UNIT: 01
INTRODUCTION TO FACILITY PLANNING

Structure

1.1 Introduction

The main aim of any business organization is to earn profit. This not only depends on the working of an organization but also on its presentation; more so in the hotel and

hospitality sector. The prime motive or objective of any hotel property is to attract more and more clients and guests and make their visits a memorable experience. It, thus, becomes a priority to give special consideration to their accommodation and needs while showcasing the best of the local traditions and culture. A great deal of this depends on the architecture and designing of a property.

Architecture is the art or science of designing and constructing buildings. A good piece of architecture is one which succeeds in satisfying its intended uses—that it should be technically sound as well as aesthetically appealing. Any building design is invariably influenced by the technologies applied. The process of planning, designing, and construction of a hotel is known as its *integration.* The designing of the building, hotel facilities, and services sets the scene for a lively atmosphere. Throughout the hotel, the designers and architects create a subliminal ambience of elegance and opulence right from the exterior, to the lobby and public areas, the guest rooms, and every section of the property. The designs are generally at their creative best in the specialty restaurants and nightclubs, as also the guest rooms.

According to noted hotel architect Morris Lapidus, hotel guests fall into two categories: Business travellers and other travellers. While the business travellers require a comfortable bed, easily accessible food, drawers space, good lighting for reading, and quick service, the other category appreciates all these necessities, but wants the atmosphere of their room and hotel to reflect the culture of the city or country they are visiting. All these travellers expect something different in a hotel than what they find in their homes.

The architecture of a hotel depends not only on the way its owner or entrepreneur wants, but also on the creativity and imagination of the architect. The final construction of the building is reflective of the skills and experience of the architect.

1.2 LEARNING OBJECTIVES

After reading this unit learner will be able to:

- Define physical plant.
- Explain Role of facilities in a hotel building
- Explain cost associated with hospitality facilities
- To explain impact of facility design on facility management
- To describe components of a facility
- To explain types of layouts and materials used
- To explain methods and type of hotel building construction
- To describe paints and varnishes

1.3 PHYSICAL PLANT

The term physical plant refers to the grounds, building structure, building systems, interior finishes (that is paint/ wall paper and so forth) and furniture, fixtures and equipment of a lodging facility. Many of these components of the physical plant are highly visible, such as grounds, the exterior building, structure and the ***furniture,***

fixtures and equipment. Other portion of physical plant such as structural steel in the building, the plumbing and the large routes of the heating, ventilating and air-conditioning (HVAC) system, are seldom seen by the guests or most of the employees. The elements of physical plant constitute a significant portion of the construction cost of a building and consume a significant fraction of the maintenance and energy cost incurred over the building's life time. The care and operation of the physical plant of modern lodging facilities is largely responsibility of the engineering and maintenance department. To understand the scope of this department's duties and responsibilities relative to physical plant, a brief overview of the physical plant of modern facilities and how these facilities have changed over time is helpful.

1.3.1 The need for Good Facilities Planning

The needs for Good Facilities Planning are:

- Plant facilities influence the costs of operating and therefore profits.
- Planning allows facilities to comply with laws ad/or regulations.
- Facilities involve high capital-cost expenditures.
- Facilities are fixed investments, not readily convertible to money or resale.
- Facilities are inflexible (i.e. physically fixed and have limited opportunities to be changed).
- Facilities are long term commitments with protracted periods of financial return.
- Facilities planning, design and construction require long lead times.
- Sound plans for implementation can avoid disruptions in production, and discontinuities for shipping or delivery.
- Operations often produce detrimental wastes that affect entire communities.
- The safety, convenience, appearance, and comfort of industrial facilities influence the attitudes of and the ability to attract suitable employees.
- Industrial facilities must be planned to meet anticipated future requirements yet compete profitably today.
- Facilities need to be planned for an appropriate degree of flexibility, expandability, versatility…
- Good planning buys time for making commitments; it minimizes being taken by surprise.
- If plans are made, managements can react faster and take advantage of business opportunities that arise.
- Good planning, especially if presented well visually, is an aid to obtain financing monies.
- The single most important cause of high materials handling costs is "ad hoc" expansion of plant facilities "in the absence of a strategic site-development plan."

1.3.2 Essential Components of the Physical Plant

The Essential Components of the Physical Plant are:

- Layout (skeleton, framework for operations)
- Material handling (muscular system for movement/activity)

- Procedures/communications (nervous system for control of activity)
- Utilities/auxiliaries (respiratory, circulatory, & digestive systems)
- Building (skin, hair, "protective covering")
- Estate: land and buildings.
- Comfortable furniture / fittings to rest or work.
- Air conditioning plant: to maintain the temperature within the comfortable parameter.
- Kitchen: to take care of customers' hunger with proper taste and flavours to liking.
- Transport system: include lifts, escalators, a fleet of buses and taxis.
- Audio and video system: to entertain the customers.
- Telecommunication system: to receive and send massages.
- Safety provisions: systems, for personal safety, fire and theft.
- Staff to manage all above.

1.4 ROLE OF FACILITIES IN A HOTEL BUILDING

Facilities provide an appealing visual environment (ambience, experience and comfort of the guest). All lodging properties including hotels, resorts, theme parks, water attractions, casinos – the facilities themselves are an attraction (engages & entertains the guests). Facilities not only improve level of guest satisfactions but also help to retain business. Facilities of a five star hotel includes well equipped front office, 24 hrs running hot and cold water supply, ala carte restaurants, coffee shop, banquets and conference rooms, swimming pool, gym, spa, 24hours in room dining, well furnished accommodation with attached bath room, and so on. Hotels are classified by a classification committee on the basis of architectural features, facilities and services from one star to five star deluxe hotels, three star apartments to five star deluxe apartment hotels by Ministry of Tourism, Government of India.

Unseen facilities create a good thermal environment – air conditioning, clean water, elimination of unwanted sound and basically protection from the elements Safety is another important factor related to facilities – protection from injury, from loss of their possessions.

1.4.1 Cost Associated with Hospitality Facilities

Cost associated with hospitality facilities varies from type of hotel as well as location of the hotel. Total Cost of a hotel project includes the following:

- Cost of land
- Cost associated with land development
- Building and Construction cost
- Cost of land escaping
- Cost of Building systems such as Heating ventilation, and air conditioning, lighting system, building transportation system, water supply system, safety and security system, waste and garbage

management system, energy management system, rain water harvesting system, property management systems and so on.

- Cost of furniture, fixtures and equipment
- Cost of interiors
- Cost associated in legal aspects
- Fee of hotel consultants, engineers, interiors and legal experts etc.

Type/ Class	One Star	Two Star	Three Star	Four Star	Five Star	Five Star Deluxe
Metropolitan city	0.35crore	.50 crore	0.60crore	0.75 crore	1.0 crore	1.25 crore
Class A City	0.25 crore	0.40 crore	0.50 crore	0.60 crore	0.75 crore	1 crore
Class B City	0.20 crore	0.30 crore	0.40 crore	0.50 crore	0.60 crore	0.75 crore
Class C City	0.15 crore	0.25 crore	0.30 crore	0.40 crore	0.50 crore	0.60crore

Approximate cost per room in star category hotels in India

Other costs are associated in maintenance of building and physical plant are as follows:

1.4.1.1 Building and System Operation

Lodging building does not operate without continuous attention. The building and the systems installing in these buildings require basic maintenance, repair or replacement of failed parts, calibration of controls and equipment, attention to factors which may pose safety problems and inevitably a major renovation or rehabilitation. A failure to provide adequate attention to these needs can result in a poor operating performance of the building which in turn may affect guest perception of quality, employee performance and morale. The safety of the guests and employees and the profitability of the operation.

Many of the system in the building never are noticed if they are working properly. For example, an air conditioning system that is maintaining the types of indoor conditions which result in guest comfort should be almost invisible to the guest. It is the failure of systems to work properly which draws unwanted attention and create managerial nightmares.

1.4.1.2 Building Maintenance

The actual physical structure of the building may initially seem like something which requires relatively little effort on the part of the engineering department. The stone, brick, asphalt, and steel of the most of the building would appear last for ever. However, there are a large number of basic maintenance activities which must be undertaken if the

building is to preserve its initial appearance and function. Approximate 5% of the Principle of Management budget is spent on non-labor aspects of building maintenance. The environment around building sometimes results in rapid deterioration of building surfaces. In some urban areas, the exterior surfaces suffer pitting and erosion due to materials in the air, cleaning of exterior surfaces may be repaired, but the engineer must be certain that the cure will not be worse than the disease since the use of some cleaning materials result damages of surfaces. Other types of maintenance include the application of protective materials to surfaces to retard corrosion and repel the attack of moisture entrained pollutants. The element of building maintenance which is unavoidable and continual problem is roofing. Whether it is the repair of minor leaks or the de-roofing of the entire building (a capital cost), roofing system maintenance is important concern.

1.4.1.3 Maintenance of Guestrooms, Furnishings and Fixtures

From the perspective of the lodging property guest, the guestrooms, furnishings and fixtures of the property are very visible features which contribute to the overall experience of the establishment either positively or negatively. The proper maintenance of these elements is usually a direct responsibility of the engineering department staff. Since these elements receive a lot of use, they are often replaced within first ten years (a capital expenditure). The department replaces the items itself or supervises outside contractors, the yearly expenditures on the maintenance of guestrooms, furnishings and fixtures of the establishment are charged against the POM account. About 2-3 % of the total POM is spent on furniture and 2.5- 4.5% on painting and decorating.

1.4.1.4 Equipment Maintenance and Repair

The amount of equipment installed in a modern hotel or motel is astounding. in the guest room there are television, HVAC Unit, various electric lamps, ventilation fans, in the bath sanitary fittings and sundry other items. Public spaces have HVAC units with fans, chillers, pumps and lighting. Pools have pumps, filters, water treatment systems and more. The kitchen and laundry are full of equipment requiring almost continual repair and adjustment. The repair and maintenance of all the equipment is the responsibility of the engineering department. Maintenance means to maintain something or is to keep in an existing state or to preserve from failure or decline. Unfortunately with respect to equipment a large fraction of the time spent in some engineering operations is directed at repair rather than at maintenance. Repair expenses have a significant effect on the cost of building maintenance.

The cost of equipment repair and maintenance includes the cost of parts and supplies for building equipment and the cost of labour used in the repair of equipment. Approximately 12% of the property POM budget is directly expended for electrical and mechanical equipment maintenance.

1.4.1.5 Budgeting and Cost Control

Approximately 11% of the property POM budget is directly expended for accurate to budget and cost control. Unfortunately at many establishments the development and

control of this budget is not approached with the same level of care and analysis that is used in other areas.

1.4.1.6 Security / Safety Maintenance

Security involves physical assets of the property, employees, suppliers and the guests while safety involves the potential injury to both employees and guests. At smaller establishments, it is not unusual for building safety and security to be largely the responsibility of the engineering department. Some specific safety and security concerns with exist within the engineering area including key control, lock rotation, control of tools and supplies, emergency response to fires and other potentially dangerous situations, safe operations of equipment and tools and outside contractor interactions.

1.4.1.7 Contractual and Regularity Compliance

The term Contractual and regularity compliance refer to requirements imposed upon the property which are of a legal nature and are sometimes directly or indirectly the responsibility of engineering. National, state and local governments are involved in establishing these requirements as are unions within the property and contractors. Some of the requirements are imposed by the Governments which are entirely or partially the responsibility of engineering include elevator inspections, and certification of fire code compliance, building code compliance, health/ sanitary code compliance, environmental protection agency compliance and occupational safety and health compliance.

The contractual responsibilities of engineering pertain to those contracts as part of their maintenance department budget for work to be performed by outside vendors. The maintenance department may also for periodic calibration of control, fire alarms and communication systems. Outside contract for water treatment, trash removal, fire extinguishers charging, cleaning and painting of kitchen duct work and maintenance of major pieces of HVAC equipment are also common.

Besides these basic maintenance contracts, major work to renovate or repair the building and grounds will also be contracted but is likely to be considered as a capital investment and handled separately from the POM budget.

1.4.1.8 Parts Inventory and Control

The nature of the work performed in maintenance results in a need for parts and supplied which are unique in many instances. The uniqueness of these parts or supplies may mean they require long lead times when they are ordered. However, the ability to operate portions of the facility safely and comfortably often requires immediate access to parts or supplies in order to affect repairs. For this reason an adequate parts and supplies inventory and control over the purchase and storage of these items are very important.

Renovations, additions and restorations: The need to redecorate and renovate whether because of wear and tear caused by use, because of changing needs for space or in order to support a new concept is a common feature of all lodging properties. For many

lodging chains expenditures in these areas are greater each year than the expenditure on new properties. Depending on the magnitude of the project and the organization of the property and company the work performed in some or all of these tasks may be the responsibility of the property's maintenance department. The responsibility may include the actual performance of the work or the supervision of outside contractors as they perform the necessary tasks.

1.4.1.9 Special Projects

With the introduction of new technologies and the needs of lodging customers to special services, the engineering department is called upon to perform many special projects. For example: new communication, solar system, water treatment plant, optical fiber lighting etc.

Special events may require the construction of display stands, protective barriers. Trade shows may require additional electric services, phone connection and special lightings. These projects require the input of the engineering department early in the negotiating stages of the contract for the event to ensure that costs are recovered and that the necessary services are ready to use for the customers upon their arrival.

1.4.1.10 Training of Staff

The training activities within the maintenance area may differ some what from those in other areas of the property, many people hired in the maintenance department (electricians, painters, carpenters) already possess specific skills or abilities. While some responsibility exists to maintain their skill levels, the primary focus of training is to inform these employees the standards and specific requirement of the property at which they are employed. This training may be grouped in the categories of general training, departmental training and job- specific training.

1.4.2 Impact of Facility Design on Facility Management

A holistic view of the subject facilities management (FM) will involve looking at it from the definition and history of the development of facilities management, through the practice of facilities management. It touches on some very important areas of the subject in relation to customer satisfaction and providing good value for money. It looks at achieving better facility that is easy to run, maintain and manage by applying whole life costing and risk management techniques. The use of value management as a means of meeting client perceived needs. The use of technology, communication and their influence in today's business is examined. FM is examined at the preoperations stage to see how early involvement can create effective operations, greater value for money and customer satisfaction while also providing better facility that is attractive and user friendly. 'FM at the design stage will add value to the facility by ensuring less 'rework', emphasising value for money, efficient control of the supply chain and team work.'

CHECK YOUR PROGRESS I

1. Define Physical Plant. List essentials of a physical plant.

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2. Enlist cost associated with a hotel building.

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3. Enumerate role of facilities in a hotel building.

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1.5 COMPONENTS OF A BUILDING

Building is the structure, which provides us living space, shelter and place to rest; it protects us from intruders, adverse climatic conditions and provides privacy. Hotel is classified as a commercial building, where tourists and travelers take temporary shelter in comfortable environment of their choice. Main Components of building: the main components of the building are listed below with their functions in short:

Foundation

- Plinth
- Damp Proof Course
- Floor
- Walls
- Stair and Staircase

- Doors
- Windows
- Ventilators
- Window Shades
- Parapet
- Subsidiary Components of Building

1.5.1 Foundation

Foundation is the portion of the building structure, which is built under the ground. The main functions and maintenance are as follows:

- It provides the building a firm hold with the ground and stability to the structure; it prevents the building from shifting and turning over.
- It distributes the total load of the building structure and its content evenly on the ground and thus prevents sinking.
- It provides an even level for the upper structures in spite an uneven ground.
- Maintenance: being an underground structure all possible precautions should be taken before hand during the design and construction. Modifications, repairs and maintenance in the foundation structure after the construction of the building are difficult to undertake.
  - It should be made of proper design.
  - Firm concrete base should be provided under the foundation to prevent displacement of soil due to building weight.
  - Anti termite (white-ant) treatment should be done under the foundation before construction.

1.5.2 Plinth

The visible structural part of the building above the foundation and below the floor level is known as Plinth. According to local conditions, the plinth is made of specified height above the ground.

- It raises the height of floor level from the ground level.
- Prevents the entry of ground water in the house.
- Checks easy access of insects and small animals.
- Maintenance:
  - Repairs of plaster as and when required.

1.5.3 Damp Proof Course

Damp Proof Course (DPC) is a layer of impervious material, which cuts off the capillary rise of water in the building floor and walls. It prevents dampness in the building.

1.5.4 Floor

Building floor is smooth clean and hard levelled surface under the walls. It supports the occupants, furniture and is used as a convenient movement area in the building.

Components of floor:

- ***Base:*** generally of waterproof cement concrete.
- ***Top:*** of desired material: mud, brick, cement sand mortar, stone-slab etc.

Maintenance: The floors do wear or crack due to continuous use. The following actions are taken to maintain conditions of the floors:

- Daily dry sweeping and wet sweeping to remove dirt and dust. This helps to prevent scratching and maintain smoothness of the surface.
- Scheduled washing with mild soap solution to remove oil and grease, which tarnish the polish, and with time harm the surface by producing acids on disintegration.
- Any crack or chipping of the floor surface should be promptly attended to.

1.5.5 Walls

Walls are the part of building structure between the floor and the roof. It may be fabricated out of:

Mud: clay is used to fabricate mud walls. These walls are easy and cheap in construction. These walls are successfully used to construct houses in hamlets. If properly made, these walls are quite stable and can stand rains.

Stone-blocks: walls are made of unfinished or finished blocks of stone layers one over other and joined with suitable bonding materials by filling the gaps. Such walls are very strong and can last centuries. Important buildings, forts and monuments are made of stone blocks.

Dried mud blocks (bricks): dried mud blocks both sun baked and fire baked are use to construct walls. The blocks are made of standard size and shape. Bricks are layered one over other and bonded with suitable mortar to make strong walls.

Reinforced brick walls: these walls are made out of fire-baked bricks and reinforced with steel bars. Such walls are very strong.

Types of walls: the walls of a building can be divided in the following two main categories:

- **Outer walls:** are those walls, which are exposed to the outside atmosphere. These walls are also known as 'Load Bearing Walls'. These walls protect the inmates of the building from adverse outer climatic conditions, dangers and intruders.
- **Inner walls or Partition walls**: these walls are made in the interior of the building and are not exposed to the outer atmosphere. These walls divide the inside of the building in proper cells for convenient use and privacy.

1.5.6 Stair and Staircase

Stairs are stepped inclined plane, which provide the facility to move between the different floors of the building. The cell or room, which encloses the stairs, is staircase.

1.5.7 Doors

Doors are opening in the walls flushed with the floor level for the entry and exit in the building or different rooms of the building. The height and width of the doors are designed for convenient use. With suitable shutters, doors are also used as barriers for entry and exit

1.5.8 Windows

Windows are suitable size openings in the walls at a suitable height from the floor. Their function is to maintain air ventilation to keep the interior atmosphere of the building fresh.

1.5.9 Ventilators

Ventilators are small openings or windows placed higher up in the wall near the roof level. They help to expel the hot stale air of the room to outside.

1.5.10 Window Shades

Window shades are slab projections at the side and top of the windows to restrict entry of rain and direct sunlight in the building.

1.5.11 Parapet

Parapet is the low protecting wall along the edge of the roof of the building.

1.5.12 Subsidiary Components of Building

Subsidiary components of a building are as follows:

- Wall and ceiling plaster or facing and waterproofing.
- Floor plaster or facing and waterproofing.
- Drains and sewers.
- Water supply arrangement and water piping.
- Electric supply arrangement and electric wiring.
- Doors and windows frames and leaves.
- Open land and garden.
- Boundary walls and main entrance gate.

1.6 TYPES OF LAYOUTS AND MATERIALS USED

Facility layout and design is an important component of a business's overall operations, both in terms of maximizing the effectiveness of the production process and meeting the needs of employees. The basic objective of layout is to ensure a smooth flow of work, material, and information through a system. The basic meaning of facility is the space in which a business's activities take place. The layout and design of that space impact greatly how the work is done—the flow of work, materials, and information through the system. The key to good facility layout and design is the integration of the needs of people (personnel and customers), materials (raw, finishes, and in process), and machinery in such a way that they create a single, well-functioning system.

1.6.1. Architectural Features and Plans

For a sector that thrives on showcasing virtually anything under the sun to its visitors, a building of a hotel must be as impressive as its interiors. Its distinctive features should, as we learnt in the last chapter, begin from the designing itself. The Greeks are generally credited with pioneering the concept of designing a building that 'could be viewed as a precious object externally too'. Box 2.1 briefly describes the distinctive characteristics of various building designs or architectural styles that evolved in various civil-izations over the ages, and their influence can be seen in some modern structures even today. The principal guiding factor for any hotelier is ensuring maximum occupancy at minimum maintenance cost.

1.6.1.1 Building Plans

The modern day constructions, including hotel properties, by and large fall in the innovative and international architectural styles, described in Box 2.1. Over the years some building designs and construction plans have withstood the test of time and become so popular that they are emulated by many players in the industry. Some of the popular types of modern hotel plans are as follows:

- Modular construction
- Slip forming
- Arch design
- Cylinder-like structure

1.6.1.2 Modular Construction

This is the most recent and promising development in the construction of hotel buildings. The technique has cut down the construction time and costs by as much as 40 per cent as compared to traditional construction methods. In this method, room units are constructed separately and hoisted into place with the help of cranes. The procedure entails putting in place all the necessary electrical and plumbing conduits with reinforcing steel, and then pouring concrete to form the room module. After curing, the unit is ready to be trucked to the site and placed in the required position. Buildings constructed with this technique are relatively low cost, time-saving in construction, fire resistant and virtually sound proof as well. An example of this type of construction is the Travelodge as showed in Figure 2.1.

1.6.1.3 Slip Forming

Slip form construction was first used in the 1930s in the building and erection of grain-storage silos and other similar structures. Early slip forming techniques relied on hydraulic jacks and the pouring of concrete into a form work made of timber. Slip forming was also used to eventually build lighthouse towers. Today, slip forming is used to build everything from silo complexes, chimneys, reservoirs, medium- to high-rise housing developments, to office buildings, hotels, hospitals, bridge support piers, in-ground shafts to dams and power stations. It is also still used to build elevator cores and batch houses. This technique is another recent variant involving reinforced concrete extension in hotel construction (Figure 2.2). It was used to raise the exterior walls and some of the interior structures of a 15-storey hotel in Petersburg, Florida. It enabled the hotel to be 'topped out' (constructed till the top storey) in just eight days. In Norfolk, Virginia, the slip forming technique, which was used in the construction of a 14-storey motor-inn, enabled the builders to cut three months from the normal construction time for a property of that size. In that property, a three inch thick reinforced slab was poured for the foundation. Then, a specially constructed slip made of steel and wood were placed, and concrete was poured into it continuously at the rate of 9.5″ per hour. At the same time the form was raised by a number of electrically operated hydraulic jacks while steel reinforcing rods were inserted into the concrete to give it shape.

1.6.1.4 Arch Design

Arch building designs have hundred per cent useable clear span space and do not have any beams, poles and trusses. They are easy to construct and most of the buildings are erected in just a few days. These buildings are well ventilated and have better air flow than other building types. These buildings are very cost effective and have very low cost in developing heating, ventilation and air-conditioning system. The maintenance cost of these buildings is also very low and they are fire resistant.

The idea of tri-arc design style was introduced by Travelodge International. In this case, [Figure 2.4(f)] the wings of the building are arch-shaped, with the guest rooms being laid on the concave face of the arch, while the facilities are planned in the central core formed at the intersection of the convex face of the arches. The main advantages of this type of designing are as follows:

- Each room has a view.
- The wedge shape of guest rooms permits each to have an unusually large bath and dressing area.
- The control core containing elevators, linen room, utilities and ice cube machines, facilitates economies in construction and operations.

1.6.1.5 Cylinder-like Structure

The cylinder-like design of a hotel building has a dist-inctive appearance and has the following advantages:

- Concentration of service and utility equipment at the centre core.
- Lower construction and operating costs.

- All guest rooms on the outer-side with view.
- Ready-made for the popular roof top revolving restaurant or lounge.
- Minimum resistance to wind.
- Suitable for site where land costs are high and minimum area is available.
- Compatibility with circumferential ramps leading to parking.

1.6.1.5 Curtain Wall

In this system, the exterior wall of each floor is hung on the iron or steel frame so that the wall supports only its own weight and not the floors above it. This method of construction reduces the overall weight of a building, which allows it to be built higher, and permits the extensive use of glass on the facade.

1.6.2 Rooms

As guest rooms or bedrooms constitute a major part of hotel construction, the key to economical design lies largely in layout of the guest room block. Some of the variants in the design layout of guest rooms are as follows:

1.6.2.1 Double-loaded Block

Considered the most economical layout, this is capable of development into courtyard plan. It requires two staircases.

1.6.2.2 Double-loaded T Shaped Block

This is capable of being developed into cross; also economical, but 3 staircases required.

1.6.2.3 Single-loaded Block

This is capable of being developed into courtyard plan; not an economical solution but may be desirable.

1.6.2.4 Square Block

This comprises a central core containing all vertical services, such as maids rooms, etc. It is compact and useful for small sites where tower development may be desirable.

1.6.2.5 Y Plan

It has more complicated structure than straight blocks, and requires three staircases. The disadvantage, however, is that this structural system may cause problems in public areas.

1.6.2.6 Tri-arc Plan

This is similar to the ‘Y’ plan, but more space is taken up by circulation; concave curve results in a bedroom wider at bath room end providing opportunity for larger bathroom and dressing area.

1.6.2.7 Circular Plan

This requires careful handling; avoid awkward and inward facing rooms; not capable of extension.

1.6.2.8 Circular with Central Core

This design is similar to the square block one. However, this too requires careful handling to avoid awkward room.

1.6.3 Materials generally used for building construction:.

Availability of raw materials and other inputs is essential for successful implementation of the project. The requirement of various inputs like raw material and labour must be estimated on the basis of estimated turnover. The availability of inputs of the right quantity and the right quality on a regular and continuous basis is essential for continuity of operations. Wherever necessary, the enterprise must enter into supply contracts to ensure availability of essential inputs. The enterprises may also create their own sources of supply.The various building materials that are commonly used in modern construction are as follows:

1.6.3.1 Brick

A brick may be defined as a block of clay or other ceramic used for construction and decorative facing. These cost relatively little, resist dampness and heat, and can last longer than stone. The colour varies according to the clay used and in proportions according to architectural tradition. Some bricks are made of special fireclays for use in fireplaces or ovens. Others may be made of glass, or they may be textured, or glazed. Bricks may be arranged in various patterns called bonds according to the way the long sides (stretchers) or short sides (headers) are placed. They can be laid in a variety of intricate patterns, such as checker, herringbone, basket weave, or Flemish bond.

1.6.3.2 Concrete

It is the most widely used construction material in the world. Concrete is the only major building material that can be delivered to the job site in a plastic state. This unique quality makes concrete desirable as a building material because it can be moulded to virtually any form or shape. Qualities of concrete as a building material are its strength, economy, and durability.

1.6.3.3 Polymer Concrete

Another composite material used in architectural elements is polymer concrete, a formulation of thermo set resins and aggregate that simulates stone. In some applications, particularly those within the reach of pedestrians, a heavy material may be desirable to provide both the look and feel of stone or concrete. The polymer concrete surface also has several advantages over real stone because it does not absorb moisture,

dirt or graffiti. Stone-like polymer concrete surfaces can also be created on lightweight fibreglass panels.

1.6.3.4 Steel

Introduction of steel for construction purposes was done by the Americans. Steel not only acts as a frame but also provides tensile strength to the building. It doesn't rot and can be easily moulded.

1.6.3.5 Glass

It is widely used for construction purpose nowadays. Frames that can be of wood or steel support them. It is common to see buildings which are made entirely of glass from all sides. This has become possible due to production of more durable glasses.

1.6.3.6 Fiber Glass

For specialty applications, fibreglass decorative architectural elements are fast becoming the first choice among building owners and architects. Not only is the installed cost of fibreglass less than that of traditional materials, but also composites are easier to install and maintain. Technological advances such as new finishes that better simulate traditional material make fibre-reinforced plastic (FRP) nearly indistinguishable from the real thing. Fibreglass decorative elements make it possible to achieve certain ornate styles. Fibreglass can be moulded into a number of different finishes to mimic wood, stone, terracotta, concrete, steel or other materials.

Noted hotel architect William. B. Tabler coined some important criteria for designing and space allocation. His thumb rules in this regard are as follows:

- Construction cost must not exceed Rs 1,000 per Re 1 of average room rate.
- The market and competition determine the room rate. If the ARR (Average room rate) is Rs 1,000 then Rs 10,00,000 should be the maximum construction cost for the finished but unfurnished room, including public space and service areas.
- The total area of bedrooms and floors should be at least as much as total public space and service areas.
- The total allowance for all facilities should not exceed 6,000 sq.ft. (162m^2 per guest room).
- Not over one employee/per room. Payrolls must be kept to minimum. The requisite number of staff is determined by the basic design which involves the number of kitchens, methods of food handling, the routine of guest and built in maintenance stores.
- Land cost must not exceed 10 per cent of the cost of the building.
- ***Profit Ratio:*** Profit mix of a hotel business may be summarized as follows: Contribution of profit from the guest rooms is average 70 per cent and remaining revenue comes from other departments such as food and beverage, shopping arcade, business centers, health club, etc. Generally a small profit is shown on food but often this does not include space rental value, cost of kitchen equipment, utility services, repairs and maintenance.

- Breakeven point at 65 per cent is a highly controversial figure. The design should permit operating costs to be reduced, proportionately if possible, when business declines by shutting down guest floors using only segments of the total kitchen facilities.

CHECK YOUR PROGRESS-II

1. Enlist materials used in construction of a hotel building:

_____
_____
_____
_____
_____
_____
_____
_____

2. Enlist building plans and explain their key features:

_____
_____
_____
_____
_____
_____
_____
_____

1.6.4 Blueprint

A blueprint of a building is a series of drawings showing the layout of the parts of the building: the rooms, their sizes and shapes, doors and windows, and details that would otherwise take thousands of words to communicate to a reader. There are chances of getting misled if one is unable to read a blueprint. Reading a blueprint for the first time is a great learning experience. Lines, numbers, symbols, and a few words are all that it takes to make a blueprint. A good blueprint should convey all the technical details to its readers. Developing a blueprint is the key responsibility of an architect, who develops the promoter's ideas and conveys them to a draftsman. The draftsman makes the first drafts original drawings that are reproduced as blueprints. Nowadays, computers are generally used to develop blueprints.

Purpose of Blueprints: A blueprint is an important document, especially in construction as it is the starting point of any building activity related to a project. It serves the following purposes.

- It acts as a 'basic talking point' between the owner and the architect.
- It conveys detailed information to the people in the trade (mostly contractors) so that they can read, understand, and construct a building

according to specifications contained in these documents.

- A plumber looks at a blueprint to study and install the appropriate types and sizes of plumbing fittings and fixtures at exact locations and points. In the same manner electricians, audio-video mechanics, gas-pipe mechanics use the blueprints for their doing their jobs to precision.
- Managers use blueprint to check the level of performance of the work performed by contractor/plumber/electricians/mechanics, etc.
- Blueprint can also be used to determine the quantity of materials required for refurbishing and redecorating. The estimates regarding the amount or sizes of floor coverings, wall coverings, paint, plaster, wallboard and drapery can be developed from blueprints.
- Blueprints can also be used to determine manpower requirements in housekeeping and maintenance.
- A blueprint may also be used as a basic tool in energy management. An energy saving renovation plan can be developed by reviewing blueprints.

Types of Blueprint: One drawing cannot show all the details of the construction procedure for a building or even a restaurant/linen room/guest room. If there is only one drawing, then it would become cluttered with too many lines, notes, and symbols. That would also increase the chances of serious errors. Therefore, a series or number of blueprints is used for every building. Each drawing is labeled and shows specific information of interest to workers in a particular field. Information which cannot be depicted graphically can be included in written specifications. The combination of blueprints and written documents is called a *construction document*.

The more common types of drawing are: plan, elevation, detail, perspective, section, mechanical, and plot and survey views. Some of these are very specialized, such as heating mechanical views, heating detail views, heating plan views, or perspective details views. It is the prerogative of an architect which views he/she should focus up on to instruct the variously skilled labour on the installation procedures to be followed. The various kinds of blueprints are explained as follows.

1.6.4.1 Plan Views

It is the most common view and is used very frequently. A plan view is akin to seeing a room from the top. If you were looking down from above a room or area with no ceiling or roof, the view you would get is a plan view. The primary use of such a view is to show room layouts. More importantly, the

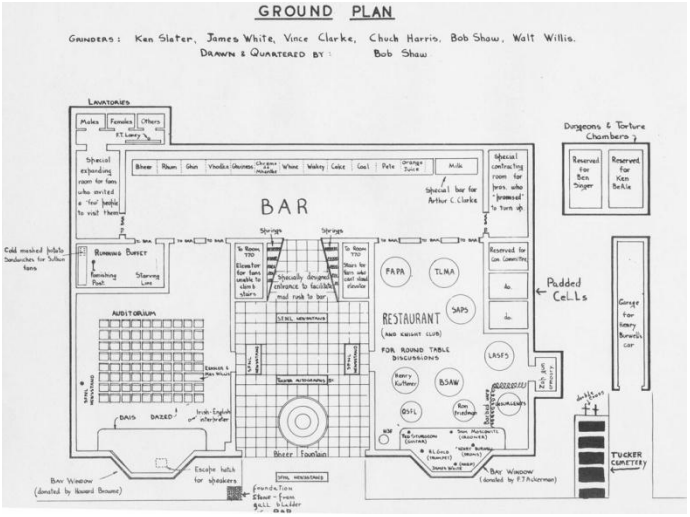


Figure 1.1 Plan view blueprint
Source:fancyclopedia.wdfiles.com

plan view serves as a basis for various calculations, such as, electrical outlets, security alarm system requirements, sizes and number of furnishings, and determination of HVAC (heating, ventilation and air-conditioning).

Figure 1.2 Elevation view blueprint of a hotel property
Source: *3dpower.in*

1.6.4.2 Elevation Views

If you were to stand outside a building and look at it and drew a picture of the building, you would get an elevation view. Elevation views help in deciding how the exterior wall would be done up. What percentage of glass would be used for windows, the types of windows, the kind of material to be used on the wall, orientation of wall, balcony areas, and most importantly, if the balcony will provide an awning effect for the lower level. This view is very important for architects, who prepare a number of alternative elevation views to let the owner or client take a final decision.

