the water deprivation problem grows larger by the day, ironically, it is only technology and the "collective Indian" that can help delay the inevitable day when our country runs out of water!

Lehry, for this very purpose, aims to bring the plumbing system from behind the walls to the front, and visually demonstrate - the purpose and working of these valve, their rightful application, problems that occur in a plumbing system & ways to debug them, and most importantly - to make visible the blind spots of water wastage.

Builders and consultants are constantly employing methods that would help in water conservation, without disrupting demand, but there are still "blind spots" in the water supply system that owe to wastage - which we have come to call - Passive Water Consumption. This could be wastage due to small leakages risen due to water hammering, higher consumption due to variable pressure distribution, employing age-old methods of tank controlling, and even the mindset of water being viewed as a free commodity (Absence of a water metering system).

Experience centre is open 6 days a week from 10:00 AM to 05:00 PM. WIth slots available by the hour to book, situated at the ICONIC Spencer Plaza Commercial Mall in Chennai. Tamil Nadu.

Outstation Guests can also book and We will organise A Pick up from the Airport or Train Station when the arrive.

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