1.6.4.3 Detail Views

Detail views serve as a vital communication link between the architect and the builder. It can be a plan view or an interior elevation drawing of an item that cannot be depicted in sufficient detail in other views. Detailed views of interior walls, location of equipment or position of permanent assets and their utility can be of special importance for future renovation of the building.

Figure 1.3 Detail view
Source*: Doubletree3.hilton.com*

1.6.4.4 Perspective Views and Models

This is an impressive technique for selling ideas. It is basically a three dimensional view of a proposed building generally showed to the owners. It may be dressed up further by showing the location of trees, parking zones, side walks, etc. The purpose of model is to help the onlookers visualize and place themselves in the proposed settings.

1.6.4.5 Section Views

A section view may be a vertical or sometimes horizontal cutaway view of a wall, roof, or foundation of a building. This is a critical from the point of view of the manager/s because it indicates the type of construction material to be used, where insulation is planned in roofs or near foundation walls. A section view is very important for energy conservation planning because the thickness of insulation is very important in reducing energy costs. An economical insulation thickness for the present may be inadequate for the future. It is important to have exterior structural walls and roofs with low heat-transmission coefficients.

Figure 1.4 Section View of a hotel
***Source*:** apartmenthotels.co.in

1.6.4.5 Mechanical Views

This is the most frequently used blueprint which gives the idea of all mechanical/electrical systems in the building separately. Each mechanical view may use a special set of symbols. System of air-conditioning, plumbing, closed circuit television, fire safety, security system, etc. may be shown on separate mechanical views.

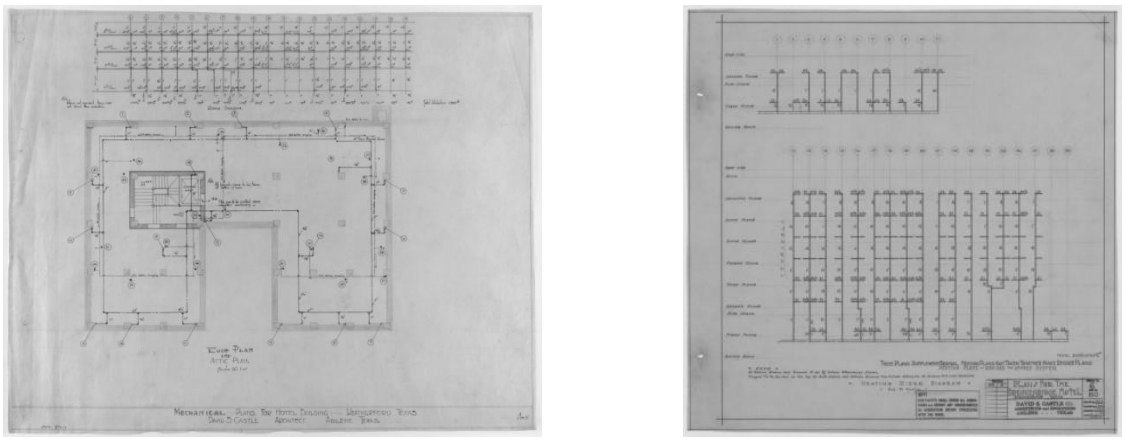
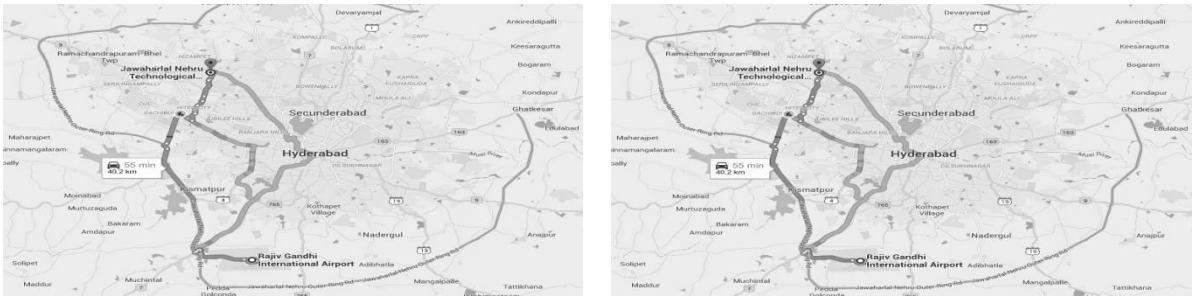


Figure 1.5 Mechanical View
Source: Nexashistory.unt.edu.in

1.6.4.7 Plot and Survey Views

These drawings are made by registered surveyors. They show the legal boundaries of the property. In most areas, a plot view is required before building permits.



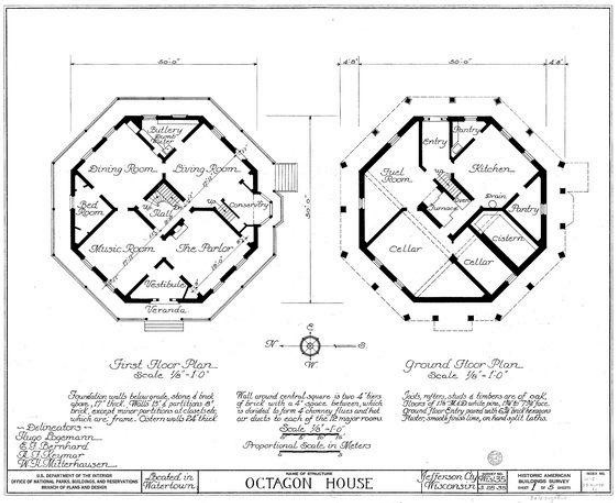


Figure 1.6 Plot Survey View
Source: **https://etravelweek.com**

1.7 COMPUTER-AIDED DESIGN AND DRAFTING (CADD)

The CADD is a relatively new technique which provides tremendous potential for cost-effective drafting and design. A typical CADD system includes a standalone mainframe or microprocessor computer, workstations with one or two terminals offering graphic and/or alphanumeric capabilities. The strength of a CADD system is its ability to recall enormous amounts of unwieldy information. Thus, turnaround time of CADD drawings is much faster than of drawings done by hand. A building system can be quickly located when questions concerning maintenance, repair and renovation must be explored. An architect can also perform a number of experiments to explore a unique building design due to unique features offered by CADD systems. Walls, partitions, doors, and furnishing can be moved in a matter of seconds to depict alternative uses of space.

1.7.1. Uses of CADD

Uses of Computer Aided Designs are as under:

1. For creation of photo simulations of intended buildings along with its existing environment to represent what that locale will be like where the proposed facilities are allowed to be built.
2. Potential blockage of view corridors and shadow studies are also frequently analyzed through the use of CADD.
3. Used in developing mechanical design of a machine by using vector based graphics. Vector graphics is mainly used today in the context of two / three dimensional computer graphics.
4. Used in computer animation for producing special effects.
5. Used in advertising technical manuals.
6. Used in ship, aerospace industries and architectural design and many more.

1.8. PAINTS AND VARNISHES

Paint- a colored substance which is spread over a surface and dries to leave a thin decorative or protective coating.

Varnish: It is resin dissolved in a liquid for applying on wood, metal, or other materials to form a hard, clear, shiny surface when dry.

1.8.1. Type of Paints

There are following types of paints:

- Distemper paint
- Solvent based paints
- Emulsion
- Functional Paints

1.8.1.1 Distemper Paint

Distemper paint is an ancient type of paint made of water, chalk, and pigment. It is bound with either animal glue or the adhesive qualities of casein, a resin that comes from solidified milk. The primary problem with distemper paint is that it is not durable. Distempered surfaces can be easily marked and discoloured, and cannot be washed down, so distemper is best suited to temporary and interior decoration. The technique of painting on distempered surfaces blends watercolors with whiting and glue. "The colours are mixed with whitening, or finely-ground chalk, and tempered with size. The whitening makes them opaque and gives them 'body,' but is also the cause of their drying light ... a source of considerable embarrassment to the inexperienced eye is that the colours when wet present such a different appearance from what they do when dry.

1.8.1.2. Solvent Based Paints

Solvent Based Paints are Luster paints, Enamel paints and oil paints all come under the category of solvent based paints. They cannot be pre-mixed with water. Oil based paints take a longer time to dry and often produce strong odors which are irritating and sometimes even toxic in nature. The advantage with these paints is that they really last long and produce rich and desiring effects on the wall.

1.8.1.3. Emulsion

This type of paint is also water based and provides a rich and Matt finish to interior walls. The differentiating factor of emulsion paints is its acrylic quality. Its composition imparts excellent durability to the painted surface and gives the walls a just painted look. It washable and most stains can be removed easily by wiping with a cloth dipped in a mild soap solution. The paint film is also fungus and mildew resistant.

1.8.1.4. Functional Paints

Functional paints are not just decorative paints; they have specific functions like eliminating insects, bacteria, fungus or dust mites. Functional paints have an in-built, safe and non-toxic mechanism to humans but fatal to insects, fungus, bacteria or dust mites.

1.8.2. Use of Paints

Uses of paints are:

- To protect material from weathering oxidation process and damages.
- To improve beauty of material
- To facilitate the cleaning process of surface
- To give high class finish and attractive color and pleasing surfaces design and appearances
- To protect substances from corrosion(iron)
- To make material long lasting

- Paint can be used for material made of wood, iron,steel,concrete and brick.

1.8.3 Varnish

It is resin dissolved in a liquid for applying on wood, metal, or other materials to form a hard, clear, shiny surface when dry. Varnish is traditionally a

1.8.4 Types of Varnish

There are following types of Varnish:

- Modified natural-resin varnishes
- Synthetic resin varnish
- Natural resin varnishes

1.8.4.1 Natural Resin Varnishes

Body made from natural resin obtained from certain trees. Natural resin obtained from living trees or from fossils(which are superior) Vehicle in varnish is the same as used in oil-based paint. Resins dissolved in oil mixture heated to temperature (500-600OF) depending on the amount of gloss required. Oil and natural resin varnish OLEO RESINOUS varnish. Thinner and dryers used in varnish are the same as used in oil based paints

1.8.4.2 Modified Natural-Resin Varnishes

Modified natural-resin varnishes are made from natural resin altered by chemical action. Common resin is heat treated with glycerin to form a gum. This gum is treated as the body for the varnish. Less expensive varnish than the oleo resinous varnish

1.8.4.3 Synthetic resin varnish

Synthetic varnish produced by plastic industry.Chemicals used include nitrocellulose, amino resins, silicon etc**.**Vehicle most often the same as for oleo resinous varnish
Coal tar derivatives may be used as thinners.Dryer is also the same as for other types of varnishes

1.8.5 Classification of Varnishes

Varnishes are classified according to oil contains: Long oil varnish, Medium oil varnish and short oil resins.

Characteristics of Long oil varnish:

- Long oil contain 40 to 100 gal of oil per 100 lbs of resin
- Takes longer time to dry
- Moderate gloss
- Marine and spar varnish belongs to this group
- Tung oil used . impervious to water

Characteristics of Medium oil varnish:

- Medium-oil contain 12 to 40 gal of oil per 100 lbs of resin
- They dry faster
- Harder film than long-oil varnish but are not impervious to water
- Floor varnish belongs to this group

Characteristics of Short oil resins:

- Short-oil contain 5 to 12 gal of oil per 100 lbs of resin.
- Dry rapidly

Uses of varnish:

1. Varnishes can be used to protect wooden surfaces like windows, doors, floors and roof trusses from atmosphere.
2. Different varnishes exist for specific needs. Oil varnish, consisting of a solvent and a drying oil, is the preferred choice for woodwork.
3. Spirit varnish, partially comprised of alcohol that creates a protective film upon evaporation, is most often used on musical instruments.
4. Natural varnish, made from tree sap, is routinely used as a maintenance coating to previously varnished items

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1.9 SUMMARY

Hotel project planning is a very complex technical that require a high label of expertise from various field of engineering and architecture. The basic building design , layout and planning of facilities and service have to be planned very carefully with a eye on the pocket of the promoters , the profile of targeted clients as also the expected returns on the investments. Some of the points that need to be considered while designing a hotel are : good location and site, attractive appearance, effective plan schedule, analysis of raw material available at cheapest rate material, good workmanship, good financing, structural regulation laid by town and country planning, survey and market analysis , and paying capacity of population to ensure adequate return on capital. Over the years, some building design and plan have withstood test of time and become so popular that they are emulated by many players in the industry. Some popular plans are modular construction, slip from, tri-arc design and cylinder like structure. Space allocation of rooms and other facilities is also a complex task, but there are certain ground rules that needed to be followed to make the activity a successful venture.

1.10 GLOSSARY

Physical Plant The term physical plant refers to the grounds, building structure, building systems, interior finishes (that is paint/ wall paper and so forth) and furniture, fixtures and equipment of a lodging facility.

Foundation it is the lowest load – bearing part of a building, typically below ground level.

Plinth is the lower square slab at the base of a column. The base course of a building, or projecting base of a wall.

Blue Print it is a piece of paper with plans for building printed on it. It is also guides or plans of the project.

CADD (Computer Added Design and Drafting) it enables and engineering or architecture to insert size annotations other notes into design.

Paint is a coloured substance which is spread over a surface and dries to leave a thin decorative or protective coating.

Varnishes it is resin dissolved in a liquid for applying on wood, metal, or other materials to form a hard, clear, shiny surface when dry.

1.11 References/ Bibliography

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- Hotel Engineering Writer – Sujit Ghosal Publisher – Oxford University Press
- Facilities Planning Writer – Dr Tarun Bansal Publisher – Oxford University Press

1.12 Suggested Readings

- Hospitality Facilities management and Design, David M. Stipanuk, Harold Roffmann Publisher: Educational Institute, AHMA
- How things work-The Universal Encyclopedia of Machines, Volume 1 & 2
- The Management of Maintenance and Engineering Systems in the Hospitality Industry, Frank D. Borsenik & Alan T, Stutts, Publisher: John Willey & Sons Inc. NY
- Air Conditioning Engineering, W.P.Jones, Publisher: English Language Book Society
- Edword Arnold Building Construction, Sushil Kumar, Standard Publishers & Distributors, Delhi

1.13 Terminal Questions

State True or False:

1 Slip forming come under Fire Safety and Security.
2 Construction cost must not exceed Rs 1000 per Re 1 of average room rate.
3 Blue Print is not a part of Layout and Drawings of the Project Design.
4 HVAC Stands for heating , ventilating and air conditions.
5 Paint protect material from whethering oxidation process and damages

Short Answer Questions:

1 Write short notes:
   a. Plinth area.
   b. Blueprint
   c. Cost associated with a five star hotel
   d. POM Budget
   e. Uses of CADD
2 Differentiate between:
   a. Paints and varnishes
   b. Floor area and Plinth area
   c. Section View and Mechanical View
3 Describe materials used in building construction.
4 Enlist five purposes of Blueprint.
5 Discuss subsidiary components of a building.

Long answers questions

1. Enumerate impact of facility design on facility management.
2. Write an essay on types of building layouts and material used.
3. Prepare a write up on components of a building.

UNIT: 02
MANAGING MAINTENANCE SYSTEMS

Structure

2.1 INTRODUCTION

If you are looking for a secure position in the hospitality industry, you should seriously consider becoming a chief engineer, the director of a physical plant or a head maintenance person. Management turnover for this position is minimal. Finding a competent chief engineer is very difficult task in comparison to finding a food and beverage manager/ executive housekeeper/ front office manager or even a chef. The maintenance department works almost completely behind the scenes, but it fulfills a tremendously important function. The department personnel and the equipment under their control provide the atmosphere and comforts demanded by the guests.

2.2 LEARNING OBJECTIVES

After learning this unit learner will be able to:

- Define maintenance.
- Explain maintenance work to be taken care by the hotel engineering department.
- Explain what are the new concepts and facilities available in today's hotel.
- Explain types of maintenance with its merits and demerits.
- Explain quality of water and water hardness

- Describe practices of removal of water hardness
- Explain water systems: Hot and cold water supply
- Explain waste water treatment.
- Explain swimming pool maintenance.
- Describe water conservation practices adopted in hotels.
- Explain energy management and conservation program
- Describe how to reduce energy costs

2.3 MAINTENANCE DEPARTMENT

The science and technology of engineering and the related field of maintenance are mysteries to most people. Many managers and departments' heads realize that their businesses are dependent on the operation of their maintenance and engineering department, especially in large buildings.

Many operations define maintenance and engineering by its areas of responsibility. Other operations rely on normal dictionary definitions. Regardless of the definition or responsibilities of an organization, the basic purpose of the department can be stated as; *keeping the structure, its machines, its systems, and it products in an existing or specified state of readiness. This definition assumes that everything is kept in repair that is operating at a high efficiency level (low energy consumption), and that there are minimal breakdowns. For a hotel it means keeping guestrooms and public space salable, at a low cost.*

The maintenance and engineering department has been treated as a catchall department, which literally means that if a problem is not related to food, marketing or sales, housekeeping, or accounting, it must be a maintenance and engineering responsibility. Maintenance department as stated above hotels have to maintain a group of officers and workers whose job is to look after the various physical plants so that they are properly maintained to function without trouble and provide comfort to the customers round the clock. This group of workers constitutes the 'Engineering maintenance department'.

2.3.1 Objectives of the Maintenance Department

The objectives of the maintenance department are as under:

- To ascertain that the machines/equipments function at the optimum efficiency for a longer period of time.
- To target for the minimum maintenance expenditure.
- To assure that the customers can easily control the equipments to create convenient conditions to suit them.
- To assure that the customers easily operate equipments with safety.
- To assure that the machines and equipments are safe to operate by the staff.
- To ensure that the machine/equipment gives trouble free service.
- To program arrange maintenance such that there is no disturbance in the running of essential departments of the hotel.

- To program and carry out the maintenance work so that the customer is least disturbed.
- To ensure good relations and coordination with other departments and customers.

2.3.2 Functions of the maintenance department

The Functions of the maintenance department are as under:

- Technical function
- Executive functions

2.3.2.1 Technical Functions

The technical functions of maintenance department are:

- Upkeep of assets and establishment: buildings, gardens, sewer and drainage, water supply, hotel roads and furniture-fittings, swimming pool.
- Electrical maintenance: to maintain uninterrupted electric supply and distribution. Up keep of electric wiring, lighting, and electric machines and equipments.
- Mechanical maintenance: maintenance of air-conditioning systems, food refrigeration and cooling machines, lifts/escalators, transport vehicles, laundry and kitchen machines and swimming pool machines.
- Electronic maintenance: communication system both internal and external, recreation equipments.

2.3.2.2 Executive Functions

The executive functions of maintenance department are:

- Planning improvements for present plant and for future plant expansion.
- Managing constructions contracts: inviting tenders, cost analysis, contract assignment, and supervision of the work in progress, testing after completion, approval, checking of bills and approving payment.
- Staff: appointment and service termination of maintenance personnel, keeping records of work efficiency and service tenure.
- Job allotment and control of the maintenance staff.
- Setting job targets and programs for the staff.
- Keeping track of the maintenance expenditure and find ways and means to reduce it.
- Maintaining coordination and friendly relation among the maintenance department and other departments of the hotel.
- Maintenance of records with respect to building and assets taxes, water tax, electricity consumption and payments, machine maintenance records, spare parts stock records, vehicles and vehicles tax records.
- To program and provide safety from fire, theft and personal safety to costumers and establishment.
- Target and program energy conservation.

- Aim for pollution control.
- Arrange for staff training and workshops and seminars to improve performance.

2.3.3 Operational Goals

When the responsibilities of the maintenance department are discussed, it is often easy to focus merely on the detail of the required activity, that is, to maintain and repair. But if we focus too narrowly on the detail, we may forget to see and appreciate the purpose of the department and its crucial role in the overall functioning of the lodging operation. A lodging property may benefit substantially if its management establishes broad goals for the hotel maintenance department. Identifying and clearly communicating such goals may help to motivate personnel, define duties and responsibilities and clarify interdepartmental relationships. The following is a sample set of general operational goals for the maintenance department which results in a functional way of viewing the department's responsibilities.

1. Protect the investment in physical plant
2. Control maintenance costs
3. Contribute as appropriate or necessary to overall guest satisfaction
4. Contribute to the efficient operation of other departments
5. Minimize the energy cost of the facility planning
6. Minimize potential safety problems

2.3.4 Coordination of Hotel Engineering Departments with other Departments

Engineering department of a hotel is required to be in constant contact with other departments of the hotel for the following reasons:

- Maintenance of building, furniture, fixture and equipments.
- To ensure supply of audio –video equipment whenever needed for conferencing, banquet functions.
- Maintenance and smooth functioning of Building system such as HVAC, Lighting, music, water, transport, etc.
- Renovation, restoration program. Of various key areas of hotel.
- Staff training and induction.
- Concern with correcting the trouble or fault that might occur any time during the functioning of equipment or machine.

2.4 TYPES OF MAINTENANCE

Maintenance is of following types:

- Routine Maintenance
- Preventive Maintenance
- Scheduled Maintenance
- Emergency and Breakdown Maintenance
- Guest Room Maintenance
- Contract Maintenance

2.4.1 Routine Maintenance

Routine maintenance activities are those which pertain to the general upkeep of the property, recur on a regularly basis and require relatively minimal training or skills. These are maintenance activities which occur outside of a formal work order work system and for no specific maintenance records are kept. Examples: carpet sweeping, washing floors, cleaning windows, cutting grass, cleaning guest rooms and replacing burned out light bulbs.

2.4.2 Preventive Maintenance

Preventive maintenance is much more directed and specific, has elements of inspection and decision which goes beyond those generally engaged in by an individual in a janitorial position, is scheduled and recurs within a much longer time frame than most routine maintenance and requires individuals with more advanced skills and training. Activities in maintenance are usually performed based on guidelines from equipment suppliers and the building engineer. Preventive maintenance includes actions to prolong the life of a piece of equipment and to minimize the breakdown of equipment. It is directed at keeping the equipment operating at or near its rated level.

2.4.3 Scheduled Maintenance

Scheduled maintenance refers to those activities which are initiated at the property based on a formal work order or a similar document which identifies a known problem or need. While preventive maintenance is initiated to delay the occurrence of a problem or to make a minor correction, scheduled maintenance attempts to meet known needs in an orderly and timely manner consistent with overall needs and demands at the property.

2.4.4 Emergency and Breakdown Maintenance

It is most expensive maintenance service since it generally requires a disruption of scheduled activity and may result in problem which could remove for service or cause discomfort, deterioration in the quality of the workplace, or a similar problem. Generally, solving the problem could be delayed but the level of general inconvenience would be high.

Breakdown maintenance is generally agreed to be the most expensive form of maintenance since in addition to the cost of the repair, there is often the potential for loss of business or production as a result. This type of maintenance results when a piece of equipment or a structure component completely fails. There is essentially no leeway in the scheduling of this maintenance- the equipment must be repaired immediately or the operation will be shut down.

2.4.5 Guest Room Maintenance

Guest room maintenance has a special meaning in the lodging industry. As it is used in many operations, it refers to preventive maintenance. In others, it takes on more

characteristics of scheduled maintenance. In whatever capacity it is an important maintenance. For the guest, the guestroom is one of the most visible elements of the lodging experience. The condition and proper operation of furniture, fixtures and equipment, the appearance of ceiling and walls, the condition of carpets and floor coverings and the cleanliness of the exteriors of windows are all included in the maintenance and repair of guestrooms.

2.4.6 Contract Maintenance

The decision is to perform maintenance within house personnel or to contract this maintenance is usually under the control of the engineering manager. There are potential advantages and disadvantages to contract maintenance services.

CHECK YOUR PROGRESS-I

1. What is maintenance? Explain various types of maintenance.

2. State objectives of the maintenance department?

2.5 DEFINING CONTRACT

Contract is defined as an agreement, between two or more persons (known as parties) to function in unison (united) to accomplish a job. The contract invariably follows proposals from one or more parties (proposors) and its acceptance by other parties (acceptors). A contract, of course, is an agreement in legal form between the owner of a building and the general contractor who is responsible for the erection of the building. He, in turn, may sublet parts of his contract to subcontractors. Thus, the subcontractor will undoubtedly do the various tasks. The form which the general contract may take will follow one or a combination of several patterns:

- **Unregistered Mutual contract**: under this contract, the parties agree mutually without registration and with or without any intermediately. This contract system is of two types:

  Verbal contract: is the contract in which the terms are settled verbally amongst the parties. In case of breach of the contract terms by any party, the aggrieved party will be at loss to appeal in the court of law. Verbal contract has no legal validity.

  Written contract: under this contract system the terms are agreed in writing on paper before two witnesses. In case of breach of contract by any of the party the aggrieved parties may appeal in the court of law putting forward the written proof. The court may refuse to hear the petition, as unregistered written contract has no legal validity.

  Merits of Written Contracts:
  - Such contracts are easily settled among parties without any cost.
  - The witness is not legally involved.

  Demerit:
  - Mutual contracts are not entertained by court of law.
  - No legal action can be taken on the defaulting party in case of breach of the unregistered contract.
  - The witness cannot be held responsible for the breach of contract.

2.5.1 Potential Advantages of Contract Maintenance

Potential advantages of contract maintenance are as follows:

1. Reduction of total labour costs.
2. Reduction of cost of supplies and equipment
3. Use of latest techniques and methods
4. Savings in administrative times
5. Flexibility to meet emergencies or changes in needs
6. Removal of the need to negotiate with labour unions
7. Removal of the need to recruit and train employees
8. Persons and experts of different fields get an opportunity to work together.

9. The job is completed in a better and efficient manner.
10. Improved quality of the job is obtained.
11. Sharing of job responsibility by the partners reduces the completion time.
12. The partners share the profit or loss according to the agreed terms.
13. Less burden on partners due to shared responsibilities.
14. The approximate cost is known before hand and it is easier to arrange fund.

2.5.2 Potential Disadvantages of Contract Maintenance

Potential disadvantages of contract maintenance are as follows:

1. False labour cost savings unless staffing levels are actually reduced.
2. Gradual escalation in total costs without property level monitoring or control.
3. Managerial laziness resulting in a failure to negotiate the best price for the service.
4. Unavailability of employees for other tasks.
5. Loss of control over employees.
6. Loss of contact with the needs of facility and staff.

2.5.3 Types of Contract Maintenance

Either it is verbal or written but all types of the contract maintenance can further divided into five major categories:

- Turn key job or Lump sum contract
- Unit price
- Cost plus
- Cost plus with upper modification
- Contract for maintenance and repairs

2.5.3.1 Turn-key Job or Lump Sum Contract

Under this form of contract, the owner agrees to pay a definite sum upon completion of the building. At first glance, such an agreement would appear to be ideal. Here, the owner finds himself with a definite amount of money at his disposal-enough to pay for the kind of building he wants; the contractor, supposedly, will deliver such a building, so why not be done with it? At the same time, the owner should plan a finishing trip for himself beginning when the contract is signed and terminating about the time the building is ready for delivery. It might even be that the contractor would help finance such a trip, for if he remains in town, he surely will be unable changes will occur to him, and much of the owner's and contractor's time will be spent in discussing such change, a new contract must be made. In large buildings, especially, it is extremely difficult to foresee everything, particularly if the owner cannot visualize readily from plans. At the time the plans are drawn, the attention of everyone is drawn to the general scheme rather than devoted to details; hence, something is bound to slip by. The rigidity of this type of contract, therefore, is apt, in the long run, to operate against the wishes and benefits of the owner.

Another serious objection to this type of contract is the fact that plans and specifications must be complete before the building can be started. The preparation of complete blueprints and specification takes a great deal of time and, while admittedly these items should be complete before the contract is let, nevertheless, when time is considerable concern, much work on the building can be done before either plans or especially specifications are completed.

The lump sum form of contract, because it is so readily subject to bid, does insure the lowest possible costs to the owner.

> The working partner is undertakes the job from the very scratch or the blueprint stage and finishes it in all respect. The financing partner has just to turn the key and start using of the project. The working partner quotes a fixed sum for full completion of the whole job.

Conditions of Turn-key Job or Lump Sum Contract:

1. No uncertain conditions involved
2. Prices reasonably stable.

Advantages of Turn-key Job or Lump Sum Contract:

- Not much of headache or problems for the financing partner to solve during the execution stage.
- The financing partner has to arrange for the plans, land, and finance. He may have to sort out only special problems such as obtaining departmental clearance etc.
- The financing partner has not to supervise the job during execution of work.
- If the working partner is experienced and capable the job quality will be of high standard.
- If the price escalates the contract is profitable to the financing partner.
- Fixation of responsibility on the working partner is easy.
- Less teething troubles, if any within a specified period, it is the responsibility of working partner to rectify it free of cost.
- Under the contract conditions working partner may have to pay penalty for delays. Therefore working contractor tries to finish the work in agreed time.
- The cost is reasonably stable and known to the financier before the start of the job. So it is easier for him to arrange the funds in time.

Disadvantages of Turn-key Job or Lump Sum Contract:

- All the plans, blue prints, execution details and cost, are to be settled before the start of the work. But many changes/modifications are required during execution.

- These changes may become the points of controversies amongst the working and financing partners. Settlement of these controversies may cause delay in execution of the project.
- The delay in execution may sometimes cause price escalation of the raw materials and the working partner may have to suffer loss. This becomes another point for controversy and settlement.
- If the price is not settled then the working partner is tempted to lower the quality of the job.
- Conflicting interest of the working and financing partners always prevails. The working partner wants more profit while the financer desires better quality work at the settled price.
- The contractor may delay the job on one or other pretext, for making more profit.

Remedy for Turn-key Job or Lump Sum Contract:

- To settle controversies arising during the contract, suitable clauses are included in the main contract for settling modifications.
- Clause for right of supervision by the financing partner.
- Clause for the right of making modifications during the job.
- Clause for process of cost settlement of the necessary modifications during execution.
- Clause for the process of price revision keeping interest of both the partners in case the raw material market price fluctuates during the execution.
- Delay penalty clause.
- Clause, which gives the right to the financier to allow or reject the appointment of subcontractor for whole or a part of the job, by the main contractor.

2.5.3.2 Unit Price Contract

The unit price contract generally exists between the general contractor and his sub-contractors. Its field is mostly in such work as has to be done in large quantities, each small division of which is a replica of every other division. As an example, a contractor may agree to remove all of the dirt from an excavation at a unit price per cubic yard. Plans and specifications, therefore, need not be complete, and because the nature of the work is usually quite simple, no difficulty is experienced in obtaining bids. By the same token, the cost of the entire job, while it can not be known in advance, can be approximated.

Conditions of Unit Price Contract:

1. Where nature of work is clearly understood.
2. Where quantity of work is not accurately known.
3. Applies usually to agreements between general contractor and sub contractor.

Advantages of Unit Price Contract:

1. Plans do not necessarily have to be complete.

2. Bids can be determined quickly.

Disadvantages of Unit Price Contract:

1. Unbalanced bids may result readily.
2. Total cost not known.

Constraints of Unit Price Contract:

- The contractors are to be provided the full details and specifications of the unit jobs. For example we consider the unit job 'Earth Excavation'.
- The job as suggested by earth excavation is not fully specified. We must provide further details or specification:
- Cost of excavation up to a specified depth.
- Cost of excavation from a specified depth to another depth.
- Cost of shifting the earth up to a definite lead.
- Cost of shifting the earth up to definite distance and loading in a truck.
- Cost of removing the excavation measuring pillars and levelling the excavation.
- The nature of the unit jobs must be fully and clearly specified.
- Full specifications avoid controversies at a later stage.
- To avoid controversies, instead of exact quantity a close approximation of the total work is revealed to the bidder.
- The bidding rates are expected in units of per hundred or thousand of the quantity.
- The main contractor is free to sublet the job to different contractors. The financier has no control on the profit the main contractor makes out of subletting.
- The financier can float unit price enquiries for a general assessment of the total cost.

Applicability of the contract system:

- This contract system is generally applicable between the main contractor and the subcontractor.
- Where the nature of the work is fully and clearly specified.
- Where the exact quantity of work cannot be estimated in advance.

Precautions:

- The contractor or subcontractor tries to finish the comparatively easier and profitable jobs first and after taking the cost thereof abandons the contract leaving the difficult and less profitable jobs undone.

Remedy:

- The part payments for the jobs finished should be so adjusted that the contractor is at loss if he does not finish the entire job.

2.5.3.3 Cost plus Contract

This type of contract provides for a payment to the contractor of the actual cost of the building plus an additional payment of an agreed percentage-10% for example- of the costs. If this agreement is entered into, the items to be included under costs should definitely be specified. It should be expected that office costs, overhead, travelling expenses, supervision of sub-contractors, and so on should be borne by the contractor out of his percentage. It operates best under two general conditions:

1. Where plans are not complete.
2. Where prices are not stable.

Its chief advantage probably lies in the fact that the owner has full control of any desired changes and that the building may be started almost at once. In addition, it is extremely fair, protecting the contractor against any rise in price, with the possible result, it would be noted , that since the contractor does not have to protect himself against an anticipated rise in costs, the final cost may be less than under the lump sum. Conversely, also, any savings due to a decrease in cost are reflected to the owner. A cost plus contract should give excellent results in the quality of the building, for no incentive lies with the contractor to cheapen the quality of work. At first glance, this type of contract might seem ideal, but it does have inherent disadvantages.

Advantages of Cost-plus Contract:

1. Owner has full control on building.
2. Work can be started immediately.
3. Extremely fair.
4. Excellent building results

Disadvantages of Cost-plus Contract:

1. Cost is not known.
2. Cost may be higher.
3. Many decisions must be made by owner who is not competent to handle them.

2.5.3.4 Cost plus Contract with Modifications

To circumvent some of the disadvantages of the cost plus contract, several modifications of this type of contract appear.

Cost plus fee: Under this type, the contractor is employed for a set fee to construct the building, the costs of construction being carried by the owner. This procedure limits the cost to some extent, and reduces the profit to the contractor if the building costs go up, at the same time protecting the owner against a fall in price. There is no incentive on the part of the contractor to increase the cost. But on the contrary, there does exist an incentive to decrease the time during which the building is under construction for. Since he receives a set fee, his earning power for a given period of time is increased if the time of construction can be lessened. Furthermore, there is no element of risk on the part of the contractor, nor do the owner and contractor come into conflict. All of the advantages

of the cost plus contract exist under these terms, while at the same time, the contractor is restrained somewhat.

Cost plus contract with upper limits: This is quite similar to the cost plus fee contract except that under this form, the contractor agrees that the total cost of the building shall not go above a predetermined amount; but up to the amount, he shall share in any additional cost. This type, perhaps, applies where plans and specifications are less specific then in the cost plus fee type, for under those conditions, the contractor may argue that the amount of the work he will have to do is not clearly known; and consequently, a set fee may not be adequate recompense. On the other hand, fairly accurate figures must be available to determine the upper limits of the contract. Sometimes this form of contract is set up with bonuses if the total cost falls below a certain figure; or what is essentially a same thing, when a descending scales of payment to the contractor. Thus for the first Rs. 1,00,000 of cost, he would receive 10% for the next Rs. 1,00,000, 9% , and so on.

Any form of contract may be highly modified, with severe penalties for failure to complete within a given time and offsetting bonuses for completion before that time, and in the final analysis, whatever form the contract takes is a matter for the contracting parties to determine. The purpose of this discussion was to present the characteristics of the more usual forms and to suggest some modifications of them.

2.5.3.5 Contract for Maintenance and Repairs

Modern hotels have to maintain big buildings and assets, large number of electrical and mechanical machineries, gadgets and equipments (physical plant) for the costumer's comfort and satisfaction.

- These physical plants differ vastly in nature and maintenance procedures, resulting in appointment of large number of technical personnel and workers to attend and maintain them.
- The expenditures on the maintenance department personnel and cost involved on the stocks of spares are a heavy burden on the establishment. These costs directly affect the profit of the business.
- Even on investing the heavy sum to maintain all the above for better customer comfort, the very purpose fails due to workers indiscipline, strikes, slow work tendency, misbehaviour and disputes with officers.
- For the above reasons the work is delayed and the quality of the work is not to the required standards. This causes discomfort to the customers and brings bad impression for the institution.
- To get rid of the above difficulties some hotels adopt the contract maintenance system on the unit price system.
- Reputed service/repairs shops, artisans and workers are selected by the administration for different jobs. Time bound contracts are signed with them to attend and maintenance equipments or machines on unit price system.

Merits of contract repair system:

- The contractors are experts of their field.

- Results in better quality of repairs and maintenance.
- Better customer's satisfaction.
- Maintenance is available round the clock.
- Work is finished in time.
- Proper record can be maintained.
- Minimum problems for the management.

Demerits of contract repair system:

- The system promotes corruption. In order to make quick money the contractors venture to pay grafts to persons in charge for getting false bills passed.
- Sometimes the contractor tries to delay work to squeeze more profit.
- The method at times proves very costly.

Remedy for contract repair system: To keep balance between expenditure and customer satisfaction the modern tendency is to adopt mixed policy. Hotels maintain their own maintenance department for the daily, not very highly technical, odd job maintenance. The work of specialized maintenance of complicated machineries, plants and equipments is allotted to qualified technical service people.

2.6 WATER AND WASTE WATER SYSTEMS

Chemically, water is hydrogen oxide (H_2O). It is available on earth in all the three phases of matter. It participates in practically every ecosystem process and is vital for the living world. Total earth water available covers about **71%** of the earth's surface. The total quantity of water on earth is estimated at about 1400-mega cubic kilo-meter or **1.400_x10^9 cubic km**. Expressed in liters **1.4_x10^{18} cubic meter or 1.4_x10^{21} liter** or **1.4_x10^{21} kg** approximately. The main approximate distributions of the water on earth is mentioned below:

- Oceans: 97.0%
- Ice caps and Glaciers: 2.2%
- Under-Ground reservoirs: 0.6%
- Lakes, rivers, Soil moisture Biosphere, Atmosphere: 0.2%

2.6.1 Drinking Water Sources

The drinking water sources can be divided mainly as:

- **Ground Water Sources**: rivers and big lakes constitute the main ground water sources. This being the reason those big ancient civilizations settled near riverbanks and perennial lakes.

- **Under Ground Water Sources**: Ancient people had the knowledge about the underground water. They tapped it by digging shallow wells. With advancement of time and technology new and better types of wells were designed which could pump out large quantities of water from deep underground water reservoirs. The water from deep underground is plentiful, more clean,

pure and potable. These days deep bore tube wells are a common arrangement for water supply.

2.6.2 Water Supply System

It is the arrangement for transporting and supply of water from the areas of abundance to areas of need or deficiency. This includes:

- **Tapping the land water sources**: Installations are constructed for the collection of raw water at the land water sources such as rivers and lakes and subsequent treatment to make it potable. The collection and treatment plants collectively are called 'Water works'. Main sections of water works are:

    - ***Pumping Stations***: high capacity pumps installed by the side of raw water sources deliver large quantities of water. These pumps are generally located near the river entry end of the city in order to get comparatively clean and less polluted raw water.

    - ***Installations for treatment of water***: the raw water from the pumping station is transported through pipes to large filtration tanks, which remove suspended impurities. The clean water is treated with coagulating agents to settle finer suspended impurities and then with chemicals to disinfect it. After this it is aerated to remove bad odors and to dissolve oxygen and carbon dioxide, all this makes the water potable and tasty.

    - ***Transportation and distribution network***: the potable water is then transported to distribution centers and then to homes, commercial establishments, industry, public utility establishments and services, and irrigation through a distribution pipe network.

- **Underground water sources:** in the present days of high technology deep underground water sources are generally tapped on a large scale to supply water for population settlements away from rivers and also to supplement supply to big riverside cities. The waters from deep tube wells require less treatment as it is comparatively clean and free from bacteria. Sometimes the water contains harmful dissolved chemicals, for which the water is suitably treated before supply.

- Numbers of tube wells are bored at suitable places in the settlement with large capacity overhead storage tanks for emergency. The pumping stations are interconnected in a net work for better supply pressure and to maintain continuity of water supply in case of failure of a well pump in the network.

- The supply pipe network is connected to distribution network throughout the settlement.

2.6.3 Water Consumption

The unit of water consumption is 'Liters per capita (head) demand' or 'L.P.C.D.' for short. The product of liters per capita demand and the population of the community calculate the total demand of water for the community habitat. The demand of water is characterized by various uses of water by the community, and the cumulative demand is better known as water consumption demand. There is usually a wide variation in the total water demand among different communities. This variation depends on several factors as below:

- The conditions of the place:
  - Geographical position of the place.
  - Climatic and seasonal conditions.
  - Social and personal habits of the population.
  - The population density.

- The various uses of water by a community:
  - Domestic use: Drinking, cooking, utensils washing, house cleaning and maintenance, sewage flushing, bathing and laundering.
  - Public places and public utilities: educational institutions, public offices, transport stations, fire protection and street washing.
  - Commercial and industrial uses: stores, offices, restaurants, hotels, manufacturing establishments and electric generation.
  - For agriculture and crop irrigation.
  - During the local festivals and functions.

- **Day to day basis**:
  - On working days the maximum demand is in the morning between 6 to 8A.M.
  - On Sundays and holidays the maximum demand is between 8 to 10A.M.
  - In winter the demand shifts to late morning.
  - In summers the demand shifts to early morning.
  -

An average breaks up of per capita demand as per Indian standards:

- Domestic use:
  - Drinking: 05 l.p.c.d.
  - Cooking : 10 l.p.c.d
  - Washing utensils: 15 l.p.c.d
  - House cleaning and maintenance : 10 l.p.c.d
  - Laundering: 20 l.p.c.d
  - Bathing:50 ;.p.c.d

    Sewage flushing: 30 l.p.c.d
- **Average domestic total** **140 l.p.c.d.**

- Public establishments : 30 l.p.c.d
- Industrial establishments: 40 l.p.c.d
- Fire protection :15 l.p.c.d
- Losses and wastage: 55 l.p.c.d

Average total **280 l.p.c.d**

The demand factor for a place is influenced by the following factors:

- Climate.
- Class of consumers.
- Industries and commerce.
- Pressure in distribution system: more the pressure the more the more the consumption due to wastage.
- Quality of water: the better the quality the more the consumption.
- Sewage disposal system: Water borne system requires more water.
- Fires.
- Maintenance of water distribution system.

Methods of meeting variations in demands:

- Overhead tanks: are designed on average daily demand variations.
- Distribution pipes: should be designed on hourly maximum demand.
- Pumps: are designed on daily average demand.

2.6.3.1 P^h Value of Water

The presence of acidic or alkali materials make the quality of water acidic or alkaline.

- Water dissociates to positive H ions and negative OH ions. The total concentration of H and OH ions is equal to 10^{-14} gm ion/liter. In neutral water H ions is equal to OH ions, therefore H ions is 10^{-7} gm ion/liter and OH ions are also 10^{-7} gm ion/liter.
- If H ions > OH ions the water will be acidic, the ph value will be 0 to 6.
  If H ions < OH ions the water will be alkaline, the ph value will be 8 to14.
  Hence the power of H ion concentration in solution when changed to number then is known as ph value.
  Hence ph value is that negative number which, when put, as a power of 10 will indicate the H ion concentration in solution or ph = - log (H^+)

2.6.3.2 Qualities of Potable Water

The Qualities of potable water is as under:

- Should be free from turbidity and sparkling transparent. Turbidity should not be more than 5ppm.
- Should be colorless, absence of metallic oxides.
- Should be odorless, absence of organic and decomposed organic matter.
- Should be cool to drink, desirable temperature should be between 5* to 13*C.
- Should be tasteful to drink. Dissolved oxygen and carbon dioxide gases make water tasteful. This explains why boiled water is tepid (tasteless).
- Should be free from harmful dissolved chemicals.

- Should be free from dissolved foul and harmful gases e.g. hydrogen sulfide, ammonia.
- Should be free from dissolved inorganic matter such as fluorides. Excess of fluorides caused softening of bones.
- Should be free from water transmitted bacteria and pathogens.
- Should be free from radioactive impurities.
- Should be free of insecticides.
- Should not be hard.
- Should contain electrolytic salts in permitted quantity.
- Ph value should be 7, i.e. should be neutral.

Contaminated water: is that water, which contains suspended particles, turbidity, harmful chemicals, and bacteria, decomposed organic wastes, industrial wastes and harmful chemicals, and is not suitable for consumption. Potable water: is the water, which can be safely used for drinking without any adverse effects and is tasty to drink.
In its raw condition water collected from the source may not be fit for human consumption due to any one or more of the following reasons:

- ***Contamination:*** means the presence of suspended or dissolved impurities (foreign materials) in the water. The following reasons are responsible for contamination:
  - *Solid suspended impurities*: fine sand, dust, clay etc.; their presence reduces the clarity of water.
  - *Undesirable and harmful dissolved salts*: Fluorides, chlorides, sulfates of metals, cadmium and mercury salts; their presence is responsible for coloration and organic diseases.
  - *Organic materials*: are present both in suspended and dissolved conditions. Sewage and decomposed matters from the dead organisms are the cause of these impurities. They impart bad odors to water.
  - *Bacteria:* the bacteria of water borne diseases contaminate water. The contaminated water may contain bacteria of Cholera, Dysentery, jaundice etc.
  - *Industrial effluents:* pesticides, acidic effluents, organic effluents, poisonous salts etc.

- ***Minerals:*** minerals are essentially inorganic salts and are needed in very minute quantities, for the body to function properly. At the same time their excess or absence in water is equally harmful and undesirable.

- ***Color:*** presence of inorganic materials or their salts are responsible for the color of water. They make water to appear bad and sometimes prove harmful and poisonous.

- ***Odor:*** presence of organic or decomposed organic materials and certain inorganic substances makes water smell bad and un-potable.

- ***Distasteful:*** absence of minerals and dissolved gases especially oxygen and carbon dioxide make water tasteless (Tepid).

- ***Hardness:*** presence of bicarbonates, chlorides and sulfates of calcium and magnesium make water hard.

Methods of disinfecting water: For making water fit for drinking following methods are used:

- By boiling.
- Lime treatment.
- Bromine treatment.
- Chlorine treatment.
- Iodine treatment.
- Ozone treatment.
- Silver treatment.
- Ultra violet treatment.
- Potassium per magnate treatment.

2.6.4 Water Treatment

Treatment of water: it is necessary to treat the raw water to make it fit for human consumption and to improve its quality as per defined specifications and standards. A few of the main processes of the water treatment are listed below:

- Removal of suspensions: to make the water clear.
- Removal of dissolved harmful and coloring salts.
- To control the quantity of minerals.
- To destroy pathogens and bacteria present in water.
- Removal of odors and odor producing materials.
- To make water soft.

2.6.4.1 Filtration

Steps in the treatment of water:

- ***Filtration:*** is the process of removing the suspended impurities. The methods depend on the size of the impurity. Some common methods are:
  - *Sieving:* removes big size objects both organic and debris floating in the water so that they may not get jammed up in the water pipe line and damage the pumps etc.
  - *Sedimentation and decantation:* the sieved water is pumped to big settling tanks. The coarse suspensions settle down and the top water slowly flows to filter tanks.
  - *Gravel filter tanks:* clears the next stage of coarse suspensions.
  - *Sand filter:* removes the turbidity or fine suspensions.
  - *Coagulation and filtering:* is adopted to remove micron size suspensions, which cannot be removed by the ordinary filtration processes. Some materials known as 'Coagulants' are added to water and properly mixed.

The micron suspensions group together as 'Flocks', become heavier, settles down, and drained. This process makes water sparkling clear. Commonly used coagulant materials are Aluminum sulfate Al_2SO_4, $[8H_2O]$(alum), ferric chloride and ferric sulfate.

Disinfecting: disinfecting is the process carried out with the object to destroy the bacteria and pathogens. Two methods are common:

2.6.4.2 Boiling

Boiling kills a wide spectrum of bacteria. The effect of the process is not long lasting. The process is time consuming and costly. It is not very practical for large-scale treatment.

Boiling removes the bicarbonate of Ca and Mg as their insoluble carbonates, and filtered. The reaction equation is as follows:

$$X(HCO3)_2 \xrightarrow{\text{HEAT}} XCO_3 + H_2O + CO_2$$

X is Calcium (Ca) or Magnesium (Mg) atom.

- **Merits of the method**:
  - It is easy and neat process.
  - It does not contain any chemical or chemical generated substances.
  - The turbidity is easily filtered which contain the Ca and Mg carbonates.
  - Carbon dioxide escapes as gas.
- **Demerits:**
  - It is not a very convenient process for large quantity of water.
  - It is a slow process.

2.6.4.3 Chemical Treatment

Water is treated with chemicals to destroy bacteria. Caution must be exercised to the choice and the quantity of the chemical so that they do not cause harm to humans. The effect of the process is long lasting due to residual presence of the chemical in water. This process is easy to apply and cheaper. Some common chemicals:

- Lime, Chlorine, Bromine, Iodine and Ozone.

Lime treatment: The temporary hardness of water is measured and then treated with calculated amount of lime.

$$X(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2CaCO_3 + 2H_2O$$

Where X = Ca or Mg atom.

The Calcium Carbonate coagulates as precipitate and filtered off.

- **Demerits**:
  - It needs a large plant.
  - It needs constant watch and adjustment of lime dose. The results are not up to mark.
  - The flocks and wastewater requires drainage space.
  - Lime is corrosive in nature.

- Lime powder makes environment dirty.

2.6.5 Hard Water

In simple terms, hard water does not produce good 'Lather' with soap due to the presence of certain salts and as a result of this, consumes more soap.

Reasons of hardness in water: During precipitation, water dissolves a number of atmospheric gases, which include CO_2, Cl_2, NO_2 and SO_2. These gases being acidic inorganic oxides produce Carbonic acid, Hydrochloric acid, Nitric acid and sulfuric acid respectively in the precipitated water.

- During run off and percolation they react with the minerals present in earth and form various salts. These salts dissolve in water, out of them, the following salts are mainly responsible for water hardness:
  - Both Calcium and Magnesium Bi-Carbonates.
  - Both Chlorides and Sulfates of Calcium and Magnesium.

2.6.5.1 Types of Water Hardness

There are two types of water hardness:

- **Carbonic or Temporary hardness**: Temporary hardness is due to the presence of Bi-Carbonates of Calcium and Magnesium dissolved in the water. Simple boiling of the water removes this hardness.

- **Non-Carbonic or Permanent hardness**: Permanent hardness is due to the present of Chloride and Sulfate of both Calcium and Magnesium. Simple boiling does not remove this hardness. Chemical or ion exchange methods are required for its removal.

2.6.5.2 Effects of Hardness on Water

Followings are the effects of hardness on water:

- It produces less lather with soap, resulting more soap consumption.
- It produces soap scum, which produces dirty feeling during and after bath and wash.
- Causes scale formation on the inner surface of water boilers and boiling utensils. This is responsible for the corrosion of the vessel surface. It affects heat transfer rate and reduces the boiling efficiency.
- It causes turbidity during boiling of water.
- It affects the taste and structure of the cooked food.
- Too much hardness affects the digestive process.
- It affects the fabric dyeing process.

2.6.5.3 Measure and Unit of Hardness

Measure and unit of hardness: The unit of hardness named 'Degree of water hardness' and is expressed as:

- '***One-degree water hardness'***: dissolving 14**.**25mgm of Calcium Bicarbonate in one kilogram of pure distilled water produces on degree hardness.
- '***One degree water hardness'*** is equivalent to 14**.**25 ppm of Calcium Bicarbonate in pure distilled water.

'One degree water hardness' is responsible for waste of 0.6 gm of Standard soap.

2.6.5.4 Methods of removing Water-hardness

Hardness of the water may be removed by:

- Soda Ash Treatment
- Zeolite

2.6.5.4.1 Soda Ash Treatment

After determining the degree of permanent hardness the water is treated with calculated amount of Sodium carbonate commonly known as soda ash. The chemical reactions are noted below:

$$XSO_4 + Na_2CO_3 \longrightarrow XCO_3 + Na_2SO_4$$

[X = Ca or Mg atom]

$$XCl_2 + Na_2CO_3 \longrightarrow XCO_3 + 2NaCl$$

[XCO3 precipitates]

Demerits:

- It needs a large plant.
- It needs constant watch and adjustment of lime dose. The results are not up to mark.
- The flocks and wastewater requires drainage space.
- Lime is corrosive in nature.
- Lime powder makes environment dirty.

2.6.5.4.2 Zeolite

Zeolite removes both permanent and temporary hardness. Zeolites are members of a family of hydrated Sodium aluminosilicate mineral [$Na_2 (Al_2Si_3O_{10}) 2H_2O$] that contain alkali and alkaline-earth metals. Zeolites, are known for their ability toward ion exchange and reversible dehydration. The sodium ions of the zeolites are exchanged with the calcium or magnesium ions of salts responsible for water hardness:

$$Na_2 (Z) + X (HCO3)2 \longrightarrow X(Z) + 2Na (HCO_3)$$

$$Na_2 (Z) + XSO_4 \longrightarrow X (Z) + Na_2SO_4$$

[Z = complex part of zeolite]

$$Na_2(Z) + XCl2 \longrightarrow X(Z) + 2NaCl$$
[X = Calcium Magnesium atom]

This property of zeolite makes it very beneficial in softening hard water.

Zeolite water softeners:

- These softeners are very efficient and suitable for both the temporary and permanent hardness.
- These softeners consist of 'Zeolite' or ion exchange resin in a tank connected directly to filtered hard water supply. The sodium ions of the resins change place with the calcium and magnesium ions of the Bicarbonate, chloride and sulfate salts dissolved in the water and causing temporary and permanent hardness.
- This exchange makes water soft, as the respective sodium, salts do not cause hardness.
- When calcium and magnesium ions from the water-dissolved salts, replace most of the exchangeable sodium ions of the resin; it is exhausted. Rinsing with 'Brine' (a strong solution of common salt) regenerates the exhausted resin.
- Reverse ion replacement process takes place and sodium ions from the brine now replace the calcium and magnesium ions in the exhausted resin. After washing, the regenerated resin becomes ready for treating hard water. Repeated use of the same resin is possible.
- These softeners are indispensable for industries, hotels, restaurants and homes.

Merit of ion exchange softener:

- They are very efficient.
- It does not produce pollution.
- The resin can be used repeatedly for long times.
- The treated water does not contain traces of treating chemicals or the resulting turbidity.
- The treated water is of good quality and potable.

2.6.6 Water Distribution System

There is several water –distribution system used in hospitality and catering industries:

- Up-feed system
- Up-feed system with circulating pumps
- Down-feed system (cold water only)
- Down-feed circulating system
- Combination system

2.6.6.1 Up-feed system

It is most commonly used water distribution system when the pressure of water is sufficient to force water throughout a hotel building of six floors or less in height. The maximum number of floors can be feeded with this system depends on pressure, resistance of pipe and the height of the building. (See figure No. 2.1)

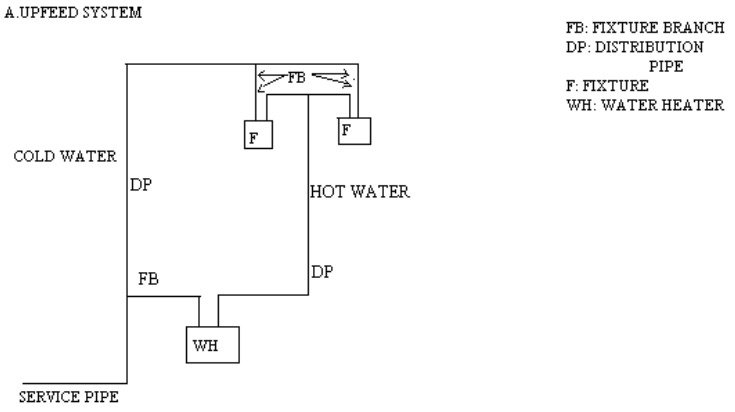

Figure 2.1 *Up-feed System*

2.6.6.2 Up-feed system with Circulating Pumps

This system is used when water pressure is inadequate and a circulating pump along with a return pipe (See figure No. 2.2) is installed to increase water pressure and water to flow constantly throughout the system. This is frequently used on hot –water lines to provide an adequate supply of hot water by making a provision of water heater.

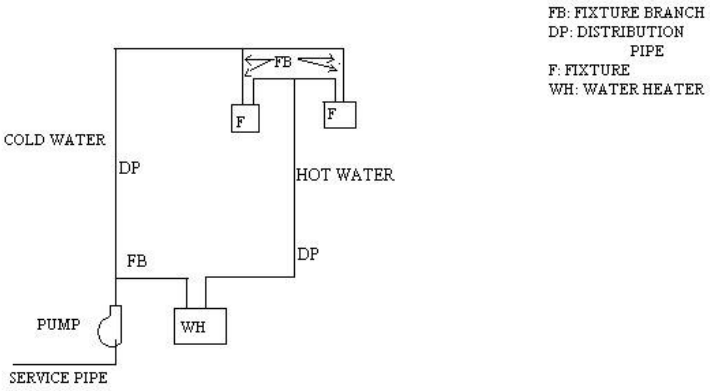

Figure 2.2 Up-feed System with Circulating Pumps

2.6.6.3 Down-feed system (cold water only)

In this system first of all water is forced or pumped to a storage tank (overhead tank) located on the top floor of the building and when water is required, it flows by gravity from the storage tank to the tap. This system is used in very tall buildings. (See figure No. 2.3).

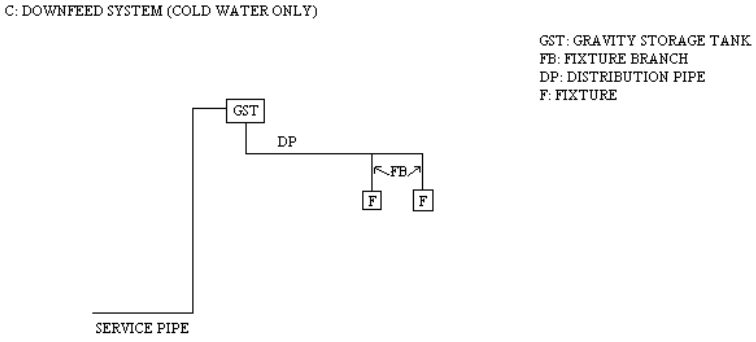

Figure 2.3 Down-feed System (Cold Water only)

2.6.6.4 Down-feed Circulating System

It is very similar to the circulating puffed system. This technique is frequently used with hot water to ensure adequate amounts of hot water at each fixtures. (See figure No. 2.4).

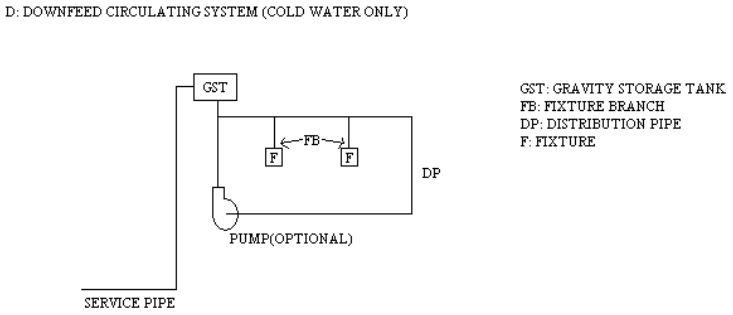

Figure 2.4 Down-feed Circulating System

2.6.6.5 Combination system

It is a combination of upfeed-downfeed system. The upfeed system is used for the lower building levels and the downfeed system for the upper building levels. This system is probably the most efficient distribution system for multiple –floor hotel building because water –main supply pressure is utilized to the full extent and additional pressure is generated by pumps to reach water on water storage tank located on top floor of the building**.** (See figure No. 2.5)

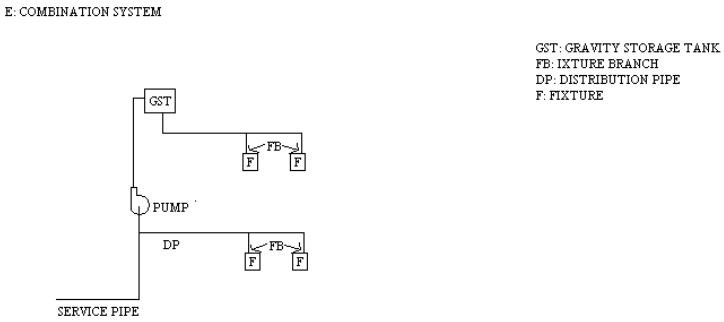

Figure 2.5 Combination System

Heating water: The normal hot-water temperature requirements in the hospitality industry are: 110 degree Fahrenheit or 43.3 degree Celsius for domestic use.
Normal personal washing: 140 degree Fahrenheit or 60.0 degree Celsius.
Food production sinks: 160 degree Fahrenheit or 71.1 degree Celsius.
Dish washing: 180 degree Fahrenheit or 82.2 degree Celsius.
Pools and spas: 80 -100 degree Fahrenheit or 26.7- 37.8 degree Celsius.
It is highly recommended to label fixtures supplied with water above 120 degree Fahrenheit or 48.9 degree Celsius with a warning that the water is hot and dangerous.

2.6.7 Swimming Pool Maintenance

Pool design, construction and maintenance are controlled by local development authorities in coordination with public health department. The equipment and their utility connections are frequently tested by these departments.

The fundamental pool device is the filter. The filter removes impurities from water and keeps it clear and sparkling. The true test of adequate filtering is to toss a small coin into the pool at its average depth and to be able to distinguish one side of the coin from the other its rest on the bottom of the pool. The filter must cycle pool water every six to eight hours. Water –turnover cycle consists of forcing all the pool water through the filter in a specified time period. In a normal operation, one water cycle is required each day. If swimming activity increases, more than one water turnover cycle may be required. Normally, pool water is used for cleaning the filter and filters are cleaned by back washing and there is a need to follow the instructions given by the filter's manufacturer. There is no set schedule of cleaning the filters.

Debris, insects, leaves and soil should be cleaned on time to time and various types of nets are used to clean the swimming pool. Pool must be treated with appropriate chemicals and the primary chemical is a disinfectant which destroys water bacteria. Chlorine and bromine are very common disinfectants. Chlorine is usual choice for pools while bromine is used in heated spas. Bromine water treatment is more expensive than chlorine but does not leave any residue on pool side or bottom. Bromine levels are kept at one part per million, while chlorine levels are maintained at about two parts per million.

The Ph level of swimming pool water should be between 7.2 and 7.6 or slightly alkaline. If Ph exceeds 7.6 than there are chances of developing problems of water algae and swimmers may suffer minor skin and mucous- membrane irritations. Conversely, water become uncomfortable when the ph drops below 6.8, metal equipment will corrode. Algaecides can be used to destroy algae and may be added every 3 to 7 days during the swimming season. Disinfectants are also excellent algaecides. Shock treatments are used to kill algae; "shock treatment" means increasing the level of disinfectant from 1 one part per million of bromine to 5 parts per million and in case of chlorine levels from two parts per million to 10 parts per million. In case of excessive growth of algae than pool water must be drained and pool must be cleaned with acid chemicals, a process called acid washing.

2.6.8 Water Conservation

- Though, water may be considered an inexhaustible resource because neither any of the ecosystem processes affect the total mass of water in the ecosphere nor water is not destroyed by any biological activity.

- However, to be useful, water must be of required potable quality and should be available in sufficient quantity at the place of requirement. Due to wasteful or heavy consumption the quantity of potable water is reduced and often becomes a scarce commodity, so it must be regarded as a renewable resource.

- The useful quality and quantity of the commodity depends on the consumption and the recycle rates. The recycle time depends on the location and climatic conditions.

- Water that falls from the atmosphere as various precipitations and run off on the land surface to form streams, rivers, and eventually reaches back to feed the ocean. The repetitive process generally operates on a one-year-renewable cycle known as the 'Hydrologic cycle'.

- Unchecked population and industrial growth, large-scale deforestation are disturbing ecological conditions. This has resulted longer and disturbed water cycle time. The rains are scarce, irregular and late, causing reduction of the ground water sources.

- As the ground water sources are depleting due to disturbed water cycle. New settlements are increasing far from land water resources. Underground water sources are tapped to supply water to new settlements and also to supplement supplies of the growing demands of the riverside settlements. The consumption of the underground water reserves has vastly increased.

- Water percolates to underground sources very slowly. Construction of houses, roads and drains for the large populated cities has further affected the percolation area and time. The water collected at the rooftops is directly thrown in the river through the drains without getting enough area and time to percolate through the earth

- The high rate of consumption and very practically no replenishment is depleting the valuable underground water resource, which has been collected during centuries in the past.

- The present situation requires a very strict and extensive water resource management policy otherwise the vast humanity will have to suffer drinking water shortage in near future.

- When the average discharge of a river is not enough for a dependable supply of water, a conservation reservoir may be built. A dam is constructed to blocks the flow of water and allowing an artificial lake to be formed. Conservation reservoirs store water during wet-weather periods for use during times of drought and low stream flow.

- Sometimes it is advisable, for economic reasons, to provide a multipurpose reservoir. A multipurpose reservoir is designed to satisfy a combination of community needs. In addition to drinking water, the reservoir may also provide flood control, hydroelectric power, water transportation and fish farms.

- The roof top drain water of buildings in the cities should be collected in deep percolating pits or poured back into shallow wells. This helps water to percolate back to under ground reservoirs rather than waste in the drains.

- Extensive education program should be launched to educate people of the impending water shortage, and its implication on the humanity as a whole. They may be educated to reduce wastage of water on their own.

Water conservation techniques and methods:

- Full tap opening should be avoided.
- Put the vessel under the tap and then open the tap.
- Close the tap before the vessel is removed.
- Washing of utensil clothes should be done in a bucket of water.
- Self-closing taps should be used at public places and water coolers.
- Children should be given knowledge about water conservation and should be instructed to follow the above instructions.
- Utilize soft water: reduce water requirements for cleaning purpose.
- Provide adequate pressure at fixtures for full water flow.
- Use threaded fittings for high water pressure.
- Reduce length of piping.
- Reduce number of fittings and valves.
- Increase thickness of insulation around the tank.
- Use larger diameter pipes if possible.
- Eliminate water leaks.
- Utilize solar water heater for the pool.

A water tap with drip rate of 50 drops per minute (5 to 6 drops per second) will discharge approximately 0.85 liter of water per hour. Annual water losses per tap 7961 liter. If hot water is being heated to 160 degree Fahrenheit the energy losses per year will be 538.992 KwH and may cost you approximate Rs.2695.00 per annum think about 500 rooms hotel property have 5000 water taps and 10% taps are dipping, losses will be 2695.00 x 500 = Rs. 1347500.00. You may also require additional manpower to maintain standards of the guest rooms as well as hotel.

CHECK YOUR PROGRESS-II

1. What is water conservation? What are the methods of conserving water?

2. What is hardness of water? What are the effect of hardness of water?

2.7 Energy Management

Management is the practical science, techniques and dynamic processes of setting/objectives (tasks), planning, organizing, arranging required resources, executing, supervising monitoring, and removing bottlenecks to achieve objectives and to set new objectives. Energy is important resource for development. Energy Management is ***"The judicious and effective use of energy to maximize profits (minimize costs)."***

Energy is the capability to produce dynamic effect like work, motion, and change in shape and so on. Real world definition of energy is defined as 'electricity, fuel, steam, heat, compressed air and other like media is better for our purpose.

- It exists in many form like mechanical, heat, chemical, electrical etc.
- Introduction of mechanical power is the beginning of machine age (industrial revolution).

2.7.1 The aims of energy management

The aims of energy management are:

- To achieve and maintain optimum energy procurement and utilisation.
- To optimize the present operations
- To minimize energy costs/ waste without affecting production and quality.
- To enhance energy security, economic competitiveness, and environmental quality.

Energy Management typically this involves following steps:

- Energy Strategy, Policy and Planting Administrative actions
- Energy Audit (Metering your energy consumption and collecting the data).
- Energy conservation opportunities (ECOS)
- Energy conservation Measures (ECMs)
- Implementation of ECMs.
- Monitoring of EC efforts (Tracking your progress by analyzing your meter data).

- Implementing staff awareness and training program.
- Regularly reporting the savings achieved. Feedback reinforces staff commitment and leads to successful energy management practices.

Energy:

- Most influential factor in shaping the present social structure.
- Basic requirement is food and next to food is energy as **development** depends on the availability of energy.
- Development of any Nation depends on the availability of Energy, Materials & Manufacturing Techniques.
- Development should be sustainable

2.7.2 Energy & Sustainable Development

Energy & Sustainable Development

- The sustainaable development, in its central perception, implies that development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
- Overall development should be approached in all of its primary dimensions: economic, environmental and social.
- Energy has deep and broad relationship with each of these three pillars of sustainable development.
- Social and economic development can be attained only so long as a secure, reliable and affordable supply of energy is ensured.
- Per capita consumption of energy is regarded as an index of economic development, prosperity and standard living.
- Dark side of using energy is environmental pollution.
- If present trends continue, including heavy dependence on fossil fuels, risks will buildup not only in the environmental dimension but also in economic dimension.
- Energy resources are limited. The oil reserve will last for 20-30 years.
- Environmental concern: Global warming and climate change due to increase of CO2.
- Limited sources of conventional energy and to ensure sustatinable development substantiate the use of energy sources effectively.
- Meeting the world's growing energy needs while mitigating the effects of climate change is one of the most demanding challenges of our time.

2.7.3 Energy Audit

Energy Audit: "The verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption".

2.7.3.1 Basic Components of an Energy Audit

Basic Components of Energy Audit are:

- The audit process starts by collecting information about a facility's operation and about its past record of utility bills.
- This data is then analyzed to get a picture of how the facility uses –and possibly wastes –energy, as well as to help the auditor learn what areas to examine to reduce energy costs.
- Specific changes –called Energy Conservation Measures (ECM's) –are identified and evaluated to determine their benefits and their cost effectiveness.
- These ECM's are assessed in terms of their costs and benefits, and an economic comparison is made to rank the various ECM's.
- Finally, an Energy Action Plan is created where certain ECM's are selected for **implementation**, and **the actual process of saving energy and money** begins.

2.7.3.2 Goals of the Energy Audit

Goals of the Energy Audit are:

- Clearly identify types and costs of energy use.
- Understand how energy is being used–and possibly wasted
- Identify and analyze more cost-effective ways of using energy
    - -improved operational techniques
    - -new equipment, new processes or new technology
- Perform an economic analysis on those alternatives and determine which ones are cost-effective for your business or industry.

2.7.3.3 Types of Energy Audit

Types of Energy Audit

- Preliminary energy audit
- Detailed energy audit

Preliminary energy audit

- Uses existing or easily obtainable data
- Establish energy consumption in the organization
- Estimate the scope for saving
- Identify the most likely area for attention
- Identify immediate improvements/savings
- Set a 'reference point'
- Identify areas for more detailed study/measurement

Detailed energy audit evaluates all systems and equipments which consume energy and the audit comprises a detailed study on energy savings and costs.
Detailed Energy Audit is carried out in 3 phases

- The Pre-audit phase

- The Audit Phase
- The Post-audit Phase

2.7.3.4 Scope of Energy Audit

Scope of Energy Audit are:

- Review of electricity bills : Improvement of PF, Minimum Monthly Charges, Reduction of Contract demand, Discussion on Electricity Board Rules and Tariff structure.
- Load & maximum demand management: Study of loading pattern, identifying essential and nonessential loads.
- Transformers: No load losses, % Loading.
- Refrigeration & air conditioning: Calculation of KW/ TR, identify factors to improve it, performance of refrigerant compressor, chilling unit.
- Boilers & furnaces: Evaluate efficiency of boiler, various losses and identify factors to improve the performance.
- Steam utilisation: Check steam leakages, proper pressure as per requirement of process, condensate and flash steam recovery etc.

2.7.4 Energy Conservation

Reduction in energy consumption without compromising on quality or lowering the production i.e. reducing losses and wastages. , it is possible to increase the production from a given amount of input.

Energy Conservation can be accomplished

- Recycling of waste
- Energy efficient technologies
- Waste heat utilization
- Judicious use of high grade energy
- Judicious use of energy commodity
- Cogeneration
- Change in habits
- Training manpower
- Proper operation and maintenance

2.7.4.1 Why Energy Efficiency and Conservation

Why Energy Efficiency and Conservation?

- Because total global reserves of oil are not going to last more than 30 to 40 years.
- Because oil prices will keep rising continuously.
- Because energy usage is directly related to Green house gases and causes global warming, climatic changes and environmental degradation.
- Because even coal reserves are limited to about 200 years.
- Finally, because high energy costs make industries less competitive

2.7.4.2 Energy Saving in Lighting

Points to keep in mind for Energy Saving in Lighting:

- Switch off lights while going out of the office i.e. no one in office or use occupancy sensor.
- Take maximum advantage of daylight.
- Avoid over illumination of the area. Remove lamps where you have more light than you need.
- Avoid using incandescent lamps (bulbs). Use energy efficient lamps as Compact fluorescent lamp (CFL), fluorescent tubes, LED. CFL uses only 20% electricity for same light output in comparison to bulb beside they last about 8 to 10 times longer in comparison to bulbs. LED lights consume about 10% electricity and last for 60 times in comparison to incandescent lamp. Life of LED is about 6000 burning hours.
- Use electronic ballast in place of magnetic ballast (choke) in the tube
- LED consumes less power in comparison to CFL but comparative to Sodium lamps.
- Relocate fixtures for improved luminance
- Avoid using one light switch to control many lights so as you can switch off unwanted lights.
- Use outdoor lights with timer switch/photo cell or CFL with photo-sensor or LED with photo sensor.
- Clean your light bulbs/tubes frequently to avoid reduction of light intensity due to dust accumulation on lights.
- Use focus light/ task light as table lamp at the place of work/ reading, instead of brightly lighting the entire room and turn off general light wherever feasible.

2.7.4.3 Energy Saving Opportunities in HVAC

Points to keep in mind for Energy Saving Opportunities in HVAC:

- Accurate measure and control of temperature.
- Reduce Air conditioning Volume and Unnecessary heat Loads keep unnecessary heat (freeze, ovens) load out Use false ceilings
- Minimize heat load check and maintain thermal insulation insulate pipe fittings
- Use Landscaping (fountains, plantation) proper shading over windows
- use low emmissivity films, air curtains
- use low conductivity windows frame provide insulation of sun facing roof and walls
- provide evaporative roof cooling
- Use heat exchangers with higher heat transfer effectiveness plate heat exchangers, avoid air cooled condenser
- provide evaporative roof cooling
- Make use of Building Inertia
- Put HAVC system on timer or Occupancy Sensor
- Interlock fan coil unit in hotels with door lock
- Improve utilization of outside air

- Maintain proper coolant
- Timely cleaning of heat exchangers
- Balance the system to minimize flow and reduce pump power consumption
- Proper and timely maintenance

2.7.4.4 Energy Efficient Building Design

- Energy efficiency needs to be considered at every stage of the design, construction and operation of a building.
- Energy efficiency should be considered from the beginning of the life of a building.
- Building should be compact and inward facing to reduce surface areas exposed to solar radiation
- Large surface be oriented North-South, as these will receive the lowest solar radiation. West facing surfaces are the most critical as peak solar radiation intensity coincides with the highest temp. in the afternoon
- Most commonly used rooms should face South
- Windows should preferably be on the South side of the house to ensure that sunlight entering the house warms the floor in winter
- Access to cooling and dust free winds should be promoted
- Small, enclosed courtyards can be designed to create useable protected outdoor space.
- The shading of buildings and outdoor spaces is critical. Projecting roofs (Roof overhangs), Verandas, Windows (Window overhangs), Shading devices.
- The roof can be painted a light colour preferably white to reflect the sun's heat. Top of the roof (outside) can be painted with white ceramic paint as it is scratch proof and can reduce inside temp by about 5 to 8° C in summer and can increase the temp. by 2-3° C in winter thus improving comfort or reducing electricity consumption in air-conditioned rooms.
- Wide roof overhangs help to shade the walls, particularly those that face west, east and South.
- Windows: Glazing should be 20 to 40 % of wall area to provide optimum daylight in a building while avoiding unnecessary heat gain.
- Window shades can be provided to those windows that face direct sun, particularly those facing west, east and South
- Using curtain to shade the windows in summer, but allow sunshine into the house in winter
- When painting /re-painting external walls, light colors should be used for walls exposed to the sun.
- If floor finishes are being renewed, use those that are good conductors of heat, such as cement screed, tiles or slate and avoid carpets, particularly on the ground floor.

2.7.4.5 Tips for Energy Saving in cooling - Fridge

Tips for Energy Saving in cooling – Fridge:
For reducing energy consumption in a fridge following should be observed

- Make sure that the doors are always closed. Make sure your refrigerator door seals are air tight, otherwise heat will leak through born out seal.
- Ensure that the cooling system at the back of the fridge is always clean.
- If your fridge is too old, you may think for its replacement as it may consume more energy.
- Location of fridge is also important, it should be placed in such a way that it should have sufficient space at its back for air circulation and it should be placed in cool place away from sunlight.
- Don't put hot food in the fridge.
- Avoid frequent opening of fridge or keeping fridge open for a long time.
- If the fridge is not frost-free type or auto defrost type, then ensure periodic defrost of your fridge.
- Don't keep your refrigerator or freezer section too cold. Recommended temperature for fresh food compartment is 3° to 5°C and for freezer section is -15°C

2.8 SUMMARY

The maintenance department is organized to provide services to the guests and the remainder of the department within a lodging facility. In order to provide the services, the staff of the department must accomplish functions that fall into two categories technical and managerial functions. Even department work almost behind a scene but the success of ant functional area of the hotel totally depends on smooth operations and performance of the hotel engineering department. Department have its own organization structure which is comparatively larger than any other organization structure of the key functional department and engaged maximum number of the employees. Engineering department is headed by the chief engineer who is responsible for administration of the department and reports to General Manager of the property. Department have its own budget and generally termed as Principle of Management budget or POM Budget. Chief engineer may select any type of maintenance by keeping a track on available resources in terms of manpower, machines and the budget. Generally daily, preventive and schedule maintenance jobs performed by regular staff or employees of hotel engineering department and in case of emergency, contractual maintenance is preferred by chief engineer of the hotel. By close monitoring of contractual staff maintenance department may save a huge amount in terms of maintenance budget.

2.9 GLOSSARY

Routine maintenance Routine maintenance activities are those which pertain to the general upkeep of the property, recur on a regularly basis and require relatively minimal training or skills

Scheduled maintenance Scheduled maintenance refers to those activities which are initiated at the property based on a formal work order or a similar document which identifies a known problem or need

Contract: Contract is defined as an agreement, between two or more persons (known as parties) to function in unison (united) to accomplish a job.

PH Value of water: the presence of acidic or alkali materials make the quality of water acidic or alkaline.

Hard water: in simple terms, hard water does not produce good 'Lather' with soap due to the presence of certain salts and as a result of this, consumes more soap.
Zeolite: Zeolite removes both permanent and temporary hardness. Zeolites are members of a family of hydrated Sodium aluminosilicate mineral [Na_2 ($Al_2Si_3O_{10}$) $2H_2O$] that contain alkali and alkaline-earth metals

Energy Audit: "The verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption.

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2.12 TERMINAL QUESTIONS

Objective Type:

Define following terms:

- Maintenance

- Contract
- Unit price
- Ph Value
- Energy
- HVAC

Short Answer Questions:

1. Water Hardness
2. Energy Audit
3. Differentiate between permanent and temporary hardness of water
4. Differentiate between preventive and breakdown maintenance.

Long Answer Questions

1. Define maintenance and discuss objectives of the maintenance department.
2. Discuss duties and responsibilities performed by maintenance department.
3. Discuss duties and responsibilities performed by chief engineer of a five star hotel.
4. Develop an organization structure of maintenance department of a 200 room's hotel property.
5. Enlist merits and demerits of contract maintenance.
6. In what conditions unit price is advisable. Explain with examples.
7. Differentiate between Cost plus fee and Cost plus contract with upper limits.

Project Assignment:

1. Prepare a report of maintenance department of your institute / nearby hotel on the following parameters:

- Organization structure
- Budget
- Contractual services
- Objectives of the department
- Duties and responsibilities of maintenance personnel
- Problems faced by the maintenance department with their possible solutions.

2. Visit nearby hotels of your town and observe activities performed and latest techniques adopted by hotel engineering department.

UNIT: 03
ELECTRICAL SYSTEMS

Structure

3.1 INTRODUCTION

Hospitality and service industries require and use vast amounts of electric energy. Cost of electricity is increasing rapidly and it has become almost three times with in last five years. Every manager spends a lot in energy cost in comparison to other operating costs of the establishment. Dependence on a single source of energy cannot be underestimated. The industry is dependent on electricity for power, light and heat and the most of the building systems operate electrically and the value of electric energy in industries is almost impossible to determine accurately. There are two kinds of electric current: direct and alternating. The former is not often used in hotels, except occasionally for special equipment. Most electricity for the public supply is produced in the form alternating current on the three phase system.

3.2 LEARNING OBJECTIVES

After reading this unit learner will be able to:

- Understand basic fundamentals of electrical engineering.
- Explain types of wire with their characteristics
- Explain different types of fixtures used in hotel and catering industry
- Explain single phase and three phase ac supply
- Explain types of lighting
- Calculate amount of bill incurred on electricity consumption
- Explain safety in handling electrical equipment

- Explain refrigeration and air conditioning systems.

3.3 BASIC DEFINITIONS AND TECHNICAL TERMS

Conductor*:* ***A*** conductor is a substance through which electricity flows freely, e.g. copper, aluminum, water or the wiring system of a building.

Volts: It measures the ***pressure of flow*** of an electric current. Before electricity can flow through a wire, the electric pressure at one end of the wire must be greater than at the other end: this is known as "**potential difference**".

One volt: One volt is defined as potential difference necessary between the ends of a conductor whose resistance is 1 ohm, to produce a current of 1 ampere. 220 volts is introduced as the standard for domestic use and 415 volts for industrial use throughout the country.

Ohms: it measures the resistance of a conductor to the flow of a current. All conductors offer some resistance, but the lower the resistance the better the conductor. A thin wire offers more resistance (causing voltage drop) than a thick cable of same material, and therefore long runs of the former should be avoided when planning the electrical wiring of a building.

Ohm's Law: The Ohm's Law defines the relation between the above three parameters of the electric circuit as follows: "The voltage drop across the load resistance of the circuit is directly proportional to the current flowing through it; provided the physical parameters viz. length, cross-section, temperature and material of the load resistance remains same."

- Mathematical representation:

  $V \alpha I$

  $= [R] * I$ [where R is a constant of proportionality and known as 'Resistance' responsible for energy waste]
  - Unit of 'V' expressed in Volts.
  - Unit of 'I' expressed in Ampere.
  - Unit of 'R' expressed in Ohm unit.
- The 'V.I.R.' triangle easily recalls the circuit parameters.

Ampere: it measures the rate of flow of a current, i.e. the amount of electricity that is passing through the circuit. If an electric wire using 10 amps is plugged into a 5 -amp. Socket, the demand will overstrain the circuit and should blow the fuse.

One Ampere = 1Coulomb /second = $1 / 1.6 \times 10^{-19}$ electrons /second = **flow of 6.25×10^{18} electrons /second**.

Watts: it measures power- that is to say, the amount of electricity used by an appliance. 1000 watts = 1 kilowatt ("kW") A unit is familiar term, is kilowatt- hour. This is the amount of current consumed, for example, by one 1,000 – watt appliance in use for one

hour, or two 500 – watt appliance in use for one hour, or two 250 –watt appliance in use for two hours.

One unit produces 3,415 British Thermal Units of heat.

One B.T.U.: It is the quantity of heat required to raise the temperature of 1 lb. of water through 1 degree Fahrenheit.
There is a simple relationship between volts, ohms, amperes and watts that can be expressed by the following equations:

1. ***volts / ohms = amperes***

For example: when the voltages of the main supply is 240 volts and the wire and other connections leading to a socket outlet have a resistance of 48 ohms, the socket outlet is able to supply 5 amps.

2. ***watts = amperes x volts***

For example: a 5 amp. Socket using a current of 220 volt can supply an electrical appliance rated at 1,100 watts

3. ***amperes = watts / volts***

For example: four 100- watt lamps using 220 volts could be safely supplied by a 2 -amp plug.

The abbreviations used by electrical engineers are: E= volts, I= amperes, R = ohms, W = watts.

Potential difference in volts unit between two points is equivalent to work involved in Joules to move one Coulomb charge through the two points.

Work = Potential difference in Volts $*$ One Coulomb
Work – One Joule = One Volt $*$ One coulomb
Work – One Joule / second = One Volt $*$ One Coulomb / second
Work Rate – One watt = One Volt $*$ One Ampere

Energy or Work / Sec. (power) = V $*$ I Joules / second or watt = V^2 / R watt = I^2 $*$ R watt

- Total energy in T sec. = Power $*$ Time in seconds
  = Watt $*$ seconds = V $*$ I $*$ t Joules
  = V $*$ I $*$ t / 4.2 cal [4.2 Joules = One calor
  = 0.24 $*$ V $*$ I $*$ t cal = 0.24 $*$

3.3.1 Effects of Electric Current

The flow of charge or electric current through a conductor produced the following effects:

- **Thermal effect:** The flow of electric current produces heat and causes rise of temperature of the resistive conductor.

- **Luminous effect:** Due to the thermal effect at high temperature the resistive conductor radiates light.

- **Magnetic effect:** The current flow in a conductor always accompanies with production magnetic lines of force.

- **Chemical effect:** Electric current flowing through electrolytes (water solution of salts) or molten salts causes chemical change.

3.3.2 Electric Wires and Types of Wiring

The standard form of a wire consists of a core containing the conductor wires preferably copper which are protected and insulated by vulcanized rubber (V.R.I.), polythene, or polyvynyl chloride (P.V.C.), the purpose of insulator is to confine electric flow to the conductor. Wire color coding is used so that the electrician can identify the different wires when connecting them at two or more locations within a building. The diameter of the conductor determines the number of amperes it can safely carry. Insulation types and thickness specify the maximum voltage the wire can handle. Insulation type and thickness will also vary because of the environment the wire may be exposed to. When specifying wires, you must specify the normal or expected environment. Wires are generally rated in amperes.

Cables: Several conductors, each with its separate insulation, can be combined with additional insulation to form a cable. Cables must be protected against physical damage such as pressure, cutting, rubbing, dampness or attack by rodents. One method is to cover them with a strong, protective sheath. The various types of sheathed cable include the following:

- ✓ Tough – rubber sheathed (T.R.S.), also known as cab-tyre sheathed (C.T.S.) - because of outer sheath of tough rubber or cab- tyre. These wires are used in 400/ 230 V grades only. It is cheap, easy to install, and fairly strong.
- ✓ Lead- alloy sheathed (L.A.S.) – neat and convenient for earthing, but vulnerable to damage.
- ✓ Mineral- insulated copper sheathed (M.I.C.S.) – very strong, will withstand extremes of heat, moistures, and fumes, etc; fairly expensive.
- ✓ Aluminium – light and stiff, self supporting on bends.
- ✓ Polyvynyl chloride (P.V.C.)- these cables resist successfully the action of acid, alkali ultraviolet radiations, ozone, sun etc and are Very flexible and waterproof. These are very difficult to ignite. These wires are made in both 400 /230 V and 1100/ 600 V grades.
- ✓ V.I.R cable- in V.I.R. cable, vulcanized rubber insulation is applied over tinned copper wires to prevent attack of sulphur in the vulcanized rubber over bare copper. Although vulcanized rubber is relatively strong, it is further covered with cotton tape with braiding spun on its top. The cable is then dipped in the solutions of bitumen or wax to make it moisture proof. These wires are made in both 400 /230 V and 1100/ 600 V grades. These wires are used in casing capping and conduit wiring.

More strength and permanent protection for the cable is provided by dusts and conduits.

- ***Ducts,*** consisting of shallow tubes or channels in the concrete, can be incorporated in the floors of a building at the construction stage.

- ***Steel conduit*** can be either light – gauge or heavy – gauge. Light gauge, with joints clipped together, is cheap but not very reliable from the point of view of earthing

- ***Heavy- gauge,*** with screwed joints, is strong, easy to re-wire, and has good earthing qualities.

- ***Plastic or fibre*** conduit can also be used. It should be firmly fixed to give rigidity and usually requires a separate earth – continuity wire.

- Conduits can be fixed to the surface of walls, floors or ceilings, or buried in plaster or other finishing material. Because of its poor appearance, surface fixing is not recommended for the public parts of a hotel building. Ducts and conduits have junction boxes at intervals to enable the electric cable to the inserted or withdrawn as required, thus facilitating repairs.

Flexible wiring is normally used for lamp pendants, portable apparatus, and, temporarily, for other purposes. It is, however, only lightly protected and must not be used for permanent fixed wiring. It is considered bad practice to have flex permanently alive and apparatus should be disconnected when not in use. In addition to being protected from physical damage, a wiring system must contain safeguards against causing fire or shock. Fire is usually the result of a long period of overheating, due to overloading, a loose connection, faulty equipment, ineffective insulation, or damaged flex.

3.3.3 Electric Circuits and Types of Circuits

Electric Circuit is path of an electric current. The term is usually taken to mean a continuous path composed of conductors and conducting devices and including a source of electromotive force that drives the current around the circuit. A circuit of this type is termed a closed circuit.

- ***Open circuit*** in which the current path is not continuous or current flow is interrupted is called an open circuit.

- ***A short circuit*** is a closed circuit in which a direct connection is made, with no appreciable resistance, inductance, or capacitance, between the terminals of the source of electromotive force. No serious damage is likely to be done beyond the blowing a fuse.

- ***Testing of circuits:*** The insulation of circuits should be tested periodically at double the normal voltage. Tests may be carried out by hand-driven generator and a direct-reading ohmmeter. The effectiveness of earthing should be tested by an earth-fault loop impedance tester of the current –injection type.

3.3.4 Series and Parallel Circuit and Their Applications

A series circuit is one in which the devices or elements of the circuit are arranged in such a way that the entire current (I) passes through each element without division or branching into parallel circuits.

When two or more resistances are in series in a circuit, the total resistance may be calculated by adding the values of such resistances.

$$R = r1 + r2 + r\,3$$

If the resistances are in parallel, the total value of the resistance in the circuit is given by the formula:

$$R_{total} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots}$$

In a parallel circuit, electrical devices, such as incandescent lamps or the cells of a battery, are arranged to allow all positive (+) poles, electrodes, and terminals to be joined to one conductor, and all negative (-) ones to another conductor, so that each unit is, in effect, on a parallel branch. The value of two equal resistances in parallel is equal to half the value of the component resistances, and in every case the value of resistances in parallel is less than the value of the smallest of the individual resistances involved. In AC circuits, or circuits with varying currents, circuit components other than resistance must be considered.

CHECK YOUR PROGRESS -1

1. What is wire ? Enumerates various types of wire.

_____
_____
_____
_____
_____
_____
_____
_____
_____

2. What is electric circuit ?Explain their types .

_____
_____
_____
_____
_____
_____

3.4 FUSES

Fuses are provided at every distribution board. They take the form of a short piece of thin wire which melts or blows, thus disconnecting the supply, if the current load becomes too heavy. There are two types of Fuses:

- Rewirable fuses
- Cartridge Fuses

3.4.1 Re-wirable Fuses

In these fuses a length of wire is screwed to a porcelain carrier; blown fuses are repaired by replacing the wire, which should be properly secured under the washer or screw head. Kit- kat type of fuse is most commonly used fuse device in domestic installation. It consists of porcelain base which has fixed contacts to which arc is connected incoming and outgoing cables of live wire. The carrier of porcelain carries the fuse element. The main advantage of this design in the case of replacement of fuse wire which does not involve the danger of coming in contact with live parts. It is also very cheap to replace fuse wire. It, however, suffers from unreliable operation due to oxidation or due to the use of improper size of wire element. These fuses have lower rupturing capacity and, therefore, are not employed in circuit whose fault current exceeds 4 K.A. Therefore, for power circuits rewireable fuses are being replaced by HRC fuses.

3.4.2 Cartridge Fuses

Cartridge fuses are self contained units with the link wire bedded in unburnable powder; they cannot be repaired; they usually give a visual indication when blown. Cartridge fuses are safer, as they smother the arc that is momentarily formed when the circuit breaks. H.R.C. fuses consists of outer ceramic body, sealed at both ends by metallic caps. To these caps are welded a number of silver wires in parallel. The space surrounding these wires is filled with compacted quartz sand which acts as a quenching medium. To the end caps are fixed tags for the purpose of fixing the fuses.

3.4.3 Advantages of H.R.C. Fuse

The advantages of H.R.C. fuse over re-wireable fuses are as under:

- H.R.C. fuses can successfully deal with high currents up to 46 Kamp. as against 4 Kamp. in case of rewireable fuses.
- There is no oxidation in H.R.C. fuses due to their hermetic sealing of silver element within fuse by cementing and soldering of end caps, while rewireable fuses face the problem of oxidation.
- H.R.C. fuse give better overload protection as compared to rewireable fuses.
- On severe short circuits, fault current in case of H.R.C. fuse is interrupted well with in first quarter of cycle, with the result that value of short circuit current does not reach its maximum value. In rewireable fuses short circuit current is interrupted only after few cycles. Thus, in H.R.C. fuse, both thermal and magnetic stresses on the equipment protected are reduced.

- H.R.C. fuse is not susceptible to tampering and over fusing as rewireable fuse.
- H.R.C. fuse has low temperature operation in comparison to kit-kat type fuse.

4.4.4 Circuit Breakers

Circuit breakers consist of an electro-magnetic trip which breaks the circuit automatically when there is an overloading of, or a defect in, the circuit. They can be reset by hand to restore the current. If, however, the fault persists; an automatic device prevents resetting until the cause of the trouble has been remedied. Circuit breakers can be used either in place of fuses or for the earth –continuity circuit in buildings where it is difficult to obtain an effective earth connection. A fuse must have the same current rating as the circuit it protests. It is most dangerous to replace a fuse with one of a higher rating. By preventing the fuse from blowing when there is a fault in the circuit, this may cause an outbreak of fire or the risk of an electric shock. No attempt should be made to mend a fuse until the current has been switched off. If a fuse blows again immediately after being repaired, it indicates that the apparatus, rather than the circuit, is at fault.

4.4.5 Causes of Blown Fuse

Causes of blown fuse are as under:

- too many appliances plugged into a circuit: a 3-Kw geyser, 1 Kw electric water boiler and 750 watt house hold iron is plugged into a power circuit 15 A; Voltage 220 .
  To find current flowing through the three appliances:
  W = V XA
  A = W /V
  = 4750 / 220 = 21.59
  Therefore current = 21.59 amperes.
  Therefore a greater amount of current than 15 A is flowing, and consequently fuse will blow and the circuit will be broken.
- Plugging a power appliance into a lighting circuit: e.g. A 3 Kw geyser plugged into a circuit to designed to carry 5 ampers, voltage 220 .

  Current flow = W /V
  3000 / 220 = 13.63 amperes
  Therefore current 13.63 amperes.
  Therefore the fuse will blow. It may also cause a strain on flex.
- Short circuit due to insulation failure
  it means that lead and return wires touch and therefore current does not reach the appliance. Often due to wear of wire insulation.

4.4.6 Repair of Fuses

Repair of fuses:

- ✓ Turn off the main switch.
- ✓ Find the fuse that has blown. This may be known before hand, if not, try each one in turn.

- ✓ Remove broken fuse wire.
- ✓ Replace with new fuse wire of the correct rating (5,10, 15 or 30 amperes).
- ✓ Before replacing the repaired fuse and before switching on, find the cause of old fuse wire melting; check all connections and the leads of the appliances if it caused the fuse is blow.

4.4.7 Earthlings

The risk of shock can arise from damage to insulation, the presence of water, or the working looses a connection. Electricity always takes the path of least resistance to the earth. It will therefore pass through the body of a person who is in effective contact with the earth, e.g. by touching a metal pipe or stone floor.

However, if there is an easier path to earth (e.g. a copper pipe) the current will take that in preference to passing through the human body. Protection against shock can therefore be given by ensuring that every circuit has an energy pat to earth (known as earth – continuity circuit), which will conduct harmlessly away any leaking electricity.

There are two types of earthing: In metal conduit installation, the path to earth is the conduit itself, which must be carefully laid to ensure that there is no break in its electrical continuity.

In metal –sheated cables, the path is usually metal sheath. Cables with a rubber or other insulated sheath usually have a special conductor incorporated in the core. The earth end of the circuit is attached to the water main or the metal covering of electric service cable. The circuit protects the whole of the wiring and fixed appliances, together with portable appliances if a three –pin plug is used.

3.5 Accessories

The electrical accessories consist of:

- Switch
- Ceiling Roses
- Lamp Holders
- Socket Outlets and Plug Tops
- Appliance Connectors
- Fans
- Wooden Boards and Blocks

3.5.1 Switch

Switch is manually operated device for closing, opening or changing the connection in a circuit. Switches used in house wiring are of surface or tumbler type and flush type. Surface or tumbler type switches project out of the switch board and are most commonly used. Flush switches as name indicates, are flush with switch board. Flush switches are some time also called as piano switches or tiny switches. These switches, for lighting circuits are of 5 amps. Rating and for power circuits these are of 15 amp. Rating. One

way switches have two terminals and are connected in series with the points. Two way switches have four terminals two of them are connected inside. These switches are used in controlling one point from two places such as in stair case wiring,. It should be clarified here that both one way and two way switches are inserted always in the live. Two pole switches are actually two single way switches linked together which control both live and neutral wires simultaneously. These switches are used as main switches for domestic installations.

In addition to above main types of switches , there are push button switches used for electric bells, table lamp and bed on-off switches. Last two types of switches have knobs of fluorescent material which enable them two glows at night.

3.5.2 Ceiling Roses

Ceiling rose forms the tapping point from electrical installation for supplying power to fans, pendants or tube lights by means of flexible cords. Ceiling roses are not used on circuit the voltage of which normally exceeds 250 V. normally only one flexible cord is attached to a ceiling rose. Ceiling roses are normally two plate type. However, three plate types of ceiling roses are used in the system of wiring employing twin cables.

3.5.3 Lamp Holders

Lamp holder connects the filament lamps to the electrical installation. These may be of brass or bakelite type. Latter type lamp holders do not give any shock but are less durable as compared to former type. Lamp holders for lamps upto 150 W are of Bayonet type and for lamps of 150 W and above are of Edison screw type. Edison screw type holder has centre contact which is connected to the live wire and outer or screw contact is connected to the neutral wire. Bayonet lamp holders may be pendant type, bracket type or batten holder straight type or batten holder angle type. Pendant holders are provided with cord grips. Filament lamps are hung at a height or not less than 2.5m above floor level.

3.5.4 Socket Outlets and Plug Tops

Portable appliances are connected to electrical installation by means of these. These may be surface type of flush type. Two pin type sockets and plug tops are used for feeding portable appliances having al insulated body such as garden standard lamp. For feeding portable appliance having metallic body it becomes necessary to earth the metallic body which ensures safety to operating personnel. Socket outlet and plug top for feeding such appliances have necessarily to be one of three pin type. Two pins are of equal size. These are connected to live and neutral wire. The third pin is thicker and longer than other two pins and is connected to earth wire in case of any leakage from the element of appliance to the metallic body; heavy current will flow through earth wire. Thicker earth pin provides sufficient contact area with hollow contact of socket. Longer earth pin engages with earth before conducting pins engage with live wire while plug top is inserted in the socket. Similarly earth pin disengages last while plug top is taken out of socket. In case of earth fault, heavy current can flow through it without over heating or burning the contact. Thicker size of earth pin also does not allow wrong insertion of

three pin plug top. Usually three core flexible cords is used to connect the plug top to the appliance-green wire being used for earth pin and red and black wires for live and neutral respectively. All the plug tops are provided with cord grips and rubber brushes at their outlet. Socket outlet and plug tops are of 5 A rating for fans, table lamps, radios etc. and 15 A for power appliances such as heaters, iron etc. Every socket outlet has to be controlled by a switch fixed preferably adjacent to it. Socket outlet will be fixed at any convenient place 23 cm. above floor level.

3.5.5 Appliance Connectors

These are used for giving supply to household appliances such as heaters, toaster, iron press, electric kettle etc. These may have either side entry or straight entry and may be flat or round type. Twin nickel spring contacts are provided on outside to establish earth connection with the metallic body of the appliance.

3.5.6 Fans

Ceiling fans should be hung at not loss than 2.75 m above floor. Lead in wires will be of normal cross sectional area not less than 1.25 mm square. Fan canopies on the top and bottom of suspension rod will effectively hide the suspension and connection to the fan motor respectively. Fan must be hung by means of suspension rod from ceiling having rubber type insulator in between the two. There shall be no joint in the suspension rod as far as possible. Exhaust fans are fixed to the wall by means of rag-bolts. Connection to the fans will be by means of flexible cord taken from a ceiling rose or special connector box. Regulators are to be connected to the earth wire.

3.5.7 Wooden Boards and Blocks

All the ceiling roses, brackets, pendants, and accessories are to be mounted on vanished teak would blocks of depth not less than 4 cm. Similarly switches, sockets outlets and regulators etc. are mounted on teak or hard wood boards. The size of wood boards will depend upon the number of accessories to be accommodated.

3.6 TYPES OF ELECTRICAL ENERGY

Appliances and devices may require different electric-energy sources. Small buildings may have very limited electric-energy capabilities, while larger buildings (hotels, institutional buildings, and health-care facilities) may provide several electric-energy sources. In this section these sources will be briefly discussed, and management recommendations will be made for utilizing these optional resources.

3.6.1 Direct Current

Direct current, or dc, has limited applications in the hospitality industry. Direct current provides a constant flow of amperes when a constant voltage is impressed on the amperes. Amperes change only if the electrical load changes or if the impressed voltage changes. Direct change is used in some security systems and for limited emergency energy use for selective devices, such as exist lighting. For these uses, dc is probably;

provided by a battery or a series of a batteries. Many data processing systems have dc sources. It is frequently important to keep theses systems in operation even when electric energy from the local electric utility is uninterrupted. These backup devices are frequently long life batteries that are automatically charged when electric energy is being supplied to the unit. Direct current may also be generated on the property. this done only for certain types of elevator motors. Some emergency lighting systems for public areas may also operate on dc power sources. In almost all cases, a battery source will be utilized.

3.6.2 Alternating Current

Hospitality industry buildings are supplied with alternating current, or ac, from the local electric utility. Electric appliances and devices generally available consume ac energy.The manager must know the characteristics of the ac being supplied to the building by the local electric utility. All electric devices used within the building must be matched to the available energy. If they are not, serious problems can result, including the loss of all electric devices. Throughout the world a large percentage of the electrical energy used is generated by alternating current generators. It is therefore necessary to understand the principles of electricity and magnetism as they apply to alternating current. The extensive use of alternating current has not eliminated he use of direct current. There are many applications where direct current essentially be used or it performs better than alternating current. Applications where direct current is must or better:

- Electrochemical process: such as electroplating, refining of ores.
- For the excitation of field poles of ac generators.
- For the variable speed motors requiring precise speed control.
- For traction motors.
- For battery charging.
- For the operation of electronic equipments.
- For arc lamps used in cinema projectors and search lights.
- For some special electric welding process.

Some of the reasons for the wide use of alternating current in preference to direct current for large generating, transmission and distribution system are as follows:

- AC generators can be built in much larger power and voltage than the DC generators.
- With the alternating current, the voltage can be easily stepped up and down by means of transformers. The transformers have no moving parts to adjust or replace and the efficiency is high from 95 to 99%.
- In alternating current, long distance high voltage transmission is possible by use of step up transformer with minimum of voltage loss and line losses. Low voltage distribution is also possible by use of step down transformers.
- A.C. induction motors are simple and robust in construction, have nearly constant speed, and are smaller and cheaper than D.C. motor of equal power.

Alternating quantities: The quantities whose magnitude and direction constantly changes periodically with time are called alternating quantities

Alternating Electric Current/voltage: the electric current/voltage whose magnitude and direction continuously changes periodically with time is called alternating current/voltage.

Alternating Current: is that current, which flows with varying magnitude first in one direction and then in the reverse direction, this completes one flow-cycle or wave of constant time interval called Time period. One half of the cycle or wave is termed Positive half cycle, while the other Negative half cycle.

Various types of alternating cycles: the figures show different types of alternating cycles or waves with their respective names. These alternating current waves are used in electrical and electronic applications.

The alternating wave use for electric supply system: 'Sinusoidal Wave' or 'Sine Wave' is universally employed for alternating electric supply system. The current and voltage waves are represented by the following mathematical formulas:

$i = I_m \times \text{Sin}\ \Theta$

$v = V_m \times \text{Sin}\ \Theta$

Where, i and v are the instantaneous values and I_m and V_m are the maximum values of current and voltage of the waves. And Theta is the time in terms of component angle value of the complete cycle of 360 degrees.

Sinusoidal Wave: A sinusoidal wave is one in which the value of the quantity (emf/current induced) at any instant or time, depends upon the product of the maximum value of the quantity and the sine of the angle at that instant.

Wave Form: The graphic representation of the alternating voltage or current in a circuit with respect to time is called the Waveform for the voltage or current.

Instantaneous value: the value of the alternating quantity at any instant on the time line is called the instantaneous value. The value is equal to the product of the maximum value of the quantity and the sine of the angle of the required instant.
Maximum value: the peak value of the alternating wave is known as the maximum value of the alternating quantity. It is represented by a suffix '$_{max}$' after the quantity e.g. I_{max} / V_{max}.

Alternation: a complete set of positive values or negative values plotted against the time is known as an alternation. One alternation is equal to half cycle, since a cycle has two alternations one positive and the other negative.

Cycle: the portion of the curve between one complete set of alternation (one each of positive and negative) and the time line is called a cycle.

Frequency: the number of cycles of the alternating quantity per second is termed as the frequency of the quantity. It is denoted by the letter 'f' or 'n'. The unit of frequency is 'Cycles per second' and the name of the unit is 'Hertz' in short 'Hz'.

Time Period: The time period of an alternating quantity is the time is seconds taken by the quantity to complete one full cycle.The letter 'T' denotes the time period the unit is 'second'

Relation between time period and frequency:
'T = 1 / f sec' or 'f = 1 / T'

Average value of an alternating quantity: an alternating quantity wave has a positive and negative half cycle, which identically equal to each other. The average of the alternating quantity over a complete cycle turns out to be 'Zero'. However at times we need to calculate the average value of the alternating quantity. The average of each half of the quantity is the average of the alternating quantity. If 'I_{av}' denotes the average value of the positive half cycle of a sine wave Alternating current, then:

$\mathbf{I_{av} = 2 / \Pi \times I_{max}}$ or $\mathbf{I_{av} = .636 \times I_{max}}$.

Average Value of Alternating current: Average value of the alternating current wave is defined as the value of that direct current, which transfers the same amount of electric charge in a circuit in the same time as transferred by the alternating current in the same circuit in half time period of the cycle.

Root mean square value of Alternating quantity: the power produced by a current of I amp flowing through a resistor of R ohm is $I^2 \times R$. As power is proportional to the square of the current hence power is always positive whether the value of the current is positive or negative. Energy is equal to the product of power and time ($I^2 \times R \times T$). Hence the Alternating current or voltage applied across a resistor will produce varying heat energy in both the positive and negative alternations of the cycle.

- 'The root mean square value of an Alternating current/Voltage is given by that steady or direct current, which when flows through a circuit for a certain time produces the same amount of heat, as produced by the alternating current when flowing through the same circuit for the same time.'

Most hospitality industry buildings are supplied with single-phase and three-phase alternating current.

3.6.3 Advantages of 3-Phase System

Present day generation of electrical power is almost 3-Phase; this is due to the following factors.

a. For the transmission of given power over given distance, there is saving in the material used in conductors in 3-phase system.
b. For given voltage and KVA rating, electrical equipment such as alternators and transformers in 3-phase system are not only lighter, and cheaper but efficient too as compared to those in single phase system.

c. Magnetic flux produced due to current flow through the armature of a single phase machine is pulsating and that through the armature of a 3-phase machine is rotating one of constant magnitude. Therefore torque produced by 3-phase motors is uniform and constant whereas that produced by single phase motors is pulsating.

d. Single phase motors operate at very low power factor as compared to three phase motors. For the same power they draw a heavy current which produces large line losses and voltage drop in the line.

e. Single phase motors are not self starting whereas three phase induction motors are self starting.

f. In 1-phase 4-wire system, we have two levels of voltage supply. Heavy loads are connected across phase wires and light loads across phase and neutral wire.

3.7 ELECTRIC LIGHTING

One of the primary uses of electric energy is for artificial lighting. In most buildings, lighting represents the second –highest energy use, following electric motor requirements. Light, its reflection, and object visibility are all interrelated. A light source radiates energy that you cannot see. Atmospheric air is transparent to light energy, which means air does not absorb or reflect the energy passing through it. As light energy strikes a surface , it may be absorbed and converted to heat, which lowers lighting efficiency; the surface may transmit some of the energy (another energy loss); or light may be reflected than only you see reflected light. Light colored surfaces reflect a high % of the light striking them. A black surface reflects very little light; hence, it absorbs or destroys light energy that's why it is more difficult and costly to light darker –colored than lighter colored rooms. Light sources can also be of different colors, which produce various qualities of light. Common light sources provide "white" light, which is generation of all colors; so various objects lighted with white light appear natural or retain their real color. Red appears red when lighted with white light. Insects are yellow blind and cannot see objects lighted with yellow. Yellow to insects is like black to us. Hence, yellow light do not attract insects. Insects can see black light, which we can not see. Therefore, black light sources are used for insect traps. Some street lights for example, mercury vapor lamps- attract large numbers of insects; others, such as sodium vapor lamps, which generate tallow colors, do not appear to attract insects.

3.7.1 Lamp

Lamp is a source of light. A lighted candle is a lamp because it is a source of light. A lamp is inserted into a lighting fixture. The combined lamp and lighting fixture is a *luminaire.* Lamplight output is given in lumens. A lumen is a quantity of light. One very good efficiency rating for lamps is the number of lumens produced per watt of energy input. The lumen is the amount of light energy that strikes an area at a specific distance from a standard candle. If 1 lumen falls on a 1-square foot area of a distance of 1 foot from a standard candle, it is called 1 foot-candle of light intensity; or of 1 lumen strikes 1 square meter of surface of a distance of 1 meter from a standard candle, it is called 1 lux. Foot-candles refer to the intensity of light.

Room lighting design is based on foot candle (lux) and lumens. The relationship is shown in figure. As you move farther away from the lamp, the lumens are spread over a larger surface area, so lighting intensity decreases. If correct lighting is not provided in an area, poorly lit objects can become hazards for guests as well as employees. Lighting design depends on the foot candle (lux) intensity required at the work surface. Highly detailed work or work with high sight requirements demands high intensity light for maximum worker productivity. Hence, lighting requirements vary with the task being done. Below mentioned table shows some recommended light intensities for various tasks. These are based on extensive research and are hospitality standards.

WORK AREA	FOOT CANDLES	LUX
Kitchen work area	30	322.8
Classrooms	40	430.4
Hotel: general areas	10	322.8
Bathroom	30	107.6
Accounting and bookkeeping	100-150	1076-1614
Food service:		
Fast food	40-50	430.4-528
Moderate-priced	10-20	107.6- 215.2
High-priced	5-15	53.8- 161.4

Table 3.1 Recommended foot-candle and lux intensities for selected tasks

3.7.2 Resistance -Type Lamp

One very common source of light which has a high-electric –resistance –filament wire. An energy flows through the filament wire, it incandesces, or glows, and the emitted energy is visible light and heat. The lamp is available in a variety of shapes, bases and operating characteristics. The more common shapes are P (pear), PS (pear straight), and F (flame). These lamps are rated in volts, Watts, hours (life in operating hours), and lumens.

3.7.2.1 Incandescent Lamps

The Incandescent lamp radiates visible light that is rich in such warm colors as red, orange, and yellow. Hence, the lamps have a tendency to bring out warm reddish color of food products. Especially cooked meat and red and rose wines. You also can cut the operating cost and improve the efficiency by replacing an incandescent lamp with fluorescent lamp. For example:

150 watt incandescent lamp may replace by 40 watt fluorescent lamp.
Installed cost of the incandescent lamp Rs. 15/-
Installed cost of the fluorescent lamp Rs. 40/-

But realizes a savings of 110 watts. Thus a lamp burns 12 hours per day the savings would be 110 watts x12 hrs per day x 365 days =481.8 KwH/ year which may save your electric cost approximately Rs.2409.00 per annum think about 100 bulbs in an establishment.

Other replacements might include: 100 watt incandescent lamp with 17 watt fluorescent capsules. 60 watt bulbs with 13 watt fluorescent screw-in-types lamps.

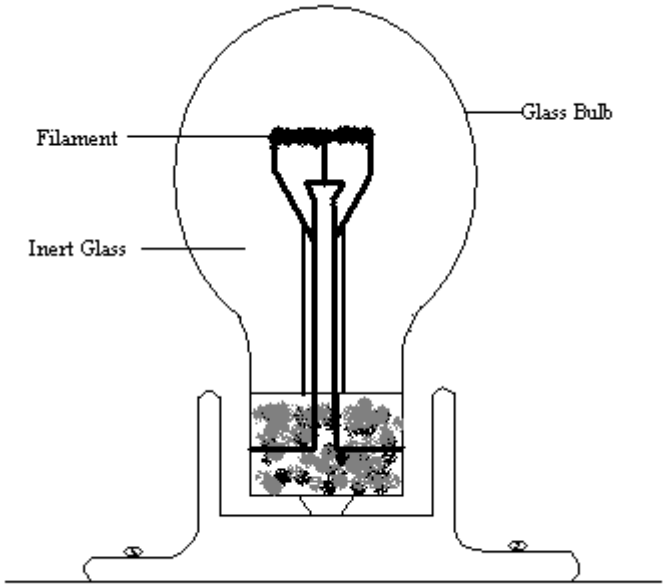

Figure 3.1 Parts of an Incandescent Lamp

3.7.3.1 Parts of Incandescent Electric Lamp

The incandescent electric lamp consists of following parts:

- ***Glass Bulb:*** it is the thin outer cover of the lamp, commonly pear-shaped, and is made of high quality temperature resistant and shockproof clear glass. The bulb has an evacuating tip at the top, which is sealed after withdrawing the air from inside. The air is withdrawn to prevent oxidation of the metallic filament at high working temperature. The glass bulb gives firm support to other parts of the lamp and protects the internal parts. The bulbs are also designed in different other shapes for correct and desired distribution of light.

- ***Glass Stem***: a hollow glass stem projects inside the bulb and is fused with the top end of the glass bulb. The function of the stem is to support internal components e.g. lead-wires, a couple of filament support wires and a filament.

- ***Lead Wires***: the stem supports two lead wires, which come out of the glass bulb through sealed holes. At the upper end of the bulb the lead wires are soldered to the brass terminal points. The lead-wires provide a conducting path for the flow of current from the outer terminals to the filament.

- ***Filament Support Wires***: a couple of thin steel hook wires are fixed radial to the base of the glass stem. These wires give support to the mid section of the filament so that it does not sag, vibrate or break due to heat and mechanical shock.

- ***Bulb Cap:*** at the top of the sealed bulb, a bulb cap is fixed by adhesive cement. An insulating disc is fixed at the top of the cap and carries two brass terminals. The lead wires are soldered to these terminals. The terminals make connection with the holder terminals when the bulb is fixed; this allows the electric current to flow when the circuit is switched on. The caps are of two types:

    - ***Bayonet Cap:*** it is a thin metallic object shaped as hollow cylinder with one end flared to fit the bulb. At the top and there are two terminals and on the curved surface there are two pins for fixing the bulb in the holder. The bulb cap is inserted in the holders with pins in the slots and then given a clockwise twist. This locks the bulb in the holder in the same way as a bayonet at the tip of a gun.

    - ***Screw Cap:*** screws are provided on the circular surface of the metallic cap. The bulb is screwed in a special screwed holder. There is only one terminal at the top, while the metallic cap itself serves as the other terminal.

- ***Filament:*** it is made of tungsten, which is high resistive material and it has a high melting point (about $2{,}300^0$ C). When heated near to this temperature it shines brightly and gives light.

3.7.4 Tungsten – Halogen Lamps

Another form of resistance lamp is the tungsten- halogen, or quartz, lamp. The life of a quartz lamp is 3-4 times greater than incandescent lamp. Its efficiency equals to the most efficient incandescent lamps and its lumen output does not vary with its age; however, its initial cost is higher in comparison to an incandescent lamp; however its initial cost is higher in comparison to an incandescent lamp.

3.7.5 Electric Discharge Lamps

Fluorescent lamp is an electric –discharge lamp, which operates on alternating current. The operation is complex in compared to an incandescent lamp. The space between the ends is filled with low-pressure mercury gas. The electrons flowing from one end to the other are absorbed by the mercury gas, and energy is emitted- for every action there is a reaction. Now, as this different energy passes through the glass tube with its chemically coated interior, visible light energy is produced along with low temperature heat. (See Fig.3.2)

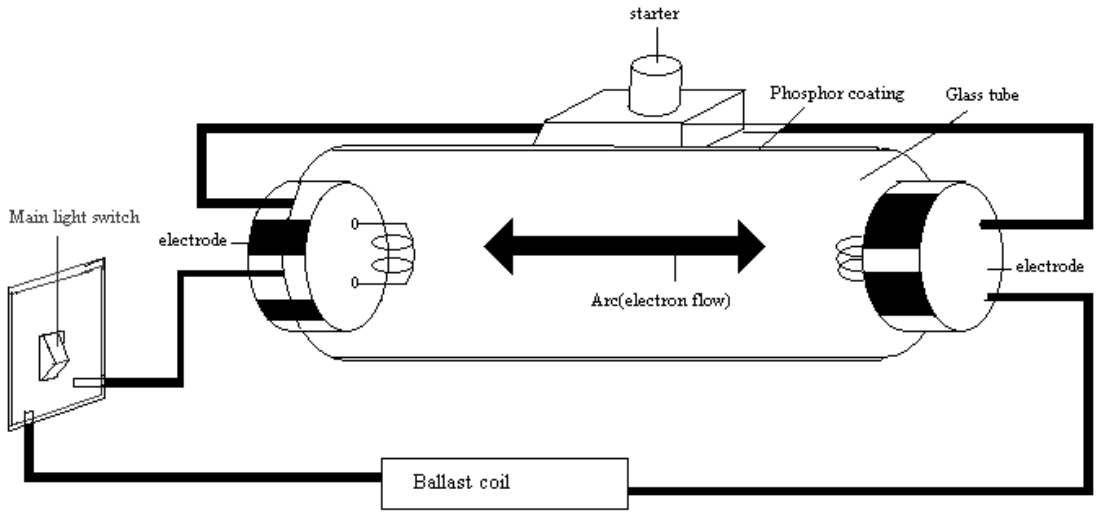

Figure 3.2 Parts of Fluorescent Lamp

The color outputs of the lamp are variable and depend on the interior glass bulb coating. Almost every color of light can be produced. The use of warm color producing is recommended in the hospitality industries, as their color emission is similar to incandescent lamps. The life of a fluorescent is approximate 16000-25000 burning hours compared to 750-1000 burning hours of incandescent lamp. Its life efficiency decreases with age and hours of operation. The light efficiency of the lamp decreases in cold and warm temperature environments. The lamp is designed for an 26.67 degree Celsius environment. Each 10 degree Celsius reduction in environment temperature reduces the light output by almost 50% and this is the reason they take more time to start in winter season and at zero degree Fahrenheit temperature the lamp may not start without external heating. Its shapes are limited and may be in the form of straight tube, the U, and circles.

The lamp requires a special circuit for operations. Ballast is required and some lamps need a separate starter. The ballast, a wire wrapped around a piece of iron, causes an induction load, which causes volts and amperes to be out of phase; this is required for the electric-discharge effect.

The instant –start fluorescent lamp eliminates the separate starter. These lamps usually have a small diameter, making it easier to start the electric-discharge process. As the lamps do not require a starter, it is easier to maintain the circuit.

The other type of fluorescent lamp is rapid start type lamp. The cathode of this lamp is always kept hot even when the lamp is off. This is done through a special ballast technique. Although it is quickly activated but consumes energy all the time, however, the consumption of energy is less when the lamp is off.

Fluorescent lamp can be dimmed by installing electronic ballast. The electronic ballast changes alternating –current cycles, which in turn changes the light output of the lamp.

3.7.6 High –Intensity Discharge Lamps

These lamps are similar to fluorescent lamps and have a glass bulb with an internal glass, quartz or ceramic tube filled with a gas that determines the High –intensity discharge lamp. There are electrodes at both ends the tube. Electric energy arcs between the electrodes. Voltage is regulated by ballast that serves the same function as with a fluorescent lamp. Metal halide and high pressure sodium produce the highest number of lumens per watt. Mercury lamps are called mercury vapor lamp and is used in arcing tube. The lamps are made in a variety of wattages. They have a very long life (16000-24000 hours). Their greater life expectancy is for continuous operation. The ballast of these lamps is very noisy and that's why it is located some distance from the lamp. Small mercury lamps have self contained ballast. These lamps are lower wattage, and ballast noise is minimal. These lamps require a long start up time (Up to several minutes). In cold temperatures, the starting time may be even longer and starting more difficult. The mercury lamp is not energy efficient as a normal fluorescent lamp.

There are three types of mercury vapor lamps; each produces different color effects. The clear mercury lamps make people look greenish. Their uses make it difficult to find red and orange objects and frequently used for large area lighting (in parking lots and warehouses). The white mercury lamp can make people look very pale, almost sickly, with its greenish white cast. It illuminates red and orange objects very poorly. The deluxe –white mercury lamp has color characteristics very similar to cool-white fluorescent lamps, and can therefore be used for interior lighting and mostly used for sporting events and in large exhibition areas.

3.7.7 Metal Halide Lamp

Metal halide lamp is very similar in construction and operations to the mercury –vapor lamp. Metal particles are added to the mercury gas in the arcing tube. This generally improves the color response to objects, and light output is double the mercury vapor efficiency. The start time of these lamps are shorter (two to three minutes) and color characteristics fall between the white and deluxe-white mercury lamps. The Restrike time is very long and it refers to the time required to restart the lamp after it has been in operation and turned off. Sodium lamps have a ceramic arc tube. Sodium is the arcing gas and provides yellowish light. Their life is similar to mercury vapor lamp (16000-24000 hours) and warm-up time is similar to metal halide lamp, but its restrike time is only one-tenth of the metal halide lamp.

3.7.8 Low Pressure Sodium Lamps

Low pressure sodium lamps (LPS), which produce about 183 lumens per watt are among the most energy –efficient light sources available. Their principal use is typically dusk-to down security lighting. However, the lamps are monochromatic, which means

that they emit only one color of the spectrum. LPS might be combined with other lamp sources to produce better color rendition.

3.8 LIGHTING SYSTEM AND CALCULATION OF LIGHT ENERGY

General uniform lighting can be provided by a variety of lighting techniques. Depending on what effects wish to create, several lighting systems are available. They are Direct, Semi direct, diffuse, semi indirect and indirect.

The most efficient lighting system is direct lighting system. All the emitted light is directed onto the activity area. This type of lighting is frequently found in institutional building because of its low installation and operating costs. Approximate 90% light goes downwards to the object and 10%light goes to the upward. Semi direct lighting diverts a portion of the light toward the ceiling (usually less than 40%) and a larger percentage is directed downward into the activity area. The technique will highlight ceiling features and provide a soft light effect within a room and most of the board/ conference/ meeting room use this type of lighting. It is not as efficient as direct lighting system but most of the food service managers preferred it over direct lighting system. A diffuse lighting system directs approximately equal amounts of light downward into the activity area and upward to the ceiling. This type of lighting mostly used in public area, including dining rooms and conference rooms. Cost of installation and operating is almost double in comparison to direst or semi direct lighting. Indirect lighting reflects 90% or more of the emitted light from the luminaire to the ceiling and upper walls of the room. Therefore, light must be redirected from these surfaces down toward the activity area.

Semi indirect lighting directs between 10% to 40% of the light output directly to the activity area. These techniques are costly to install and operate for high footcandle (lux) intensities. Generally, only direct, semi direct and diffuse lighting are recommended for large areas and rooms. The indirect and semi indirect systems are recommended only for small rooms where special effects are to be created, or where you want an especially relaxed mood, such as cocktail lounge and in guest rooms.

3.8.1 Calculation of Amount of Electrical Energy

a. Compute electricity bill for the month of January 2009 of ABC enterprises having the following electric load:

Electrical appliance/ s	Unit Nos.	Operating Hrs/ day	Capacity
Bulbs	20	20	100 watt
Fans	10	20	60 watt
Geysers	02	2	3000 watt
Hotplate	02	2	2000 watt

b. Also calculate the capacity of fuse required.
Hints: Electricity tariff Rs. 5/- per Kilowatt-Hour, Voltage supply: 220 volts

a. Solution for bill amount

Electrical appliance/ s	Unit Nos.	Operating Hrs/ day	Capacity	Power consumption/ day
Bulbs	20	20	100 watt	20 x20 x100= 40000 watt
Fans	10	20	60 watt	10 x20 x60 = 12000 watt
Geysers	02	2	3000 watt	2 x2 x3000 = 12000 watt
Hotplate	02	2	2000 watt	2 x2 x2000 = 8000 watt
				Total 54000 watt

54000 watt/ 1000 = 54 kilowatt / day (Converting 54000 watt into kilowatt-hour)
Bill amount = consumption per day x tariff rate x numbers of day in Jan 2009
Rs. 54 x 5 x31 = Rs. 8370.00

b. Solution for fuse capacity

Electrical appliance/ s	Unit Nos.	Capacity	Total connected load
Bulbs	20	100 watt	20 x100 =2000 watt
Fans	10	60 watt	10 x 60 =600 watt
Geysers	02	3000 watt	2 x3000=6000 watt
Hotplate	02	2000 watt	2 x2000=4000 watt
			Total 12600 watt

Capacity of fuse required = total connected load/ voltage supply
A = W/ V
A= 12600/220= 57.27 Ampere.

3.8.2 General Safety Precautions

It is our common observations that natural forces work through certain rules and regulations and abide by certain control channels. Electricity, being no exception to this, also obeys certain rules and regulations. For instance it can flow without harm and hazard if harnessed within proper barriers and channels. It is these barriers and channels which we have to know and be masters of so that the electricity works for us as our humble servant and no longer remains a life threatening and formidable monster. The other name for these barriers and channels is the safety precautions. To ensure public safety in the use of electricity. Indian Electricity Rules are laid down. These rules become applicable to every electrical installation and are mandatory in terms of Indian Electricity Act. In the following paragraphs, we will discuss certain specific provisions and practices in connection with the safe use of electricity.

1. If the live wires or electric elements are not insulated properly, this will result in not only leakage of power but it will also give shock to the persons making use of electricity. It is, therefore, necessary that insulation resistance should be above certain minimum level.

2. If the first line of defense i.e. insulation fails, we have to depend upon the second line of defense offered by earth wire and fuse. In the event of leakage being developed, the metallic body of the appliances will acquire certain potential above earth. If a human being happens to be in touch with the charges metallic body, current will flow through his body to earth.

3. All single pole switches should always be placed in live wire only and not in the neutral wire.

4. Use correct size of fuse wire. Use of over size fuses will allow isolation of the circuit only when rubber insulation of cables has been sufficiently overheated to firing temperature.

5. Many a time's too many appliances are connected to one socket outlet by means of adopter without carrying for the current carrying capacity of the wires feeding the socket outlet. This results in overloading of wires which may possibly catch fire.

6. Combustible material should not be stored near the fuse board. Spark emitted from the fuse due to short circuit and melting of the fuse element should ignite the combustible material nearby.

7. Earth wire in no case should be connected to gas pipe if any. If this is done, loose connection between the two will produce spark and gas may produce explosion.

8. Poor joints in the wiring result in minute sparking not perceptible to the eyes and hence all the connections should be periodically checked for tightness to avoid accidents.

9. Conduit wiring is safer and use P.V.C. cables.

10. In case of electrical fires, use of **carbon tetrachloride type fire extinguisher** should only be made to ensure safety. **In no case should water be thrown on the equipment and wiring to extinguish the fire.**

11. Electrical appliances should not be handled with wet hand or while standing on wet floor.
12. Insulations of wires, for connections, should be stripped off to the minimum extent necessary. If insulation is stripped off too long, the possibility of short circuit increases.

13. Electrical appliances should not be unnecessarily tampered with. Electricity does not spare anybody; therefore do not take any chance with it.

14. The circuit diagram should be carefully preserved for future use. If the diagram is just printed on the equipment, it should be copied and preserved.

15. For replacing a blown fuse, main switch should first be made off.

16. Never touch naked wires unless you are sure that they are dead.

17. While working on electrical equipment, the mains should be put off and properly earthed.

CHECK YOUR PROGRESS-II

1. Enumerates the electrical fixtures uses in hotels.

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2. Prepare a notes of on types of electrical energy.

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3.9 HEATING, VENTILATION AND AIR-CONDITIONING

This section deals with removal of heat, or refrigeration. Refrigeration system is a need of hour not only in home but also in all types of catering units and hotels. We can not

assume a life without refrigeration and air-conditioning system. Refrigeration is necessary for food storage and air-conditioning is for comfort and most prominent facility offered in hotels, clubs, food service and health care facilities. Costs of refrigeration and air-conditioning have been increasing and many energy management techniques have been utilized to reduce these costs. These techniques and latest model of refrigeration and air-conditioning are highlighted in the topic.

3.9.1 Refrigeration and Air Conditioning Terminology

***Heat Flow*:** Heat always flow from a warmer to a cooler substance. Heat causes some solids to become liquids or gases.

Cold: It means low temperature or lack of heat. It is the result of removing heat.

***Absolute Zero Temperature*:** It is that temperature where molecular motion stops. It shows that there is no more heat in the substance at this point.

Pressure: Pressure is the force per unit area, and it is expressed in pascals (pa) and in kilopasaclas (Kpa).

***Pascal's Law*:** It states that: pressure applied upon a confined fluid is transmitted equally in all directions. It is the basis of most hydraulic and pneumatic systems.

Humidity: The word humidity refers to water vapour or moisture in the air. Air absorbs moisture (water vapour). The amount depends on the pressure and temperature of the air. The higher the temperature of the air, the more moisture it will absorb. The higher the pressure of the air, the smaller amount of moisture it will absorb. A relative humidity of 50% indicates the air has 50% as much as it will hold at that particular temperature and pressure.

***Area Measurement*:** The measurement of area involves the measurement of two dimensional spaces.
For example : if width of a table top is 20 cm and length of the table is 30 cm then area of the table top is 20 x30 = 600 square cm.

***Volume Measurement*:** The measurement of area involves the measurement of three dimensional spaces (cubic). The volume of an object is determined by multiplying the width by the length by the height.

***Evaporator*:** It absorbs heat and must be located in the space that is to be cooled. It can maintain temperature as low as the boiling point of the refrigerant.

***Compressor*:** There are two purpose of compressor:

1. to pump the refrigerant gas out of the evaporator
2. to increase refrigerant pressure.

Condenser: The purpose of condenser is to release the refrigerant heat that was absorbed in the evaporator and during compression.

Expansion Valve**:** It is primary system control and activates the compressor. When the valve allows refrigerant to flow into the evaporator, it permits the compressor to operate; when the valve closes, it stops the compressor.

Tons of Refrigeration**:** A ton of refrigeration represents the rate of cooling when a ton (approximately 907 Kgm or 2 000 lb) of ice melts during one 24- hour day.

1 ton = 907 Kg

Latent heat= 337 kJ/Kg

Energy absorbed = latent heat x weight
=337 kJ/ Kg X 907 Kg
= 305 659 kJ

The melting of this ice in one day has a cooling or refrigeration capacity of 305 659 kJ. To convert the rating to a kilowatts:1 Kw = 1 Kj/sec

1 ton refrigeration capacity = 305659 / (24x 3600 sec)
= 305659 / 86 400 sec
= 3.54 Kj/sec
= 3.54 kW

Ambient Temperature**:** It means the temperature of the air surrounding a motor, a control mechanism, or any other device. It is not usually constant and may change day to day and hour by hour, depending on sunshine, space and many other factors.

Critical Temperature**:** The critical temperature of a substance is the highest temperature at which the substance may be liquefied, regardless of the pressure allpied upon it. The condensing temperature for a refrigerant must be kept below its critical temperature. Otherwise, the refrigerator will not operate.

3.9.2 Refrigerants

In refrigerating systems fluids which absorb heat inside the cabinet and release it outside are called refrigerants. These fluids, in their liquid form, under a pressure, absorb heat in the evaporator and, in absorbing heat, change to a vapour form, the fluids are taken into the compressor where the temperature and pressure are increased. This allows the heat that was absorbed in the evaporator to be released in the condenser, and the refrigerant is returned to a liquid form. These are the members of halocarbon family and are non-toxic, no corrosive, nonexclusive, and non-flammable. Refrigerants have a relatively low specific volume. Some popular refrigerant applications are shown in table 14,1. One type of refrigerant may be used in a number of applications.

APPLICATION	REFRIGERANTS
Domestic refrigerator	R-12, R-22
Domestic food freezers	R-12, R-22. R-502
Automobile air conditioning	R-12
Home air conditioning	R-22, R-500
Public building air conditioning Low capacity Medium capacity High capacity	 R-12, R-22 R-11, R-12, R-22 R-11, R-12, R-22
Frozen food delivery system	R-22, Solid carbon dioxide

DRY ICE: Solid carbon dioxide is used for refrigeration. It is a white crystalline substance; it is formed when liquid carbon dioxide is allowed to escape into a snow chamber. It has a greater heat-absorbing capacity than water ice. Never place dry ice in a sealed container. At ordinary temperatures, the dry ice will turn into a vapour (sublime), the resulting may cause the container to explode. Avoid touching dry ice. It will instantly freeze the skin

3.9.3 Properties of Good Refrigerants

Properties of a good refrigerant are:

- It should be non-poisonous and non-irritant.
- It should be non-inflammable and there should be no fire or explosion hazard.
- It should be chemically stable and should not dissociate in extremes of temperature and pressure.
- It should be non-corrosive, should not react with the working pars of the compressor, evaporator and radiator.
- It should have no objectionable odour.
- Could be easily and reliably detected in case of leakage.
- The latent heat of vaporization be large to minimize the quantity of refrigerant.
- The volume of vapour for a given weight should be low to reduce the size of the compressor.
- The cost should be low.

3.9.4 Study of Refrigeration Systems

Refrigeration:

- We know that heat flows from the body of higher temperature towards the low temperature body.
- Extracting heat from a body or space and transferring it somewhere else will cool or lower the temperature of the desired body or space.
- Refrigeration is the process of cooling by extraction or pumping heat out of a body or space and transferring it to another with higher heat capacity.

Methods of natural cooling or refrigeration:

- Conduction: a body is cooled by extraction of heat though conduction mode on keeping it in contact with another conducting body of lower temperature.
- Convection: A hot body is cooled when surrounded by a cool fluid. The cool fluids absorb and displace the heat away from the body by convection currents, thus the body looses heat and cools down.
- Radiation: a hot body when kept isolated in an evacuated cool space will continuously loose heat and gets cooled neither by conduction or convection but by a process known as Radiation.
- Evaporation: when a liquid evaporates it cools down on account of extraction of the latent heat of evaporation from its own mass and as result of this it gets cooled till the evaporation process continues, subsequently it can cool any object kept in contact with the evaporating liquid.
- By dissolving salts: certain salts (ammonium chloride or ammonium nitrate) when dissolved in water the temperature of the solution is lowered. The cool solution in turn will cool the object in contact with it.
- Chemical reaction: certain chemical reactions are endothermic, and are able to extract heat from the surrounding and lower the temperature.
- Cooling by refrigeration: refrigeration is a cyclic process of extracting heat out of a closed space and transferring the heat to a space of higher temperature. The method depends on the absorption of the latent heat of evaporation of a working fluid. The vapours are then compressed and allowed to loose heat in a the warmer space and get condensed the condensed fluid is again used to absorb heat by evaporation and the cycle of operation is repeated.

3.9.5 Basic Refrigeration Cycles

Two systems of refrigeration are common in use:

- ***Vapour Absorption System***: this system does not involve any mechanical system. It cools a space by directly using the heat of an external source. The use of electricity for heating is optional.

- ***Vapour Compression System***: it is based on the electro mechanical process; the use of a compressor is essential.

3.9.5.1 Working of Vapour Absorption System

It functions on the principle of vapour absorption principle. It consists of a highly concentrated water solution of ammonia or lithium bromide gas, which acts as the cooling medium or refrigerant. When the concentrated solution is heated the gas is liberated at high pressure. The high-pressure gas on cooling in the radiator liquefies into high-pressure liquid. The high-pressure liquid refrigerant is sprayed in the evaporating chamber. The sprayed refrigerant absorbs the latent heat of evaporation in the cooling chamber. After cooling, the low-pressure gas is reabsorbed in the leftover weak solution and turns into concentrated solution to repeat the cycle.

As already told it does not contain any mechanical moving parts. The heating arrangement need not be electrical; a wick type lamp may be used as the heat source. (See Fig 3.3)

- It basically consists of the following sections and working stages:

  - ***Generator:*** it is a strong tank, which contains the highly concentrated solution of refrigerant. On heating the concentrated solution, refrigerant gas is liberated at high pressure. The weak solution is diverted and collected in the weak solution reservoir.

  - ***Radiator:*** the high-pressure refrigerant gas (ammonia) is directed to the radiator, where it looses its' heat and changes to high pressure liquid refrigerant.

  - The liquefied high-pressure refrigerant is directed to the cooling chamber where it is sprayed. The liquid refrigerant spray readily evaporates and in the process it absorbs its latent heat of vaporization, necessary for change of state. As a consequence of this the evaporator is cooled and the cooling is used for further cooling of the desired closed space.

  - ***Absorber:*** the low-pressure vapours are then directed to the absorber tank. The absorber tank is also connected to the weak solution reservoir from where it collects the weak solution. The gas is dissolved in the weak solution and turns it into concentrated solution. The concentrated solution is then directed to the Generator through a heating tube to repeat the cycle.

  - ***Heating Source***: the heat source may be a wick type kerosene lamp or an electric filament heater.

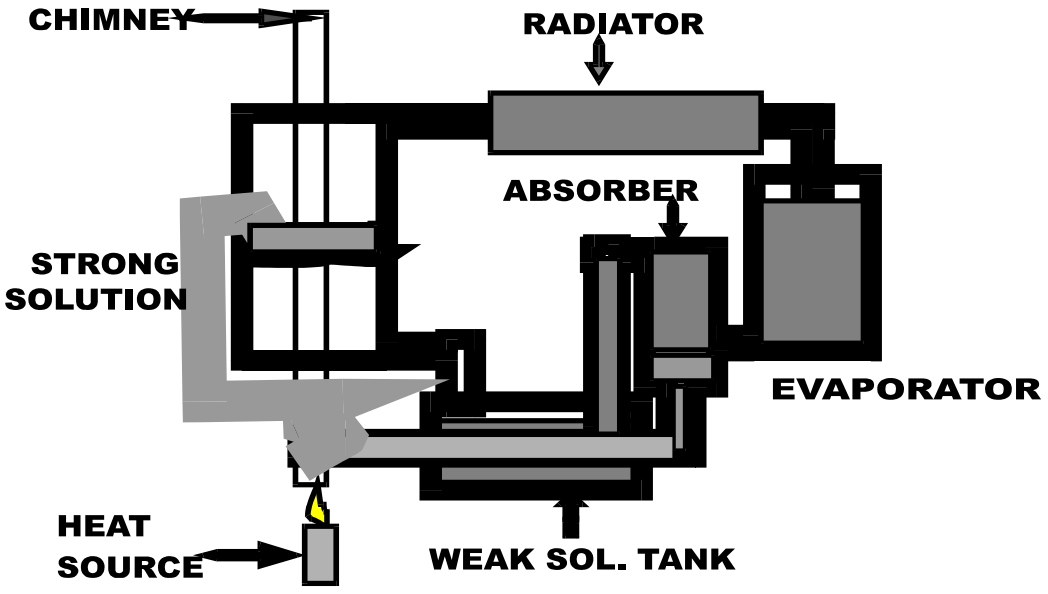

Figure 3.3 Absorption System of Refrigeration

Merits and de-merits of the vapour absorption system:

- Merits:
  - No mechanical moving parts.
  - No wear and tear problem and requires practically no maintenance.
  - Its operation is completely silent.
  - This process can function even without electricity.

- Demerits:
  - The ammonia gas has relatively high liquefaction temperature hence the cooling efficiency is low in very hot summer seasons.
  - Ammonia gas corrodes the metal of tanks and piping.
  - Ammonia is highly irritant and toxic gas; hence leakage is a source of hazard.

3.9.5.2 Vapour Compression System

This is electro-mechanical system, which makes use of temperature, pressure and latent heat of a suitable refrigerant, for pumping heat from a lower temperature to higher temperature level. In this system heat is absorbed by the by the refrigerant at a low temperature, and is discharged at a high temperature level into the atmosphere. That is why it is termed as 'Heat pump'. Basically the system consists of the following four parts: (See Fig 3.4)

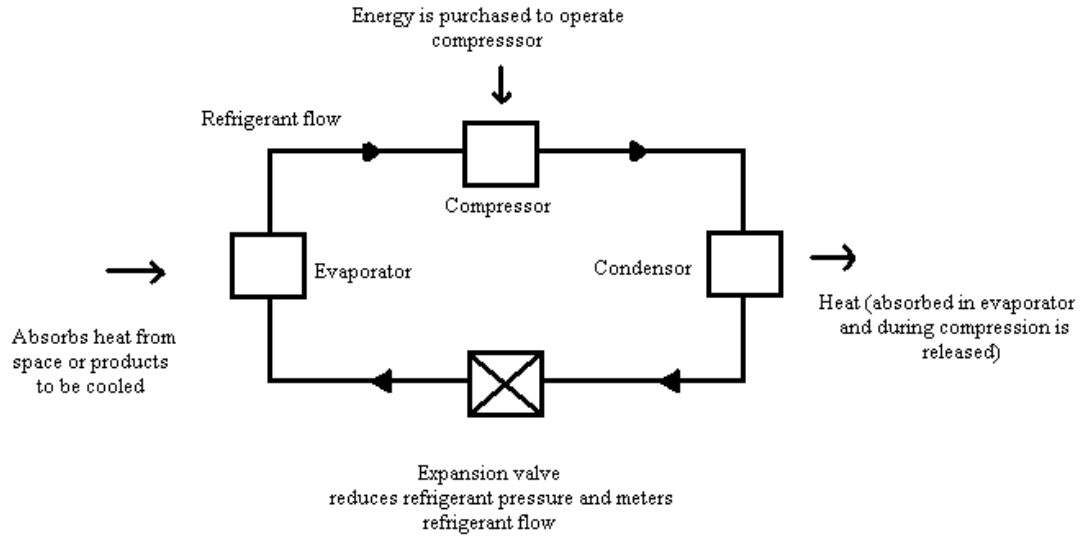

Figure 3.4 Vapour Compression Refrigeration Cycle

- ***Compressor*:** It has two fold function:
  - It extracts the refrigerant gas from the evaporator or cooling chamber coils, as fast as they are formed at a low-pressure of 35 lbs/square inch.

- It compresses and delivers the gas to the condenser at a pressure of about 136 lbs/square inch. Because of the rapid high compression the gas becomes hot.
- The high-pressure gas is diverted to the radiator tube.

- ***Radiator or Condenser***: the hot high-pressure refrigerant gas is received at the upper end of the radiator tubing. The hot gas looses its heat across the radiator tube to the atmosphere and liquefies on the bottom side of the tube. The radiator tube may be cooled by air or water.

- ***Expansion Valve***: The high-pressure liquid refrigerant is diverted to an expansion valve just at the inlet of the evaporator chamber tubing. The function of the expansion valve is to control and regulate the flow of the high-pressure liquid refrigerant and allow it into the evaporator tube at low pressure.

- ***Evaporator***: This constitutes the cooling unit, in which the liquid Freon (refrigerant) under a low pressure of about 35 lbs/square inch is sprayed in the cooling tubes. In doing so it quickly absorbs its quota of latent heat of evaporation and evaporates, thereby cooling the space medium surrounding the cooling coils.

The efficiency of the system depends mainly upon two factors:

- ***Compression Efficiency***: which is directly proportional to the compression ratio (high-pressure / low pressure)?
- The difference between the cooling coil temperature and the temperature at which the heat is rejected out of the radiator.

3.9.6 Ice Maker

Ice makers use various types of refrigerating systems. The compressor and condenser are usually located in the bottom of the cabinet. Liquid refrigerant flows from the bottom of the condenser up through a filter drier. It enters through a capillary tube. The evaporator surrounds inverted (upside-down) ice cube molds. Clod water is sprayed into the inverted ice cube molds. The temperature of the molds is very cold. Water striking the molds freezes to the mold surface and gradually builds up until ice cubes are formed. Then the refrigerating cycle is stopped. Now an electric heating unit heats the ice cube molds until the cubes fall out and slide down into the ice cube bin. Most surfaces in contact with water and ice are stainless steel for cleanliness.

3.9.7 Drinking Water Cooler

The water cooler is a special use of a refrigerating mechanism. It is used to cool water "on tap" at a drinking fountain. Since the demand on a drinking fountain is very irregular, it is necessary that it have some hold-over capacity. Still it must not over cool the water. The necessity capacity is provided by using either an insulated storage tank or large cooling surfaces in the evaporator. To increase

The mechanism's efficiency, the waste water flows down a tube alongside or attached to the fresh water inlet. In this way, the warmer fresh water is cooled; to some extent. A water pressure regulator adjusts the bubbler. Water leaving the bubbler should be at 10 degree centigrade or 50 degree Fahrenheit. A thermostat with the control bulb attached to the water dispensing tube maintains the desired temperature of drinking water.

3.9.8 Air Conditioning System

Different types of air condition plants: according to the plant the air conditioners can be broadly divided into the following categories:

- Unit systems:
  - Window types units.
  - Floor mounted package units.

- Central plant system:
  - Full ducting system for cool and return air.
  - Ducting used only for conveying fresh air for ventilation with unit coolers installed in each room and served by a common refrigerant pipe system.
  - Chilled water system with unit coolers in each room with independent fresh air inlet.

3.9.8.1 Window Types Units.

Window type air conditioning units: are completely self contained units, with the compressor, condense, evaporator, refrigerant piping and air filter all assembled in a very compact assembly and fitted with an attractive frontage to harmonize with the interior of home or office.

- The window units are usually of half to two-tons capacity, and fitted with 230 volts motors up to 3 horse power.

- Modern tendency is to use sealed type compressor units with brazed piping system; so that it virtually eliminates the leakage of refrigerant and the unit can serve for long period with hardly any filling of gas.

- The condenser is air-cooled. The fan motor has blades on both ends, blades of one side cools the condenser, while the other blade circulates the room air over the chilled tubing.

- Adjustable dampers are provided to properly circulate the air in desired directions.

- There is provision to control the fresh air intake.

- Good quality filter pad is provided in the circulating fan suction duct and is capable of filtering micron size particles from the fresh and the circulating air.

- These units are fitted flush with the window on the interior. The bulk of the unit hangs on the exterior of the window with support on brackets.

Merits:

- The units are easy and convenient to handle.
- A faulty unit can be conveniently replaced with a good one temporarily for repairs.
- Large number of units can be fitted in big rooms. This eliminates extensive alterations in the present building structure for fitting ducts.
- These units provide flexibility of operation. Units can be turned 'Off' or 'On' on requirement; this saves energy.
- These units are very popular for domestic and small offices.

Demerits:

- These units are not suitable for large buildings.
- The installation and running cost is higher compared to centralized cooling for big buildings.
- These units require at least one wall of the room free and open to atmosphere, so that the hot air is discharged in the open.

3.9.8.2 Package Units

Package units: these units are functionally very similar to window models but are much bigger in size and therefore arranged at a suitable position on the floor of the conditioned space.

- These units contain all the elements for cleaning, cooling, ventilating, filtering humidification / dehumidification and throwing hot air to outside.
- For the ventilation and circulating air concealed duct connections are provided with the outside.
- The cover panels are removable making the access to machine parts convenient and maintenance and repair work easy.
- Adjustable dampers are provided to divert cool air to desired directions in the room.

Merits:

- Only one or two such units are sufficient for a moderately large room or hall.
- Extensive alteration of the building is not required.
- They are easily installed and replaced with new ones for temporary repairs.

- Units can be easily switched on and off as per requirement; thus saves energy.

Demerits:

- The installation cost is higher compared to central cooling for large buildings.

3.9.8.3 Central A.C. Plant with Air Ducting

Central A.C. plant with air ducting: A central plant with full ducting is best suited for air conditioning of large buildings, such as theatres, halls and un-partitioned offices those having interiors which do not have an outside exposed wall. The conditioning plant consists of two or more heavy compressors including the attached essential components. These are located at central place preferably usually on the ground or basement level of the building.

o The conditioned air is delivered through a ducting system to all parts of the building. A duplicate ducting system is required to lead back the return air from the inside to the plant to be humidify/de-humidify and recharged with fresh air to be circulated again.

Demerits:

- The ducts are bulky, as they have to handle a large quantity of air, they occupy a lot of space.
- Poses lot of difficulties to conceal these heavy ducting and requires substantial changes in the building structure.
- Individual choice control is not possible
- It permits mixing of air, cigarette smoke, bacteria and odors between different areas and offices.

Merits:

- The processing of air is centrally controlled and easy to work with.
- The efficiency of the plant is high.
- It is sturdier and operates for long periods with less attention.
- Summer load is easily taken care of.

3.9.8.4 Chilled Water System

This system overcomes the difficulties encountered of the above system. Water is used as the transfer medium to carry the heat absorbed in the rooms back to the central cooling plant where the water is cooled again. Individual heat exchanging units are provided in each room and chilled water is piped into the units. The cool water absorbs the room heat and is diverted back to the cooling plant.

Merits:

- This is a flexible system and well suited for large and multi-storey buildings as well as for medium and small buildings.

- Heavy duct arrangement is not required.
- Checks mixing of air of different rooms.
- Permits individual control of temperature and fresh air content.
- Exchanger units are simple in design with no moving parts, silent in operation and practically maintenance free.
- The piped water conveying system is equally good for conveying hot water in winters for heating the rooms.
- Pipe work is un-obstructive and can be concealed in the building walls.
- The system is very flexible in nature i.e. exchanger units can be switched on and off as required.
- The chilled water storage tank is quite sufficient to run a few exchange units even after the cooling plant shutdown only by running the water circulation pump. This improves the economic efficiency.

Demerits:

- There is some amount of heat absorption in the chilled water pipe work; this can be minimized by proper lagging (heat insulation) of the pipe work.

3.9.8.5 Care and Maintenance

Refrigeration system

- ✓ Do not place refrigerated equipment near sources of heat or near window area where the sun's rays will strike any portion of the unit.
- ✓ Keep the condenser clean and open to allow air to circulate around it.
- ✓ Dirt accumulations on the condenser serve as insulators and reduce the rate of heat transfer from the condenser to the environment.
- ✓ Ensure periodic vacuum cleaning of air cooled condenser.
- ✓ Kitchen grease may have to be removed by washing.
- ✓ Use best quality of insulation and must have a low thermal conductivity rating.
- ✓ Serious thought should be given to increasing thickness of insulation.

Air-conditioning system

- ✓ Ensure correct ventilation system in a building.
- ✓ Air filters should be cleaned or changed at frequent intervals.
- ✓ Motor and fan bearings should be proper greased or oiled.
- ✓ Ensure insulation of ducts.
- ✓ Check interiors of the ducts periodically.
- ✓ If belt driven connections are used between the fan and motor, belt slippage must be to keep a minimum.
- ✓ An energy management system may also include ventilation control.

3.9.9 Energy Management Systems for Refrigeration Cycles

By introduction of computer controlled energy management system, considerable savings can be made by the owner of the property. This system continually monitors temperature of compressor, condenser, evaporator, and cooled space. As temperatures

are continuously monitored in the cool areas an undesirable high temperature could activate an alarm if stored products are in potential danger. The system can control expansion devices and compressor operating times. The same system can be installed food chillers or freezer entrances by personnel. A well qualified refrigerator engineer or mechanic can quickly review temperatures and identify if a refrigeration cycle is operating efficiently. The EMS will also control performance of cooling tower and regulate the flow of water or air. A well designed and maintained computer EMS can reduce energy consumption by 20% or more, reduce the cost of spares, maintenance cost, and equipment –down time, reduce product spoilage etc.

3.10 SUMMARY

This unit has considered the very basic of electrical engineering and it is not expected that students of hospitality education need to become electrical engineers but however, they must have sufficient knowledge of the subjects dealt in this topic to enable them to recognize electric faults, make the best use of modern ideas, purchases wisely, protect their own life, colleague life and most important the life of your guests who are staying or dining in your establishment by keeping a track of faulty electrical fittings and fixtures. A careful examine of your expenditure on electricity may give you an insight to perceive in better manner about your decisions. The best understanding of the topic will help you to develop in planning a safe and secure hotel or restaurant building.

3.11 GLOSSARY

Conductor: A conductor is a substance through which electricity flows freely, e.g. copper, aluminum, water or the wiring system of a building.

Volts: It measures the pressure of flow of an electric current. Before electricity can flow through a wire, the electric pressure at one end of the wire must be greater than at the other end: this is known as "potential difference".

One volt: One volt is defined as potential difference necessary between the ends of a conductor whose resistance is 1 ohm, to produce a current of 1 ampere. 220 volts is introduced as the standard for domestic use and 415 volts for industrial use throughout the country.

Ohms: it measures the resistance of a conductor to the flow of a current. All conductors offer some resistance, but the lower the resistance the better the conductor. A thin wire offers more resistance (causing voltage drop) than a thick cable of same material, and therefore long runs of the former should be avoided when planning the electrical wiring of a building.

Ohm's Law: The Ohm's Law defines the relation between the above three parameters of the electric circuit as follows: "The voltage drop across the load resistance of the circuit is directly proportional to the current flowing through it; provided the physical parameters viz. length, cross-section, temperature and material of the load resistance remains same."

Ampere: it measures the rate of flow of a current, i.e. the amount of electricity that is passing through the circuit. If an electric wire using 10 amps is plugged into a 5 -amp. Socket, the demand will overstrain the circuit and should blow the fuse.

One B.T.U.: It is the quantity of heat required to raise the temperature of 1 lb. of water through 1 degree Fahrenheit.
Thermal effect: The flow of electric current produces heat and causes rise of temperature of the resistive conductor.

Luminous effect: Due to the thermal effect at high temperature the resistive conductor radiates light.

Magnetic effect: The current flow in a conductor always accompanies with production magnetic lines of force.

Chemical effect: Electric current flowing through electrolytes (water solution of salts) or molten salts causes chemical change.

Open circuit in which the current path is not continuous or current flow is interrupted is called an open circuit.

A short circuit is a closed circuit in which a direct connection is made, with no appreciable resistance, inductance, or capacitance, between the terminals of the source of electromotive force. No serious damage is likely to be done beyond the blowing a fuse.

Heat Flow: Heat always flow from a warmer to a cooler substance. Heat causes some solids to become liquids or gases.

Cold: It means low temperature or lack of heat. It is the result of removing heat.

Absolute Zero Temperature: It is that temperature where molecular motion stops. It shows that there is no more heat in the substance at this point.

Pressure: Pressure is the force per unit area, and it is expressed in pascals (pa) and in kilopasaclas (Kpa).

Pascal's Law: It states that: pressure applied upon a confined fluid is transmitted equally in all directions. It is the basis of most hydraulic and pneumatic systems.

Humidity: The word humidity refers to water vapour or moisture in the air. Air absorbs moisture (water vapour). The amount depends on the pressure and temperature of the air. The higher the temperature of the air, the more moisture it will absorb. The higher the pressure of the air, the smaller amount of moisture it will absorb. A relative humidity

of 50% indicates the air has 50% as much as it will hold at that particular temperature and pressure.

Area Measurement: The measurement of area involves the measurement of two dimensional spaces.

Volume Measurement: The measurement of area involves the measurement of three dimensional spaces (cubic). The volume of an object is determined by multiplying the width by the length by the height.

Evaporator: It absorbs heat and must be located in the space that is to be cooled. It can maintain temperature as low as the boiling point of the refrigerant.

Condenser: The purpose of condenser is to release the refrigerant heat that was absorbed in the evaporator and during compression.

Expansion Valve: It is primary system control and activates the compressor. When the valve allows refrigerant to flow into the evaporator, it permits the compressor to operate; when the valve closes, it stops the compressor.

Tons of Refrigeration: A ton of refrigeration represents the rate of cooling when a ton (approximately 907 Kgm or 2 000 lb) of ice melts during one 24- hour day.

Ambient Temperature: It means the temperature of the air surrounding a motor, a control mechanism, or any other device. It is not usually constant and may change day to day and hour by hour, depending on sunshine, space and many other factors.

Critical Temperature: The critical temperature of a substance is the highest temperature at which the substance may be liquefied, regardless of the pressure allpied upon it. The condensing temperature for a refrigerant must be kept below its critical temperature. Otherwise, the refrigerator will not operate.

Vapour Absorption System: this system does not involve any mechanical system. It cools a space by directly using the heat of an external source. The use of electricity for heating is optional.

Vapour Compression System: it is based on the electro mechanical process; the use of a compressor is essential

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3.13 SUGGESTED READINGS

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- How things work-The Universal Encyclopedia of Machines, Volume 1 & 2
- The Management of Maintenance and Engineering Systems in the Hospitality Industry, Frank D. Borsenik & Alan T, Stutts, Publisher: John Willey & Sons Inc. NY
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3.14 Terminal Questions

1. Enlist types of fuses and discuss advantages of H.R.C. fuse over rewireable fuses.
2. Describe following terms:
    - Earthing
    - Ampere
    - Volt
    - Watt
    - Power
    - Circuit
3. Being an owner of a catering unit how you will decide installation of wiring system.
4. Discuss types of lighting fixtures in two or three lines.
5. Explain safety precautions while handling with electric appliances.
6. Discuss types of lamps used in a small hotel building with their characteristics.
7. Discuss Advantages of 3-Phase system over Single Phase System.
8. Discuss the reasons of fuse blown off.

Numerical problems

1. (A). Compute electricity bill for the month of April 2009 of Taj enterprises having the following electric load:

Electrical appliance/ s	Unit Nos.	Operating Hrs/ day	Capacity
Incandescent lamps	25	10	100 watt
Hot plate dispenser	04	2	3000 watt
Rechauffe unit	02	2	2000 watt

(B). Also calculate the capacity of fuse required.

Hints: Electricity tariff Rs. 5/- per Kilowatt-Hour, Voltage supply: 220 volts

2. A building has a load of 300 100-watt lamps. What current is required to supply the building if it is connected to 220 –volt supply?

3. Find the current flowing through a 100 watt lamp connected to 220 volt supply.

4. Three resistance of one ohm, 2 ohm and three ohm are connected in series, find equivalent resistance.

5. Three resistances of one ohm, 2 ohm and three ohm are connected in parallel, find equivalent resistance.

Project assignments:

- Discuss with a chief engineer of a hotel about their installed lighting system and submit a report with its merits and demerits.
- Cross examine the lighting fixtures used in your house with your colleagues.
- Prepare a report on types of lighting used in your nearby areas such as your school/ institute/ malls/ hospital/ community centre and discuss with your faculty.
- Examine color scheme of your model room and suggest lighting system.

UNIT: 04
LIGHTING SYSTEMS

Structure

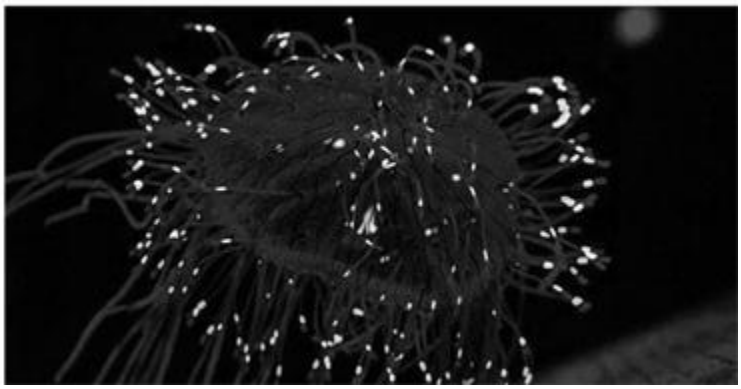
4.1 INTRODUCTION

First impressions are important, and when it comes to hospitality, lighting plays a bigger role than you might expect. With some still in the dark about how to create the right mood, we asked an expert. The food can be delicious, the drinks perfectly chilled, but if the light isn't right, the customer won't bite. And there are studies to prove it. A recent survey* found that "72% of respondents had left a venue earlier than planned because it was too brightly or poorly lit," whilst "74 % of respondents had stayed longer than planned because the lighting made them feel relaxed and welcome. We look at a leaf we know that it is green in colour because light bounces off the leaf to our eyes to tell us that it is green. But what is light? Which are the sources of light from which light is originated? Light is an electromagnetic radiation. A particular frequency of this radiation (around 390-700 nm) is visible to the human eye. Everything that we see around us is because of light. Light is a form of energy and like all energies, it is produced from a source. In physics, these are called Light sources.

Types of light sources: There are countless sources of light but they can all be categorized under either of the two following categories:

- Natural sources
- Artificial sources

Natural Light Sources



The universe is filled with objects that emit light. Some of the light from these sources reach the earth. The following things in nature have the ability to emit light:

- The Sun is the major source of light for the earth. The sun is a massive ball of fire, at the centre of which nuclear fusion produces massive energy. This energy comes out as heat and light. The light from the sun is one of the major factors behind the sustainability of life on earth.
- Every other star produces light too, but only a small or no amount of it reaches the earth because of the huge distance.
- The moon provides light as well but it cannot produce light on its own. The light that we get from the moon is the light reflected by it from the sun.
- Some living organisms have the ability to produce light too. It is called bioluminescence. It is the effect of certain chemical reactions within the organism. Fireflies, jellyfish, glow worm, certain deep sea plants and microorganisms can be cited as examples.

- Certain other natural phenomena such as lightning and volcanic eruptions also emit light. Artificial Light Sources:

Apart from the natural sources, light can be produced artificially too. The different light sources produced artificially can be put under three broad categories-

Incandescent Sources: When certain objects are heated to a high temperature, they begin to emit light. Both infrared and visible light is produced in the process.
Example- Candle, incandescent lamp.

Luminescent Sources: Light can be produced by accelerating charges in a luminescent material. One common way of doing it is by passing current through the material.
Example- Fluorescent tube light, electric bulb

Gas Discharge Sources: Passing electricity through certain gases at a very low pressure can produce light too.
Example – Neon lamp, Sodium lamp.

4.2 OBJECTIVES

By the end of the lesson you will be able to:

- Understand basic fundamentals of lighting system.
- Explain types of light with their sources.
- Explain design considerations.
- Explain lighting system and maintenance.
- Explain Cleaning fixtures and lamps
- Explain Replacing lamps.
- Explain Effects of maintenance on light outputs.

4.3 SOME BASIC DEFINITIONS

Lamps -Lamp is equipment, which produces light. The most commonly used lamps are described briefly as follows:

• **Incandescent lamps:** -Incandescent lamps produce light by means of a filament heated to incandescence by the flow of electric current through it. The principal parts of

an incandescent lamp, also known as GLS (General Lighting Service) lamp include the filament, the bulb, the fill gas and the cap.

• **Reflector lamps:** -Reflector lamps are basically incandescent, provided with a high quality internal mirror, which follows exactly the parabolic shape of the lamp. The reflector is resistant to corrosion, thus making the lamp maintenance free and output efficient.

• **Gas discharge lamps:** -The light from a gas discharge lamp is produced by the excitation of gas contained in either a tubular or elliptical outer bulb.
The most commonly used discharge lamps are as follows:

- Fluorescent tube lamps (FTL)
- Compact Fluorescent Lamps (CFL)
- Mercury Vapour Lamps
- Sodium Vapour Lamps
- Metal Halide Lamps

Luminaire- Luminaire is a device that distributes filters or transforms the light emitted from one or more lamps. The luminaire includes all the parts necessary for fixing and protecting the lamps, except the lamps themselves. In some cases, luminaires also include the necessary circuit auxiliaries, together with the means for connecting them to the electric supply. The basic physical principles used in optical luminaire are reflection, absorption, transmission and refraction.

Control Gear -The gears used in the lighting equipment are as follows:

Ballast: -A current limiting device, to counter negative resistance characteristics of any discharge lamps. In case of fluorescent lamps, it aids the initial voltage build-up, required for starting.

Ignitors: -These are used for starting high intensity Metal Halide and Sodium vapour lamps.

Illuminance -This is the quotient of the illuminous flux incident on an element of the surface at a point of surface containing the point, by the area of that element. The lighting level produced by a lighting installation is usually qualified by the illuminance produced on a specified plane. In most cases, this plane is the major plane of the tasks in the interior and is commonly called the working plane. The illuminance provided by an installation affects both the performance of the tasks and the appearance of the space.

Lux (lx) -This is the illuminance produced by a luminous flux of one lumen, uniformly distributed over a surface area of one square metre. One lux is equal to one lumen per square meter.

Luminous Efficacy (lm/W) -This is the ratio of luminous flux emitted by a lamp to the power consumed by the lamp. It is a reflection of efficiency of energy conversion from electricity to light form.

Colour Rendering Index (RI) -Is a measure of the degree to which the colours of surfaces illuminated by a given light source confirm to those of the same surfaces under a reference illuminent; suitable allowance having

4.4 NATURAL LIGHTS

Natural sources of light include sunlight, the stars, volcanoes, meteorological lightning and biochemical sources. These types of light are naturally occurring and do not necessarily need humans to create light. Sunlight is one of the most obvious and prominent sources of natural light for humans. It is constantly present in the Earth and provides a large amount of light for people to see by on a daily basis. It is also the largest source of light available to humans. Starlight is similar to sunlight in that it comes from stars that are within the galaxy and beyond, although these stars are much smaller and further away than the sun. Lightning also exists in the atmosphere under ideal conditions and is able to provide a small source of light for the people who live on earth to use. It is generally a quick flash of light.Due to the high temperature of the volcanic materials within a volcano, it is able to light up and provide a source of light for humans. This light is extremely hot and is not a good source of light on an everyday basis. An example of biochemical light on the Earth would be lightning bugs or afireflies and jellyfish who emanate their own light sources from places within their bodies.

4.4.1 Natural Light Sources and Types

Daylight is the natural light sources which are obtained as daylight directly or through various openings in building like windows, door, glass roofs and atrium.

4.4.1.1 Day Lighting

Day lighting is the practice of placing windows, other openings, and reflective surfaces so that sunlight (direct or indirect) can provide effective internal lighting. Particular attention is given to day lighting while designing a building when the aim is to maximize visual comfort or to reduce energy use. Energy savings can be achieved from the reduced use of artificial (electric) lighting or from passive solar heating. Artificial lighting energy use can be reduced by simply installing fewer electric lights where daylight is present or by automatically dimming/switching off electric lights in response to the presence of daylight – a process known as daylight harvesting. The amount of daylight received in an internal space can be analyzed by measuring illuminance on a

grid or undertaking a daylight factor calculation. Computer programs such as Radiance allow an architect or engineer to quickly calculate benefits of a particular design.

The source of all daylight is the Sun. The proportion of direct to diffuse light impacts the amount and quality of daylight. Direct sunlight reaches a site without being scattered within Earth's atmosphere. Light that is scattered in the atmosphere is *diffused daylight*. Ground reflected light also contributes to the daylight. Each climate has different composition of these daylights and different cloud coverage, so daylighting strategies vary with site locations and climates. There is no direct sunlight on the polar-side wall (north-facing wall in the Northern Hemisphere and south-facing wall in the Southern Hemisphere) of a building from the autumnal equinox to the spring equinox at latitudes north of the Tropic of Cancer and south of the Tropic of Capricorn.

Traditionally, houses were designed with minimal windows on the polar side, but more and larger windows on the equatorial-side (south-facing wall in the Northern Hemisphere and north-facing wall in the Southern Hemisphere). Equatorial-side windows receive at least some direct sunlight on any sunny day of the year (except in the tropics in summertime), so they are effective at daylighting areas of the house adjacent to the windows. In higher latitudes during midwinter, light incidence is highly directional and casts long shadows. This may be partially ameliorated through light diffusion, light pipes or tubes, and through somewhat reflective internal surfaces. In fairly low latitudes in summertime, windows that face east and west and sometimes those that face toward the pole receive more sunlight than windows facing toward the equator.

4.4.1.2 Window

Windows are the most common way to admit daylight into a space. Their vertical orientation means that they selectively admit sunlight and diffuse daylight at different times of the day and year. Therefore, windows on multiple orientations must usually be combined to produce the right mix of light for the building, depending on the climate and latitude. There are three ways to improve the amount of light available from a window: (a) placing the window close to a light colored wall, (b) slanting the sides of window openings so the inner opening is larger than the outer opening, or (c) using a large light colored window-sill to project light into the room. Different types and grades of glass and different window treatments can also affect the amount of light transmission through the windows. The type of glazing is an important issue, expressed by its VT coefficient (Visual Transmittance), also known as visual light transmittance

(VLT). As the name suggests, this coefficient measures how much visible light is admitted by the window. A low VT (below 0.4) can reduce by half or more the light coming into a room. But be also aware of high VT glass: high VT numbers (say, above 0.60) can be a cause of glare. On the other hand, you should also take into account the undesirable effects of large windows.

4.4.1.3 Clerestory Windows

Another important element in creating daylighting is the use of clerestory windows. These are high, vertically placed windows. They can be used to increase direct solar gain when oriented towards the equator. When facing toward the sun, clerestories and other windows may admit unacceptable glare. In the case of a passive solar house, clerestories may provide a direct light path to polar-side (north in the northern hemisphere; south in the southern hemisphere) rooms that otherwise would not be illuminated. Alternatively, clerestories can be used to admit diffuse daylight (from the north in the northern hemisphere) that evenly illuminates a space such as a classroom or office. Often, clerestory windows also shine onto interior wall surfaces painted white or another light color. These walls are placed so as to reflect indirect light to interior areas where it is needed. This method has the advantage of reducing the directionality of light to make it softer and more diffuse, reducing shadows.

4.4.1.4 Sawtooth Roof

Sawtooth roof-Another roof-angled glass alternative is a saw tooth roof (found on older factories). Sawtooth roofs have vertical roof glass facing away from the equator side of the building to capture diffused light (not harsh direct equator-side solar gain).[The angled portion of the glass-support structure is opaque and well insulated with a cool roof and radiant barrier. The sawtooth roof's lighting concept partially reduces the summer "solar furnace" skylight problem, but still allows warm interior air to rise and touch the exterior roof glass in the cold winter, with significant undesirable heat transfer. Skylights-Modern skylight -Skylights are light transmitting fenestration (products filling openings in a building envelope which also includes windows, doors, etc.) forming all, or a portion of, the roof of a building space. Skylights are widely used in daylighting design in residential and commercial buildings, mainly because they are the most effective source of daylight on a unit area basis. An alternative to a skylight is a roof lantern. A roof lantern is a day lighting cupola that sits above a roof, as opposed to a skylight which is fitted into a roof's construction. Roof lanterns serve as both an architectural feature and a method of introducing natural light into a space, and are typically wooden or metal structures with a number of glazed glass panels.

4.4.1.5 Atrium

An atrium is a large open space located within a building. It is often used to light a central circulation or public area by daylight admitted through a glass roof or wall. Atria provide some daylight to adjacent working areas, but the amount is often small and does not penetrate very far. The main function of an atrium is to provide a visual experience and a degree of contact with the outside for people in the working areas. The daylighting of successive storeys of rooms adjoining an atrium is interdependent and requires a balanced approach.Light from the sky can easily penetrate the upper storeys but not the lower, which rely primarily on light reflected from internal surfaces of the atrium such as floor-reflected light.[The upper stories need less window area than the lower ones, and if the atrium walls are light in color the upper walls will reflect light toward the lower stories.

4.4.1.6 Translucent Walls

Walls made of glass brick are translucent to transparent. Traditionally, they are hollow and grouted with a fine concrete grout, but some modern glass brick walls are solid cast glass grouted with a transparent glue. If the glue matches the refractive index of the glass, the wall can be fairly transparent. Increasing the amount of concrete, bottle walls embed bottles that run right through the wall, transmitting light. Concrete walls with glass prisms running through them have also been made] With the advent of cheaper optical fibers, fiber-optic concrete walls.[Daylight (and shadow images) can then pass directly through a solid concrete wall, making it translucent; fiber optics will lead light around bends and over tens of meters. Typically only a few percent of the light is transmitted (the percent transmittance is about half the percent of the surface that is fibers, and usually only ~5% fibers are used). Both glass and concrete conduct heat fairly well, when solid, so none of these walls insulate well. They are therefore often used outdoors, as a divider between two heated spaces (see images), or in very

4.5 ARTIFICIAL LIGHTS

Definition **-** Artificial light, as opposed to natural light, refers to any light source that is produced by electrical means. Artificial lighting has many different applications and is used both in home and commercially. Artificial lights are available in a wide variety of

shapes, sizes, colors of light emitted, and levels of brightness. The use of artificial lighting is crucial in agriculture and gardening, particularly in indoor cultivation.

Artificial Light-There are several different types of artificial light sources. Some of these sources are incandescent bulbs, halogen lamps, metal halide, fluorescent tube, compact florescent light, and LEDs. All lights emit energy in the form of photons. Light is absolutely essential to plant growth and vitality as it is a key component in photosynthesis. However, different types of plants, both indoor and outdoor, require different amounts of light. Although sunlight is best for most plants, they can still be successfully grown using only artificial light. Artificial lights, when used as grow lights, can be used to aid in both in-home and commercial plant growth. Artificial lights can provide supplemental light to some plants, or can be the only light source available. Some growing methods, like hydroponics, almost exclusively rely on artificial lighting, particularly in large-scale, indoor commercial operations.

When choosing the proper grow light, it is important to consider several different factors in artificial lighting. First, plants require a light that emits the complete spectrum of light, or "full-spectrum" lights. Although blue and red lights seem to have the most effect on plant growth, plants use the full spectrum for photosynthesis. Another aspect of lighting that should be noted is the intensity of light. This is determined by the wattage of the bulb and how close the plant will be to the source of light. Additionally, care should be taken when deciding how much lights to expose plants to as all plants differ in light intensity needs. Last, but not least, light duration should also be considered. Some plants need varying amounts of light and darkness for proper growth. This is particularly true in flowering plants. For example, short-day plants will thrive on less than 12 hours of light a day. However, long-day plants need at least 14 to 18 hours of light per day.

Types of artificial lights: Artificial light sources are other sources of light which developed to compensate for or assist the natural light. It will have different frequencies and wavelengths that determine the light color.

4.5.1 First -Artificial Light Sources

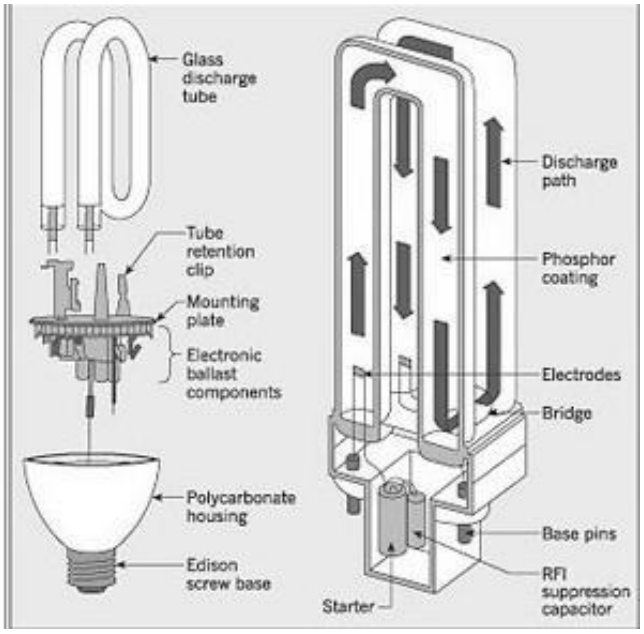
First :Artificial light sources : Artificial light sources are categorized by the technology used to produce the light. There's dozens of sources, with a few common in household applications and others more suitable for industrial uses. The five most common light sources are as follows:

1. Incandescent lamp.
2. Compact fluorescent lamp.
3. Fluorescent tube.
4. Discharge lamps.

5. Light Emitting Diode (LED).

1- Incandescent lamp: Until recently the most common electric light source was the incandescent lamp. This is still widely used, although its relatively low energy efficiency is leading to its replacement by other more efficient lamps such as the CFL. The connection to a light fitting is either by screw thread or bayonet. A large variety of shapes, sizes and power is available, as well as different colour ranges. Typical lamps for household use range from about 40 to 100 W, giving a light output of 420 to 1360lm at the typical lamp efficiency of about 12%.

2- Compact fluorescent lamp: The compact fluorescent lamp (CFL) was designed as a more efficient replacement for incandescent lamp. It is supplied with the same fixing system (screw or bayonet), and can be used in many light fittings designed for incandescent lamps. Power ratings of CFLs that can provide approximately the equivalent light output to incandescent lamps are shown in the table below, together with their efficacy ratings



Compact fluorescent lamp

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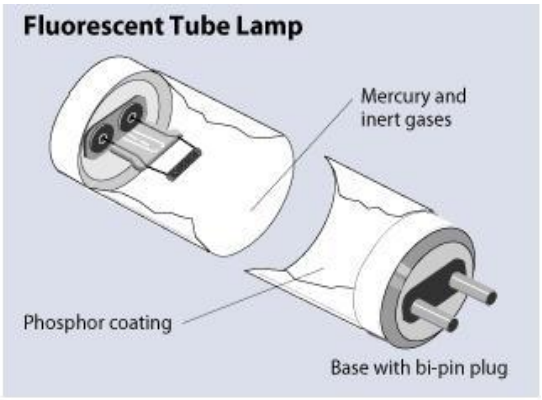
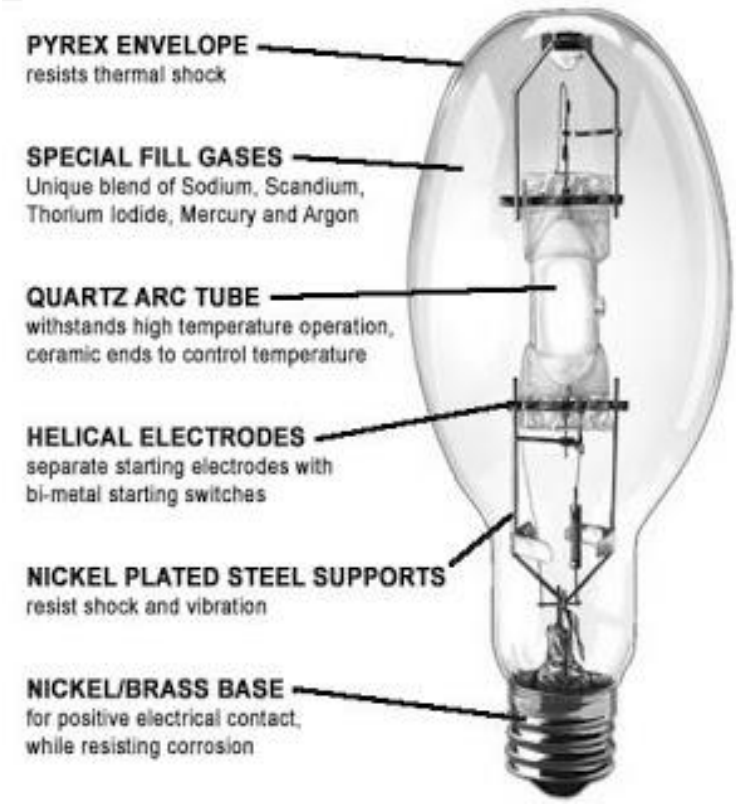
3- Fluorescent tube: Fluorescent tubes are the main form of lighting for offices and commercial buildings. They are a form of gas discharge lamp, and are formed in a long thin glass cylinder with contacts at either end that secure them to the fitting (or luminaire) and provide the electrical connection. The tube contains mercury vapour at low pressure, and the inner wall of the glass is coated with a phosphor that reacts to ultra-violet radiation. When electricity is passed through the vapour it emits UV radiation that is converted by the phosphor to visible light. The most efficient fluorescent tubes are the T5. With a smaller diameter (16mm) than earlier tubes, these can achieve a luminous efficacy of up to 104lm/W.



4- Discharge lamps: Discharge lamps work by striking an electrical arc between two electrodes, causing a filler gas to give off light. Different metals and filler gasses can be used to provide a range of colour and brightness. Discharge lamps provide high luminous efficacy combined with long life, resulting in the most economical light source available.



Discharge lamps

Types of gas-discharge lamps: The gas discharge lamps have three types as follows:

A- Low pressure discharge lamps: Low-pressure lamps have working pressure much less than atmospheric pressure. For example common fluorescent lamps operate at a pressure of about 0.3% of atmospheric pressure.

- Compact fluorescent lamp,
- Fluorescent lamps,
- Low pressure sodium lamps: the most efficient gas-discharge lamp type, producing up to 200 lumens per watt, but at the expense of very poor color rendering. The almost monochromatic yellow light is only acceptable for street lighting and similar applications.

B- High pressure discharge lamps: High-pressure lamps have a discharge that takes place in gas under slightly less to greater than atmospheric pressure. For example, a high pressure sodium lamp has an arc tube under 100 to 200 torr pressure, about 14% to 28% of atmospheric pressure; some automotive HID headlamps have up to 50 bar or fifty times atmospheric pressure.

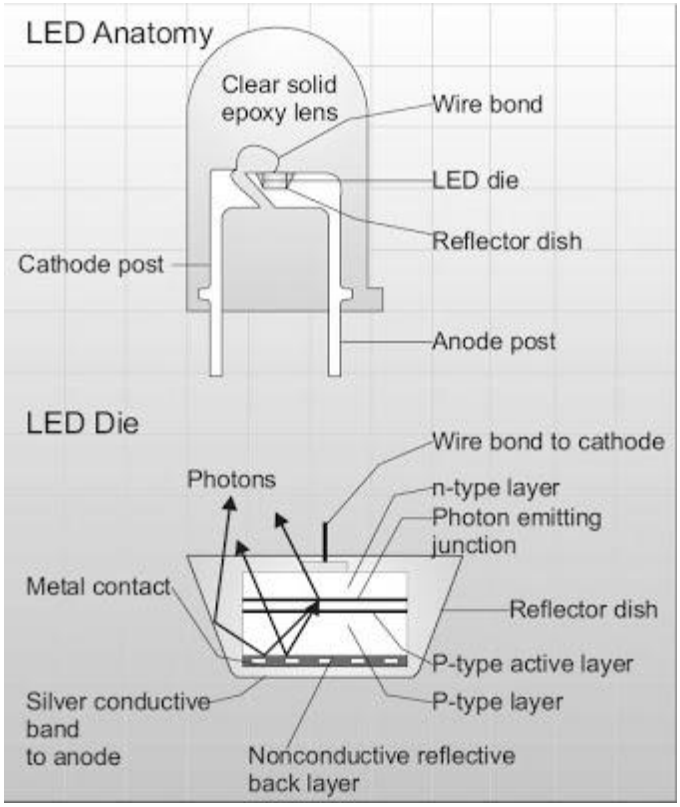
- Metal halide lamps: These lamps produce almost white light, and attain 100 lumen per watt light output. Applications include indoor lighting of high buildings, parking lots, shops, sport terrains.
- High pressure sodium lamps: producing up to 150 lumens per watt. These lamps produce a broader light spectrum than the low pressure sodium lamps. Also used for street lighting, and for artificial photo assimilation for growing plants
- High pressure mercury-vapor lamps: This lamp type is the oldest high pressure lamp type, being replaced in most applications by the metal halide lamp and the high pressure sodium lamp.

C- High-intensity discharge lamps: A high-intensity discharge (HID) lamp is a type of electrical lamp which produces light by means of an electric arc between tungsten electrodes housed inside a translucent or transparent fused quartz or fused alumina arc tube. Compared to other lamp types, relatively high arc power exists for the arc length. Examples of HID lamps include:

- Mercury-vapor lamps.
- Metal halide lamps.
- Ceramic discharge metal halide lamps.
- Sodium vapor lamps.
- Xenon arc lamps.
- Ultra-High Performance (UHP).

HID lamps are typically used when high levels of light and energy efficiency are desired.

5- Light Emitting Diode (LED): LEDs use semi-conductors to convert electrical energy directly into light. They are only recently becoming available as a light source for lighting purposes, and are highly efficient and long lasting. LED torches are becoming very popular, as they provide a far longer battery life than other.



Light Emitting Diode (LED)

4.5.2 Second- Forms of Artificial Lighting

Second: Forms of Artificial lighting: There are two forms for Artificial lighting as follows:

1. Indoor lighting
2. Outdoor lighting

1- Indoor lighting-Indoor lighting is usually accomplished using light fixtures, and is a key part of interior design, these light fixtures or light luminaries can be defined as follows:

Luminaire is a device that distributes filters or transforms the light emitted from one or more lamps. The luminaire includes all the parts necessary for fixing and protecting the lamps, except the lamps themselves. In some cases, luminaires also include the necessary circuit auxiliaries, together with the means for connecting them to the electric

supply. The basic physical principles used in optical luminaire are reflection, absorption, transmission and refraction.

Types of Indoor Light fixtures/luminaires: Light fixtures/luminaires are classified according to the following:

- The light function.
- Lamp type.
- Installation method
- The percentage of light output above and below the horizontal.

1- Types of Light fixtures according to light function: There are five basic types of light fixtures according to the function or aim of using it as follows:

- Ambient (general lighting).
- Task.
- Accent.
- Informational lighting/Guidance Lighting.
- Decorative lighting.

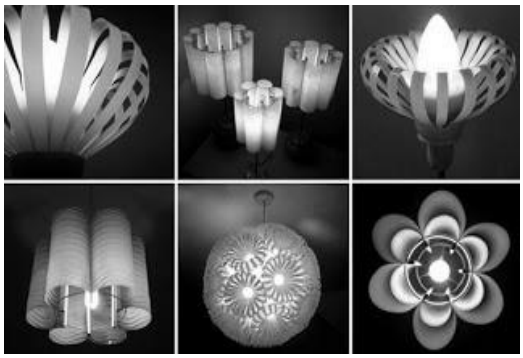
A- Ambient lighting -Ambient lighting provides an area with overall illumination. Also known as general lighting, it radiates a comfortable level of brightness without glare and allows you to see and walk about safely. Ambient lighting is often provided by traditional pendant type fixtures, down lights, chandeliers, or ceiling mounted fixtures etc. The general decor and aspect of the room will affect the amount of general lighting required. Having a central source of ambient light in all rooms is fundamental to a good lighting plan

B- Task lighting -Task lighting, or directional lighting, is aimed at a specific task; It is a way to provide more light on a specific area to perform a task that requires more light than the ambient fixtures can give. It can be provided by recessed and track lighting, pendant lighting and under cabinet lighting, as well as by portable floor and desk lamps. Task lighting should be free of distracting glare and shadows and should be bright nough to prevent eye strain.

C- Accent lighting: Accent lighting is also a sort of a directional lighting that adds drama to a place by creating visual interest. As part of an interior design scheme, it is used to draw the eye to houseplants, paintings, sculptures and other prized possessions. It can also be used to highlight the texture of a brick or stone wall, window treatments or outdoor landscaping. To be effective, accent lighting

requires as least three times as much light on the focal point as the general lighting surrounding it. Accent lighting is usually provided by recessed and track lighting or wall-mounted picture lights .

D- Informational lighting (Guidance Lighting) -It is designed to help us see our way safely. The light in your closet, the light by your doorbell, and night lights, as well as path lighting and motion lights, are all good examples of informational lighting. The photo to the right is a typical night light with a photosensor. Informational lighting can be beautiful as well as functional, and can create dramatic statements. Lights inset on stairs can create pathways that enhance architecture, while outdoor informational lighting can create



E- Decorative lighting: Strips, pendants, chandeliers, and sconces are all examples of light fixtures that draw attention to themselves and add character to the place being lighted. Many are also used for general lighting.

CHECK YOUR PROGRESS -I

1. What is light? Explain their types.

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2. What are the sources of the lights ?

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4.6 LIGHTING SYSTEM AND DESIGN

4.6.1 Make lighting central to design

"Lighting is often an afterthought," says Ms. Morosow, "an added extra thrown in shortly before opening a venue." However, as a number of factors such as the location of electricity sockets and venue layout are essential to lighting design, it makes sense to consider everything together. Take tables for example. An effective way to highlight individual tables, especially in restaurants, is to install pendant lights (lone hanging fittings) above them. "Without careful planning, it might only be possible to have lights above certain tables!"

4.6.2 Apply different layers of light

Different lights can perform different tasks. The first step is ambient lighting. This is the main source of light in a bar or restaurant, providing the general level of lighting. Used as diffuse surface-directed lighting, it can also make ceilings seem higher or walls wider. Next comes task lighting. These are fittings applied in areas where work needs to be carried out, such as the cash register or the kitchen. Then comes accent lighting. This is typically spot lighting that draws attention to the architecture or a particular feature. It includes up-lighting on walls or columns, as well as back bar lighting. Finally, comes the fun bit! Both decorative lighting and effect lighting is what personalizes a bar or restaurant. Functionality is less significant here; it's about creating an individual style.

4.6.3 Use light to guide people around your venue

When someone enters a venue, they should know within the first few seconds where to go and where to find what. "Orientation is essential." Light can be used to guide guests around a venue by drawing their attention to different focal points or areas. Focal points are created through contrasts in brightness, often between accent lighting and ambient lighting. Recommendations vary, but a 5:1 contrast ratio of accent to ambient is a good starting point to make items stand out.

4.6.4 No one size fits all: be aware of your space and concept

Each bar and restaurant has its own individual style. "When designing your venue, you should consider three things: concept, target audience and the space you are using," explains Morosow. For example, a small bar might only require individual tables to be accentuated, whilst a larger space may need to use lighting to differentiate and separate different areas.

4.6.5 Set the right mood by paying attention to brightness

Lighting is key to atmosphere. "Generally speaking, warm, cozy light makes people feel most comfortable, especially in cooler climates." By warm light we are generally referring to lamps with less than 3000 Kelvin. Installing a dimmer switch adds an element of flexibility, enabling the brightness of a venue to be adjusted to create different moods. Automated control systems can further aid the process, enabling different settings to be programmed according to the time of the day or year.

4.6.6 Apply color, but sparingly!

Bar lighting tends to be different to restaurant lighting. As bars normally also aim to provide a form of entertainment, it is more common to experiment with color. Restaurants on the other hand often require more reserved lighting, creating a relaxed environment. Of course this varies according to concept. Color is also used to promote branding and a good way to introduce brand colors. "Be careful not to overdo it though!"

4.6.7 Reveal the real color of food and drinks

Not to be confused with colored lighting, color rendering is the ability of a light source to reveal the true colors of various objects. Expressed as an index, the lower the score, the poorer the color rendering properties of a lamp. The highest score is 100. In restaurants and kitchens, a minimum of score of 80 is required; but 90 is better. Getting the color rendering index (CRI) wrong could mean that the visual impression of food (and drinks) doesn't reach its full potential, having a strong impact on customer experience.

4.6.8 Take care when it comes to customer comfort

"However unusual or experimental the design of a bar, a minimum level of comfort should always be ensured," explains Morosow. Guests must always be able to read the menu and see their food. Direct glare should also be avoided by placing lamps outside the natural field of vision. Watch out for light that could be reflected into people's view from shiny surfaces or mirrors. Diffusers, such as frosted glass or fabrics, can be useful here.

4.6.9 Keep an eye on current trends: some are set to stay

Current trends are seeing a return to basics. "Light sources are now open, with lampshades removed and chords hanging from the ceiling." Retro-feel light bulbs with an exposed filament are very popular, as it is the bulbs themselves that are the design feature. When it comes to non-decorative lighting, bars and restaurants are increasingly turning to LEDs in order to save money and reduce maintenance. "Both these trends are likely to be here to stay," says Morosow.

4.7 LIGHTING MAINTENANCE

According to the U.S. Department of Energy, lighting accounts for an estimated 20 percent of the total energy used in commercial buildings. A large part of reducing energy use is proper lighting maintenance. More often than not, many buildings do not have detailed lighting maintenance policy other then replacing burned-out bulbs. Poor lighting maintenance can lead to visual degradation, reduce worker productivity, and contributes to higher energy costs. Having an effective lighting maintenance schedule can include many things including scheduling, policies, and inventory control. Your business should practice basic maintenance strategies between professional visits including:

- Cleaning dust off fixtures, lamps, and lenses every 6 to 24 months. Tip: Never clean an incandescent bulb while it is turned on. If the cloth is damp, the cooling effect of the liquid may shatter the hot bulb.
- Replace lenses if they appear yellow.
- Clean or repaint small rooms every year and larger rooms every 2-3 years because the dirt collected on these surfaces could reduce the amount of light they reflect.
- Consider group light replacement. Common lamps lose up to 30 percent of light output over their service life. Replacing all the lamps in a lighting system at the same time saves labor, keeps illumination high, and avoids stressing ballasts with Lighting Maintenance Policies

A lighting maintenance policy is a set of written procedures designed to serve as a guideline, not only for everyday maintenance practices, but for optimizing lighting systems on a year-round basis. Elements of an effective maintenance policy include:

- Blueprints of the facility
- Fixture and lighting controls schedule
- Equipment and service provider sources and contacts, including utility contacts
- Fixture cleaning and re-lamping schedule with service tracking log
- Procedures for re-lamping, re-ballasting, and cleaning fixtures
- Procedures for the adjustment of controls and occupancy sensors
- An overview of proper lamp and ballast disposal.

4.8 CLEANING FIXTURES OF LAMP

It's understood (and somewhat expected) that lighting wears down over time. However, did you know that routine cleaning can add years to the life of bulbs, fluorescent lamps and LEDs According to lighting engineer Dr. Cristian Suvagau, a fixture's light output (which is measured in lumens) can be reduced by 30% to 50% if it isn't clean. Dirty bulbs and lamps also overcompensate for filth by operating at higher than normal temperatures, shortening their lifespan. A cleaning routine, says Suvagau, is an easy way to get the most out of your lights. Here, he shares a few tips to consider before you start scrubbing:

Tip 1: Check the manufacturer's cleaning guidelines before you begin.
Suvagau points out that some bulbs, lamps and even LEDs require special handling – some may even ban wet cleaning. So always check the manufacturer's instructions before you start. The manufacturer may even go so far as to specify the kind of cleaning solution you should use, such as a degreaser, general-purpose detergent, a metal polish, or a heavy-duty cleaner, so look over their guidelines carefully before you begin. Dr. Cristian Suvagau, a lighting expert at BC Hydro, suggests twice-a-year cleaning as a rule of thumb.

Tip #2: Take the proper safety precautions
Before you get out the ladder, Suvagau recommends taking the following safety precautions:

- Gather all of the tools, equipment, cleaning supplies and safety gear that you'll need, such as a ladder, gloves, goggles and a dust respirator.
- Clear and secure an 8-foot work area underneath your fixture in case of falling debris.
- Turn off power to area and/or fixture.
- Remove bulbs and lamps and store them securely. If one breaks, use a broom to clean up the broken glass – never use your hands.
- Protect yourself by wearing a dust respirator when you remove built-up dust.

Tip #3: Clean fixtures twice a year, or whenever you see soil build-up
To ensure cleaning is done regularly, Suvagau suggests business owners create operating procedures for staff, such as mapping out a specific days and times that lights are cleaned, and the steps required to do the job properly. Having a plan in place reminds staff of the need to be diligent about cleaning routines, not only for the sake of energy efficiency, but for fire prevention too.

Tip #4: Keep other surfaces, such as tabletops, clean too
Surfaces, such as walls, ceilings and tabletops should also be kept clean because their reflection of light can impact the quality of light in a facility or a room. Granted, cleaning light fixtures is a hassle that requires a stepladder and a steady hand. But it’s a necessary spring-cleaning chore that freshens your home and gives you the light you’re paying for. Dirty bulbs shed 30% less light than clean ones, says the U.S. Department of Energy. Add a dusty, dead-bug riddled cover, and you’ve got an automatic dimmer, whether you want one or not.

4.8.1 Chandeliers

Yes, you should dust your crystal chandeliers weekly, especially during pollen season. But once or twice a year, you should make those crystals sparkle with a thorough wash.

- If the chandelier isn't too big, take it down and lay it on top of a towel spread on a table. If it's huge, hire a handyman to bring it down, or grab a stepladder and clean it while it hangs.
- Take a picture of the chandelier before you start cleaning. That way you'll remember where each crystal belongs if you take them off during cleaning, says Meg Roberts, president of Molly Maid cleaning service.
- Mix a solution of 1 ounce mild dish soap with ¼ cup white vinegar and 3 cups water.
- Add to a spray bottle.
- Spritz each crystal.
- Let dry and polish with a microfiber cloth.

4.8.2 Light Bulbs

Light Bulbs-these days, bulbs have long lives thanks to new led and CFL technology. They're bound to get dirty and should be cleaned. Mary Beth Gotti, manager of the GE Lighting Institute, says a thorough wipe with a dry cloth is the best way to get rid of dust and dirt."If you use a damp cloth, you can get water into crevices in the lamp that can damage electronics," Gotti says. Also, don't spray cleaning solutions directly onto the light bulb, which could damage the bulb.

Most important: Turn off the electricity to the fixture before messing with the bulbs. To be extra cautious, turn off the circuit breaker, or put a piece of tape over the switch so no one else turns it on while your working.

Ceiling Fixtures: Ceiling fixtures can be a dusty, grimy, buggy mess. Carefully take down the fixture cover and slide it into a sink full of soapy water. Dry and shine with a microfiber cloth. Avoid the temptation to put glass fixtures into the dishwasher. The glass can shatter, ruining your fixture and your dishwasher.

4.8.3 Pendant Lights

These usually are easier to reach than ceiling fixtures, so you can clean in place.

Turn off the light, let bulbs cool, then spray and wipe the outside of globes with a microfiber cloth and cleaning spray.

Wipe bulbs and extension rods and cables with a dry cloth.

Recessed Lights

Dust weekly with a long-handle duster, such as a Swiffer, that traps dust and cobwebs.

For a more thorough cleaning, wipe the insides of canisters and the bulbs with a microfiber cloth or a slightly damp rag.

Caution: Before cleaning, make sure the electricity is off and the bulb is cool.

4.8.4 Ceiling Fans

***Ceiling Fans*-** Dust the lights on ceiling fans weekly when you clean the fan blades. When a bulb goes out and you have to climb a ladder anyway, clean globes and bulbs with a microfiber cloth. If the globes are really dirty, take them down and clean with soapy water or a cleaning solution. When removing or returning globes or bulbs, be sure not to steady yourself by grabbing fan blades, which will turn if touched.

4.9 REPLACING OF LAMPS

Different types of replacement parts for lamps include sockets, cords, plugs, fixtures and switches. The most common replacement part for a lamp is a light bulb; check to make sure that the light bulb is okay before embarking on a quest to repair an otherwise healthy lamp.

- To replace a lamp socket, remove the socket shell from the base, cut the wires to remove the socket, and loosen the setscrew to unscrew the base. Types of replacement sockets include gilt and brass, nickel, phenolic, porcelain, candelabra sockets and more. Choose the appropriate socket for your lamp.
- Cord insulation can become stiff and brittle over time and can deteriorate to the point of becoming a fire hazard. Remove the old cord by cutting the cord at the socket and pulling it out. Insert a grommet into the cord hold; a grommet protects the new cord from chafing against the lamp material. Buy a cord that's attached to a plug to save yourself the trouble of purchasing and assembling more individual parts. Use an 18-gauge cord for lamps that require 840 watts of lighting or less, or bring your lamp to a repair shop if it requires more than 840 watts.
- How you replace a lamp switch depends on several factors including the switch's location, and whether the socket is one piece of plastic or brass. The brass socket switch offers the greatest number of options when replacing the switch.

4.9.1 How to replace the lamp switch

- **Ensure the problem is the switch**-Before beginning the process of replacing the switch, try another bulb.
- **Unplug the lamp**-Before working on a lamp, disconnect it from the power source. Remove the light bulb from the socket.
- **Remove the socket**-Squeeze and pull the top of the lamp socket to remove it from its base. If it resists, use a screwdriver to pry it from the base. Once it is apart, use pliers to cut the wires.
- **Replace the switch**-The switch is located in the socket and should now be loose. Remove it, and replace it with a new switch. Reattach the wires, and reassemble the socket. Replace the light bulb, and test the lamp.

- **Replace the socket**-If replacing the switch does not repair the lamp, the socket is likely bad. Unplug the lamp, and remove the light bulb again. Remove the socket from its base. Loosen the set screw in the narrow part of the socket base. Turn the base to unscrew it from the lamp. Replace the old socket with a new one. Reassemble the lamp, and test again.

4.10 REPAIR OF LAMP SWITCH

To repair a table lamp switch, replace the bulb, tighten or reattach any loosely attached or broken terminal wires inside the socket respectively if the new bulb fails to light, and then replace the socket if the bulb still fails. This procedure, however, varies with the lamp type and make.

Disconnect the lamp from the power supply, then unscrew and remove any light bulb. Locate the electrode that attaches to the bulb, usually found at bottom of the bulb. If necessary, push in the electrode to detach it from the bulb and gently pry up the electrode with a screwdriver. Replace the bulb with a new one, reconnect the lamp and test the switch. If the new bulb fails to work, disconnect the lamp and unscrew the light bulb again. Using a small screwdriver, press the latch located on the socket cover to pull up the cover and access the wires inside the socket. Tighten any loose terminal screws to firmly secure the wires on the posts. If necessary, use a wire cutter and stripper to cut and strip any broken wires respectively, before securing them to the terminals with screws. Replace the cover and bulb, then plug in the lamp. Replace the socket if the bulb fails to light.

4.11 HOW DO YOU REWIRE A LAMP

- **Unplug the lamp, and remove the covering**-Switch off the power to the lamp. Unplug the lamp, and remove its shade, harp and bulb. With the folded towel beneath it, turn the lamp on its side, and peel back the felt covering the base.
- **Loosen the screw**-Turn the lamp right side up, and use a screw driver to loosen the base screw if there is one. If necessary, take out the knob to unscrew the socket.
- **Remove the socket**-Pull the socket up about 6 inches above the lamp. Using wire cutters, cut the cord where it emerges from the bottom of the socket, and remove the socket.
- **Splice the cords**-Using a stripper, strip the ends of the new and old cords, and splice them together. Wrap the joints with electrical tape.
- **Remove the old cord**-Pull out the old cord through the top of the lamp until the splice emerges, and snip the electrical tape. Undo the splice, and cut off the old cord.
- **Rewire the lamp**-Wrap the live wire around the brass screw of the socket, and tighten the screw. Using the same criterion, wrap the neutral wire under the other screw. Replace the socket and covering, and screw in the bulb.

CHECK YOUR PROGRESS -II

1. What are the design considerations for light?

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2. What are the procedure of light maintenance .explain with some examples.

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4.12 REPLACEMENT CYCLES

The only certain fact regarding equipment is that someday it will fail. The exact time can only be estimated from probability theory. The classic example in the bulb that has an average life of 1000 hours for certain wattage normal life lamps. All this means is that the probability of a particular lamp operating 1000 hours is 50%. If 1000 lamps were installed at one time, and if all were operated for an equal length of time, only 500 would still be in operation after 1000 hours of use. Most failure curves follow the same general shape. A manufacturer's warranty is based on such curves. Warranty periods increase as the estimated life of the product increases. If manufacturer data are not available and large numbers of units are installed in a building these mortality curves can be developed for a particular operation.

The replacement of items that fail generally assumes that the efficiency of the unit is stable over its life. If the efficiency does not significantly vary from its initial value to its failure, the procedure that follows can be used to analyze and develop replacement cycles.

This procedure becomes economically feasible when the cost of labor is very high in relation to the cost of the item being replaced. The costs of labor include the preparation, removal, installation and clean up man-hours for replacing items. It also assumes that if items fail prematurely, they will be replaced on a route basis. Hence sending an

electrician to a guest room to replace a burned-out lamp can become very costly. The electrician may start from the location of the engineering and maintenance department, walk to the room, remove and install a new electric lamp, and return to his department. If all of this time is accumulated, the cost of changing one lamp could be very expensive. It may be better to replace all the lamps in the room while the electrician is there. These at least will greatly lower the average cost per lamp.

An initial cycle of replacement must be assumed for the analysis. The procedure will provide an ideal cycle of replacement.

The cycle of replacement may be expressed in hours, days, months or years. The estimates must be reasonable if an operating life is assumed. Once information is obtained regarding the proposed cycle of replacement and the rate of failure, the remaining data is based on the cost labor and material for replacement. The cost of individual or spot replacement is compared to the cost per unit for group replacement. Generally these are estimated average costs. But if previous data are available for a particular property that should be used.

The cost of an item is also considered. If large numbers of items are purchased at one time, quantity discounts may be available which may lower unit costs for group replacement. In a group replacement all items are removed at one time and the majority of these items are discarded. Some are retained for future spot replacement.

Case study 3: The following mortality rates have been observed for a certain type of light bulb:

Week	1	2	3	4	5
% failing by end of week	10	25	50	80	100

There are 1000 bulbs in use and it costs Rs. 3 to replace an individual bulb which has burnt out. If all bulbs are replaced simultaneously it would cost Rs. 1 per bulb. If is proposed to replace all bulbs at fixed intervals, whether or not they have burnt out and to continue replacing burnt out bulbs as they fail. At what intervals should all the bulbs be replaced.

Solution:

We first compute the probability that a new bulb fails in successive week (no group replacement in operation). Let P1 denote the probability that a bulb which was new then installed fails during the ith week of its life. The probability is clearly the difference between the proportion alive at the end of ith week and the proportion alive at the end of the ith week. We obtain the probability as follows:

Week	1	2	3	4	5	Total
Probability that a new bulb installed at time zero fails during week I (p)	.10	.15	.25	.30	.20	1.0

Note : that no installed bulb survives more than 5 weeks. Thus a bulb that has already lasted 4 weeks is sure to fail the fifth week. However, the unconditional probability of failure during the fifth week for a new bulb installed at time zero is what we are denoting by ps and has the value 0.20.

With two simplifying assumptions, we can compute the number of replacement due to failure in successive weeks under a policy of no group replacement. We assume:

1. That bulb fails during a week are replaced just before the end of the week.
2. That the actual % of failures during a week for a subpopulation of bulbs with the same age is the same as expected % of failures during the week for the subpopulation.

Let n1 denote the number of replacements made at the end of the ith week of all 1000 bulbs are new initially. Then under our assumption we immediately obtain.

n 0 = n	= 1000
n 1 = n 0p1	= 100
n 2 = n 0p2 + n 1p1	= 150 + 10 = 160
n 3 = n 0 p3+ n 1p2 + n 2 p1	= 281
n 4 = n 0p4 + n 1 p3 + n2 p2 + n 3 p1	= 377
n 5 = n0 p5 + n1p4 + n2p3 +n3p2+ n4p1	= 350

It will be noticed that the number of bulbs failing each week increases until week 4 and then decreases. It can be shown that the number will later start to increase and it will continue to oscillate until ultimate systems settle down to a steady state in which proportion of bulbs failing each week I the reciprocal of their average life. The average life is (1x.10)+ (2x.15)+ (3x.25)+(4x.20) + (5x.20) = 3.35 weeks. In the steady state, the number of failures each week will be 1000/ 3.35 =299 bulbs. Hence the failure replacement policy will cost 299 x 3 = Rs.897.00 per week.

Let us compare and find the optimum replacement cycle.

Optimum replacement cycle

Week	Probability	Total nos. of failed	Cumulative no. of failure	Cost of replacement after failure	Cost of previous. replacement	Total cost	Average cost/ week
1	.10	100	100	300	1000	1300	1300
2	.15	160	260	780	1000	1780	890
3	.25	281	541	1623	1000	2623	874

4	.30	377	918	2754	1000	3754	938
5	.20	350	1268	3804	1000	4804	961

Thus it would be cheapest to replace all the bulbs

4.13 SUMMARY

Lighting design process and proposes an improved strategy which provides a holistic approach including human response to the appearance of the whole visual environment. In particular, it considers the aspects of visual function and amenity, integration with the architecture and energy efficiency. It draws from previous work, experience, recent thinking and research studies. Both the art and science aspects, together with their inter-relationships, need to be regarded in the process, and a framework for design is proposed. An all embracing approach is necessary if both high qualities in lighting and high energy efficiency are to be achieved.

4.14 GLOSSARY

Lamps -Lamp is equipment, which produces light.

Incandescent lamps: -Incandescent lamps produce light by means of a filament heated to incandescence by the flow of electric current through it. The principal parts of an incandescent lamp, also known as GLS (General Lighting Service) lamp include the filament, the bulb, the fill gas and the cap.

Reflector lamps: -Reflector lamps are basically incandescent, provided with a high quality internal mirror, which follows exactly the parabolic shape of the lamp. The reflector is resistant to corrosion, thus making the lamp maintenance free and output efficient.

Gas discharge lamps: -The light from a gas discharge lamp is produced by the excitation of gas contained in either a tubular or elliptical outer bulb.

Luminaries: Luminaire is a device that distributes filters or transforms the light emitted from one or more lamps. The luminaire includes all the parts necessary for fixing and protecting the lamps, except the lamps themselves. In some cases, luminaires also include the necessary circuit auxiliaries, together with the means for connecting them to the electric supply. The basic physical principles used in optical luminaire are reflection, absorption, transmission and refraction.

Control Gear: The gears used in the lighting equipment are as follows:

Ballast: -A current limiting device, to counter negative resistance characteristics of any discharge lamps. In case of fluorescent lamps, it aids the initial voltage build-up, required for starting.

Ignitors: -These are used for starting high intensity Metal Halide and Sodium vapour lamps.

Illuminance -This is the quotient of the illuminous flux incident on an element of the surface at a point of surface containing the point, by the area of that element.

Lux (lx) -This is the illuminance produced by a luminous flux of one lumen, uniformly distributed over a surface area of one square metre. One lux is equal to one lumen per square meter.

Luminous Efficacy (lm/W) -This is the ratio of luminous flux emitted by a lamp to the power consumed by the lamp. It is a reflection of efficiency of energy conversion from electricity to light form.

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4.17 TERMINAL QUESTIONS

1. what are the sources of lights ?explain it with examples .
2. Describe following terms:
    - Lamp

- Natural lights .
- Artificial lights .
- Ballast
- Lux

3. Discuss types of lighting fixtures in two or three lines.
4. Explain lighting system and maintenance.
5. Discuss replacing of lamps.

UNIT: 05
SAFETY AND SECURITY SYSTEMS

Structure

5.1 INTRODUCTION

India's hospitality industry which includes hotel, travel and tourism, catering units is expected to grow by about 7.3% in 2014, according to World Travel & Tourism Council (WTTC). The total market size of tourism and hospitality industry in India stood at USD 117.7 billion and is anticipated to touch USD 418.9 billion by 2022. The domestic hospitality sector expects 52,000 new hotel rooms to be added in five years (2013-17), according to a survey by real estate consultancy, Cushman & Wakefield. This will lead to a rise of over 65% in total hotel inventory in India. The Hotel Management is fully responsible for the safety and the well being of guests as well as of the hotel staff. In case of any harm to the guest due to accidents on account of negligence, the hotel management has to face legal proceedings and pay compensation as decided by the Court of Law. Such occurrences bring a bad name to the organization and affect business. The management must pay serious attention for the personal safety and security of the guests, customers, patients, members of organization and building property. The management should understand the importance of remaining prepared for events that threaten the life and property of guests and employees, as well as the assets of the business. The common problems generally center on:

- Fire

- Accidents in the hotel e.g. Electrical-shock, burning, injury due to falling or slipping and swimming pool accidents.
- To some extent on natural disasters e.g. earthquakes, floods and tornadoes.
- Criminal attacks on guest and the theft of guest and hotel properties.

5.2 OBJECTIVES

After reading this unit learner will be able to:

- Define fire and its causes
- Explain classes of fire
- Explain fire extinguishing techniques
- Explain types of fire detectors, and fire alarms
- Explain legal requirements
- Explain care and maintenance of fire extinguishing devices

5.3 SAFETY AND THE HOSPITALITY INDUSTRY

Since the 26/11 attack the hospitality industry has continuously been fighting with every challenge in respect with terrorism and other security risks by adapting to new technologies and training the security personnel and other employees as well. Today, there is a sea change in terms of security to protect guests and property from any kind of damage. Before 2011, hotel staff did not focus a lot on the security department. It was just a supportive department that focused on guest related operations. However, after 2011, there was a drastic change in thought process of hotel managements. People started security centric programs and protocols. Good amount of money was pumped in to enhance the security of guests and the property. Extensive awareness and training schedule was created for the guards and security personnel. Newer hotels under development relooked at their design aspects with greater attention given towards integrated surveillance systems, advanced lock and access control systems, and sophisticated asset protection tools. All of this done in a manner that blends aesthetics and security. Today, business travelers and corporations, especially, are more concerned with the safety of their traveling employees. Today, safety and security is becoming a sales differentiator for many hotels. Most of the hotels have created an emergency response team or a crisis team to handle any kind of emergency. Regular programs are held to train staff not only theoretically but also on practically implementing terms. The hotel staff is constantly trained on areas such as handling stressful situations, crowd control and management in emergencies, escalation procedures, detecting unauthorized access, medical procedures and facilities, including first aid, fire safety, criminal activities, terrorism and responses to terror threats, emergency drill and legal concerns.

CHECK YOUR PROGRESS-I

1. Define safety.

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2. Discuss role of hotel staff in hotel safety.

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5.4 FIRE SAFETY

Fire is the most common damaging agent and a major disaster. About 80% of the property is rendered total loss after a building is engulfed in fire; at the same time fire causes substantial number of burn and deaths cases. Provisions should be made for the safety of customers and property against fire.

5.4.1 Classification of Fire

According to the type of the fuels, fires can be classified under the following categories:

TYPE 'A' FIRE: This type of fire is causes by burning of solid organic materials, for example wood, plastic, paper, cloth and rubber etc. Type 'A' fire is also known as 'General fire'.

TYPE 'B' FIRE: caused by burning of liquid organic materials, for example petrol, diesel, kerosene oil, alcohol and other oils, cause the type of the fire. This 'B' fire is also known as 'Oil Fire'.

TYPE 'C' FIRE: burning of inorganic materials causes this fire, for example Potassium, Sodium, sulfur etc. This fire is also known as 'Chemical fire'.

TYPE 'D' FIRE: This fire is caused by the combustion of both organic and inorganic gases, for example Methane, petroleum gases and Hydrogen gas etc. This fire is known as 'Gaseous fires'.

TYPE 'E' FIRE: Electrical sparks or short circuit initiates the fire and it is maintained by the burning of combustible materials used as indicated above. This fire is known as 'Electrical fire' and requires different preventive techniques.

5.4.2 The Conditions for Fire

The following three conditions are essential for starting and maintaining fire:

- Presence of combustible material or fuel.
- Presence of oxygenated air: oxygen is supporter of combustion and is essential for it. Normal air contains about 20% of oxygen of its volume.
- Ignition temperature: fuel materials have their own specific ignition temperatures. This temperature is necessary to start combustion and maintain fire.
- Variation in any one of the above conditions will affect and control the intensity of fire.
- The above condition is explained with the 'Fire triangle' diagram. The fire will maintain itself if the triangle is closed.

5.4.3 Fire Prevention Techniques

Fire Prevention Technique for General Fires (Type 'A' Fire):

- If conditions favor the fire can be contained in a limited space by the removal of the un-burnt fuel material from the vicinity of the fire.

- Covering the fire by a layer of incombustible material such as sand, thick woolen blanket etc. This restricts air supply and controls the fire.

- Spraying or throwing water over general fires, controls it. Water forms a temporary layer on the burning surface and restricts air supply. At the same time water absorbs sensible heat @ 1 kilocalorie per kg per degree Celsius up to boiling point and then 540 kilocalorie per kg as the latent heat of evaporation. The heat thus absorbed cools the fire and drops the temperature much below the ignition point. Further the water vapors envelope the fire and restrict the air supply to fire. Water therefore proves to be an easily available good fire quencher for general fires.

Fire Prevention Technique for Oil Fires (Type 'B' Fire):

- It should be noted that sand or water should never be used to quench oil fires. The reasons being that sand and water are heavier than oil and settle down in the burning oil mass, leaving the top burning layer in contact with air to continue burning. At the same time the sand or water, which settles in the oil, displaces the burning oil and spreads the fire further.

- For control of oil fires foam type fire extinguisher should be used. The foam spreads on the top of the burning oil surface and cuts off the air to come in contact with it.

- Dry calcium bi-carbonate powder extinguisher can also be used with oil fires. Bicarbonate powder releases carbon dioxide gas on coming contact with the burning layer. The powder, oil and carbon dioxide gas forms foam with CO_2

filled bubbles, which floats on the surface and cuts the air supply to burning surface.

Fire Prevention Technique for Gas Fires (Type 'D' Fire):

These fires require very special techniques to control them:

- ***Use of Oxygen Absorbing Gases***: Some gases such as 'Halon' 1301 (bromotrifluoromethane) is especially favored for extinguishing general and gaseous fires and electrical equipments because it leaves no residue and does not cause electrical short circuits or damaging corrosion of the equipment. These gases have a very high affinity for oxygen and they absorb about 20 times of their own volume, of oxygen. When sprayed over the gas fire zone they absorb the oxygen from the space around the fire and by creating an oxygen deficient zone around it extinguish it. These chemical gases are though very costly but are very efficient not only for gaseous fires but other fires as well.

- ***Explosion Method:*** This method is suitable only for gas fires, especially in oil fields. A series of explosions are carried out in quick succession over the gas fire. The fire heat ignites the explosive material, which absorbs a large amount of oxygen from the surrounding during explosion. Simultaneously explosions create a high pressure over the space thus spreading the fire. The spreading of the fire helps to cool and control the fire. This method is highly technical and requires experienced people and sophisticated machine.

Fire Prevention Technique for Electric Fire (Type 'E' Fire):

- It should be noted that water or Soda acid fire extinguisher should never be used in case of electric caused fires.

- The reason is that water and soda acid extinguishers products are good conductor of electricity. This may cause spread of electric current and electrocution of the fire fighting persons.
- For attending electrical fires special carbon tetra chloride fire extinguishers are used. CCl_4, which is an insulating liquid is stored in container and sprayed with the help of pressurized Nitrogen gas. The Nitrogen gas displaces the oxygen and covers the fire and the liquid cools the fire.

- Nitrogen displaced foam type fire extinguisher may also be used in some cases of electrical fires.

Some of the important points are noted below:

- The design of the building should comply fully with the established rules and regulations of fire safety norms.

- The building structure should be so designed that the fire can be isolated and contained in the affected portions without much spreading to other portions of the building.

- The building design should be able to ventilate hot gases, smokes and toxic fumes to reduce suffocation and also the building temperature does not increase much so that the evacuation of people is made easier.

- The building design should provide enough and easy EXIT points for quick evacuation of guests and hotel staff.

- Enough emergency stairs should be provided out side the building to serve as exits in case the internal stairs are full of smoke.

- Good fire alarm system is provided in all sections of the building and especially in strategic areas such as kitchens, storerooms and underground floors.

- Enough automatic fire extinguishing systems and manually operated extinguishers are provided at suitable and easily approachable points in every section of the building.

- Large overhead and underground water storage tanks should the maintained full of water, exclusively for fire emergency.

- The readiness of fire alarm and fire extinguishing systems should be checked at scheduled intervals.

- The hotel staff should be trained to respond to fire emergency without panic and should prove helpful to the customers not much familiar with the hotel corridors and exit points.

5.4.4 Fire Detection

Fire Alarm Circuits: Fire alarm is a device used to warn the occupants of a building, the presence of a fire before it spreads and blocks escape routes or attempts to extinguish it. On sensing smoke the detectors emit a loud, high-pitched alarm tone, usually intermittent and sometimes accompanied by a flashing lights. There are two types of smoke detector:

1. **Photoelectric Smoke Detectors**:
    a. ***Light Beam Obstruction Detector***: Utilize a small light source and a light-sensitive cell. The spot of light falls on the photocell; due to this the photocell generates current that keeps an alarm circuit 'open'. When particles of smoke interrupt the ray of light, the photocell stops generating current and the alarm circuit is triggered 'on'. Sometimes the control circuit is so arranged that it automatically start water-sprinkling system in the affected zone. The system is to be installed

high enough so that the beam of light is not interfered by the general movement on the floor area.

b. ***Light Diffusion Smoke Detector***: This photoelectric detector is widely used; it employs a detection chamber in which smoke can enter. The light and the photocell are fixed in the chamber in such a way that light-sensitive element cannot ordinarily "see" the light source, usually a light-emitting diode [LED]. When particles of smoke enters the chamber that holds both the LED and the photocell, the smoke particles diffuse or scatter the light ray so it can be "seen" by the photocell. As a result the light-sensitive cell generate a current is and the alarm is triggered. Photoelectric detectors respond faster and more effectively to the large smoke particles generated by a smoldering, slow-burning fire.

2. **Ionization Detectors**: Employs radioactive material in so tiny quantities that they pose no significant health hazard. The radiation beam ionizes the air molecules between a pair of electrodes in the detection chamber. This enables a minute current to be conducted by the ionized air. When smoke enters the chamber, the smoke particles attach themselves to ions and diminish the flow of current. The reduction in current triggers 'On' the alarm circuit. Ionization detectors respond faster to the tiny smoke particles released by a rapid burning fire. For this reason some manufacturers produce combination versions of detectors. Many fire-prevention authorities recommend the use of both photoelectric and ionization types in various locations in a private home. Either type of detector.

5.4.5 Fire Notification

Local rules regarding fire safety and the building design

- Provision of correct types of fire extinguishers at appropriate positions.
- Properly designed building structure to localize and prevent spread of smoke and fire to unaffected sections of building.
- Properly designed smoke-free staircases.
- Enough safe escape routes for the guests and employees for quick evacuation of building.
- Enough water in suitable capacity overhead and underground tanks for emergency water supply during fire accidents.
- Provision of fire and smoke sensors and alarms.
- Automatic water sprinkling arrangement at strategic positions in the hotel building.
- Provision of staff training to handle fire situations and help costumers to get out of the building through safe and convenient routes.
- Exit access: there should be two separate exits are required from each floor or area of the building.

- Distance a guest or employees should have to travel before reaching an exit should be according to NFPA.(National Fire Protection Act).
- Doors must swing open to outside.
- Discharge area should be clear and not blocked by vehicles, debris or other material.
- The exit should be illuminated on a continual basis.
- Emergency power should be arranged so as to provide the required illumination automatically in the event of any interruption of normal lighting. All lighted exit signs should also be connected to the emergency power supply.
- Follow the local codes (NFPA) which generally specify the size of letters, color, lighting level and position of sign.

General Accidents: Arrangement should be made for the safety of the costumers and staff:

- Electrical safety norms should be strictly adhered according to rules in force.
- Electrical control and safety devices such as switch, fuse and 'earth' etc. should be provided and tested at regular intervals.
- Staff should be trained to handle electrical shock accidents and fires caused by electricity.
- To prevent general accidents the building floor should be kept clean of slippery materials e.g. oil, soap, high polish and wax etc.
- The floors of passages and movement areas should be free of obstructions.
- Staircase side rails should be strong and properly fixed.
- Hanging and overhead machines and equipments should be properly fixed on ceiling and walls at proper height as not to obstruct movement.
- Rotating machines should be properly guarded.
- Strong and well-fixed grills should be provided in the windows to prevent accidental falling and attempted suicidal jumping.
- Swimming pool rules and safety precaution should be strictly observed.
- Trained guides should be available at the swimming pool during swimming sessions.
- Some beds in a well-established hospital should be kept hired for necessary emergency admission of hotel patients.
- A well-equipped ambulance van with staff must be maintained by the hotel round the clock to transfer the patient to hospital without delay.

Natural Disasters: Are though rare but when they strike they create havoc. Their occurrence and effect can neither be ruled out nor predicted, but the damage can no doubt be minimized if proper preventive measures are ensured.The management must ensure that the local safety rules and regulations presently in force for such disasters are strictly observed without any discrepancies whatsoever. Hotel management should be in touch with the local authorities for advance warnings, help and rescue facilities.

Criminal cases are very common in hotels. The guests, customers and employees of the hospitality industry are vulnerable to robbery, assault, rape and larceny. The management should seriously consider the effectiveness of security personnel, procedures and equipments. The following information will focus on desirable practices and equipment that decrease the likelihood of crime.

5.4.6 Fire Suppression

How a fire starts and sustains itself:

- When an external heat source heats a fuel material in the presence of oxygen, the portion of the substance, which first attains the ignition temperature, starts burning.
- The heat liberated by the combustion process is dived in two portions:
  - One part of the heat generated by burning is released to the atmosphere.
  - The other part of the heat is utilized in warming and raising the temperature of the fuel material adjoining the burning zone. Under favorable conditions if the adjoining material attains its proper ignition temperature the fire proceeds further and sustains itself.
  - If this part of heat is not enough to raise the temperature of the fuel material to the ignition point the fire will not sustain and would ultimately extinguish.
  - At the same time other fire sustaining conditions (oxygenated air and fuel material) should be available.

Conditions, which will retard or subdue fire:

- Restriction or absence of combustible material.
- Restriction or absence of oxygenated air affects the intensity of fire and under severe reduction of oxygen the fire may not be able to sustain itself.
- Coolness or less heat of fire; if the heat of the fire is not sufficient enough to raise the temperature of adjoining fuel material up to the ignition point, the fire will not sustain.

5.4.7 Fire Control

Methods for extinguish fires:

- ***Methods, which depend on the cutting off the fuel:***
  Removing the un-burnt fuel material away from the vicinity of the fire. This method is not suitable for closed spaces or heavy materials objects. The shifting is difficult due to smoke in the closed space or due to the weight of the objects.

- ***Methods depending on the oxygen supply cut off:***
  Covering the fire with a layer of un-combustible materials will restrict air to reach the fire zone. The fire gets starved of oxygen and extinguishes.

Example putting sand or dust on burning material or covering it with woolen blankets.

- ***Methods depending on the cooling of the fires:***
  - If large amount of air is blown over small fire it absorbs the heat of the fire and the adjoining material fails to reach ignition temperature and the fire is unable to sustain itself.

  - Small explosions over the fire remove the hot gases and cool the fire by expanding the hot flames. This method is vastly used is controlling the oil well fires.

  - Pouring water over general fires: the pouring of water over the fire first absorbs the sensible heat (heat to raise its temperature to the boiling point) and secondly absorbs vast amount of heat as latent heat of vaporization. Thus the fire is cooled and quickly brought under control.

5.5 HOTEL SAFETY

Restricted Access: many lodging units and other related hospitality activities allow unrestricted entry and movement of visitors everywhere in the building. This results in the approaches and main building to remain open 24 hours a day. Poor security of the perimeters and the building can create potentially hazardous situations for the safety of guests and property. The criminals do generally carry out their activities in the buildings and the lodging areas.

Restricted access has a psychological effect on an offender. It signals a warning that steps have been taken to check them. At the same time it generates confidence in the customers that steps are in force to protect them. Closed circuit television monitoring of the hotel floors, galleries, urinals and stairs is a must.

LIGHTING: A dimly lit area provides favorable conditions for criminal activities not only against the guests and costumers but also guests' and building properties. On the other hand a well-lit area is a psychological deterrent to criminal activities.

- The best checking time of exterior building lighting is dark late evening hours. The checking during dark late hour gives the actual lighting conditions and discrepancies of the present scheme.
- Extra fill up lights should be installed for deficient light positions to cover the dark zones and improve illumination.
- The lighting system should be electronically controlled and self-activating. It should automatically switch on and off with changes in natural light levels.

PARKING: Vehicle-parking facilities need constant watch and monitoring to minimize:

- Exhaust pollution in the parking area.
- Proper parking of vehicles.
- Risks of hit and run accidents.
- Vandalism.
- Auto-theft and burglaries in the parking area.
- Pollution and security of the parking area will improve if the management:
    - Provides displacement arrangement (ventilation) of the vehicle exhaust gases with fresh air in the parking zone.
    - Utilizes the services of uniformed vigilance staff.
    - Provides adequate lighting in the area.
    - Provides CCTV to monitor the parking areas.
- To reduce the incidence of room theft and assaults in the high rise buildings with inter-connecting section and galleries, all persons entering the building from the garage areas should pass through manned and monitored security posts or through supervised lobby or electronic security devices before they can enter the guest area.
- Problems occur when people can enter unnoticed in an elevator in the garage area and travel and roam unnoticed and unchecked at a floor in the building.
- Constant CCTV monitoring should be provided at strategic points in the elevators, lobbies and galleries.

DOORS LOCKS AND WINDOWS: Consider the following guidelines:

- Solid-core doors should preferably be used on the corridors or exterior openings. The average hollow-core wood or iron doorframe can be easily punched through even the doors are provided with strong locks.
- Hinges on all guest room doors should be concealed. An intruder can easily snap off exposed hinges with simple tools.
- Strong metal doorframes should be used for guest rooms. Wooden or hollow metal frame can be peeled off or twisted to render the doors useless.
- Dead-bolt latches and locks are to be provided on guest-room doors. The bolt must extend at least 1 inch (25.4 mm) from the door lock into a bolt receptacle in the doorframe. The lock must automatically engage when the door is closed so that the room occupant does not have to bother to engage the lock.
- Spy lens must be provided on the doors at face level.
- Coded or computerized locks should be used instead of keyed locks. These locks allow the guest to program their own codes on a plastic card. In case of loss or theft of the card the code needs to be changed by the hotel computer system.

- Strong grills or special burglary resistance glass panes should be provided on the windows.

KEY CONTROL: Locks are useless without correct key control arrangement.

- The security manger should ensure that the keys to guest rooms are unmarked and should not identify the room location in the property.
- The keys should be stamped with the massage "DO NOT DUPLICATE" and should be changed only when a key loss is reported.
- Keys should be available to the room-service workers on a controlled and recorded basis. The records should mention the name of the room-service worker, time of issue and return of the key.
- Coded and computerized locks provide greater protection and key control.
- Different types of card systems are in use to mark the personal identity number (PIN) by the guests.

VALUABLES: Since problems can occur with key and control of codes, the manager may have to provide a 'property safe' (locker room) at the front desk, some other secure area or the guest rooms itself for the protection of expensive property. The safe should have the following specifications:

- Safes should be fire resistant and should be able to protect the valuables inside for specified time at the specified temperature.
- The safes should have burglary resistant rating.
- They should be firmly secured in the building structure as not to be easily removed and stolen together with the contents inside.
- Should have easy re-coding facility with new occupancy of room.

Safety measures in mechanical workshops and electrical installations:

1. The following safety precautions should be taken in workshops where mechanical work is undertaken:
   - Unauthorized persons should not be allowed to enter the workshop and operate any machine.
   - All the exterior moving and rotating parts of machines such as belts and pulleys should be guarded with a cover.
   - Proper eye protecting glasses and hand gloves should be worn while grinding and welding.
   - Shoes with Hard heels and toes should be worn in workshops.
   - Properly fitting clothes be worn. Neckties and other loose clothes should be strictly avoided.
   - Helmets should always be used in workshops.
   - Tight Apron should be worn over the normal clothes.

- All the sections of machines, which carry electrical current or voltage should be well guard covered with an enclosure.
- All load lifting tools and tackles such as chain pulley blocks and cranes should be mechanically strong and tested at proper intervals according to rule. The test records are properly maintained for inspection by factory inspectors.
- Proper clearance should be provided between machines and between machine and workshop walls for easy movement and maintenance.
- Machines should not be over speeded beyond the rated limit.
- Machine should not be overloaded beyond the rated capacity.
- While handling explosive and combustible materials proper protection should be undertaken.
- While handling corrosive chemicals proper eye and body protection be undertaken.
- Oil should not be spoilt on the floor to prevent slipping and if it is there it should be properly cleaned immediately.
- Danger boards and indicating light should be installed at proper places so that they are easily visible.
- Vulcanized rubber mats should be used under the feet while operating a machine run by electrical energy.
- Recommended fire extinguishers should be fixed at strategic places and should be easily approachable.
- Workers should be trained to operate and attend to machines under their responsibility.
- The workshop should be properly ventilated.
- The work place should be properly illuminated.
- The working place should be maintained neat and clean.
- All the tools should be flawless and in good working condition.

Hotel Safety Management Plan

Crisis Management Plan:
• Staff must be trained with mock drills in evacuation to help people in terror situations. • A nodal point and designated person for information of crisis. • Liaison with local administration and intelligence network
External Access Control:
• Limiting access point • Perimeter safety system • Road barrier • Shrubs and vines • Patrolling

Material Access Control:

- Guest baggage check
- Hotel supplies check

People Access Control:

- Walk in guests
- Guest profiling (check ministry of home affairs for watch list)
- Employee verification
- Visitors management system

Internal Access Control:

- Restriction of access to different parts of hotel
- Access of staff regulated through proximity cards with magnetic interlocks.
- Lift usage

Other Security Measures:

- Room key scanners
- Snifex: it is a small handled device with an Ariel. The Ariel starts pointing to the direction where explosive is kept from distance of few minutes.
- Trash Management
- Commitment to ongoing training
- Maintain Emergency Response Plan & Team
- Assess location and local crime statistics

CHECK YOUR PROGRESS-II

1. Define Fire and enumerate types of Fire.

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2. Explain fire safety procedure in a hotel building.

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3. Enlist importance of fire detectors.

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5.5 FUEL

Substance that reacts chemically with another to produce heat, or that produces heat by nuclear processes. The term *fuel* is generally limited to those substances that burn readily in air or oxygen, emitting large quantities of heat. Fuels are used for heating, for the production of steam for heating and power purposes.

5.5.1 Basic Definitions and Technical Terms

Heat: It is a form of energy and can be converted to other forms of energy i.e, steam, mechanical etc.

Temperature: It indicated hotness or coldness and also a measure of heat intensity. It is measured by using degree *Celsius* or degree *Fahrenheit.*

We also can convert degree Celsius into degree *Fahrenheit*. or vice versa by using a simple formula:

$$9\ C = 5\ (F - 32)$$

For example: you want to convert 100 degree Celsius into ---- degree *Fahrenheit.*
Then

$$9 \times 100 = 5\ (F-32)$$

$$900 = 5F - 160$$

$$5F = 900 + 160$$

$$5F = 1060$$

$$F = 1060 / 5$$

$$F = 220$$

It means 100 degree Celsius = 220 degree *Fahrenheit*.

Striking Back: This applies to aerated type gas burners and is caused by the gas being ignited at the air vent hole of the burner, causing the flame at the burner head to be luminous with disturbed combustion.

Causes of striking back: causes if striking back are as under:

- Incorrect lighting by placing lighter flame too close to the burner.
- Incorrect gas/ air adjustment.
- Dirty burners causing gas starvation at gas/ air adjustment.
- Rough interior of burner tube.

Transference of heat: There are three techniques of heat transfer namely as conduction, convection and radiation.

Conduction: It means traveling of heat through a solid, or from one solid to another, provided they are in contact. You can experience it by keeping your frying pan on fire, after some time you will find that frying pan is becoming hot. All metals are good conductors of heat. Bad conductors of heat are cork, plastic, chinaware, wood; cotton and these materials are used for manufacturing of certain articles or parts of articles which require to be kept cool.

Convection: Convection is the passage of heat through liquids and gases, e.g. a kettle of water being heated; the water at the bottom becomes heated first and then because it is lighter rises to top and the heavier cold water takes its place at the bottom.

Radiation: In this, hot body loses its heat and cold body receives it through some medium, e.g. we get heat from the Sun by means of heat radiation through air as a medium.

British Thermal Unit : Fuel efficiency or heating value of a fuel is usually measured in terms of the number of Btu (British Thermal Unit) that are produced when a given amount of the fuel is burned under standard conditions. Heating values for solid and liquid fuels are stated in terms of Btu per lb, and values for gases in Btu per cu ft.
Scientifically, one Btu is the amount of heat needed to raise the temperature of one pound of water one degree Fahrenheit.

1 B.T.U. = 0.252 Kcal = 0.556 CHU (Centesimal Heat Unit)

1 Kcal = 2.21 CHU = 3.97 B.T.U

In practice an average of 600 Btu are required to heat 1 pint (16oz) of water from cold to boiling point.

5.5.2 Types of Fuels

Solid Fuels: The common solid fuels, in order of heat potential, are coal, coke, wood, sugarcane and peat. Combustion of these causes decomposition of the fuel and evolution of the volatile matter as a gas that may burn with a sooty flame. The solid carbonaceous residue burns at a rate determined by the diffusion of oxygen to the surface. This latter combustion requires a higher surface temperature, about 400° to 800° C (about 752° to 1472° F), which is obtained by radiation of heat from the hot products or from hot surroundings. If the fuel is burned on a grate, air is forced through a bed of solid fuel particles, and the necessary temperature is maintained by inter-particle radiation.

Liquid Fuels: Common liquid fuels are oils, gasoline's, and naphtha's derived from petroleum, and to a lesser extent, coal tar, alcohol and benzol obtained from coke manufacturer.

Gaseous Fuel: Fuel, any combustible gaseous mixture used as fuel to provide energy for domestic or industrial use. Fuel gases consist principally of hydrocarbons, that is, of molecular compounds of carbon and hydrogen. The properties of the various gases depend on the number and arrangement of the carbon and hydrogen atoms within their molecules. All these gases are odorless in the pure state, and carbon monoxide is toxic. It is therefore common practice to add sulfur compounds to manufactured gas; such sulfur compounds, which are sometimes normally present in the gas, have an unpleasant smell and serve to give warning of a leak in the supply lines or gas appliance. In addition to their combustible components most gases have varying amounts of noncombustible nitrogen and water as their end products.

Fossil Fuels Energy: Rich substances that have formed from long-buried plants and microorganisms. Fossil fuels, which include petroleum, coal, and natural gas, provide most of the energy that powers modern industrial society. The gasoline that fuels our cars, the coal that powers many electrical plants, and the natural gas that heats our homes are all fossil fuels.

Chemically, fossil fuels consist largely of hydrocarbons, which are compounds composed of hydrogen and carbon. Some fossil fuels also contain smaller amounts of other compounds. Hydrocarbons form from ancient living organisms that were buried under layers of sediment millions of years ago. As accumulating sediment layers exerted increasing heat and pressure, the remains of the organisms gradually transformed into hydrocarbons. The most commonly used fossil fuels are petroleum, coal, and natural gas. These substances are extracted from the earth's crust and, if necessary, refined into suitable fuel products, such as gasoline, heating oil, and kerosene. Some of these hydrocarbons may also be processed into plastics, chemicals, lubricants, and other non-fuel products. Geologists have identified other types of hydrocarbon-rich deposits that can serve as fuels. Such deposits, which include oil shale, tar sands, and gas hydrates, are not widely used because they are too costly to extract and refine. The majority of fossil fuels are used in the transportation, manufacturing, residential heating, and electric-power generation industries.

Comparative study of fuels based on their characteristics

TYPE OF FUEL	CONTROLLABILITY OF HEAT OUTPUT	CLEANLINESS	SMOKE EMISSION	FUEL STORAGE
Coal	Fairly good if the draught is thermostatically controlled	Not clean	Considerable smoke emission unless very carefully fired	1 cu.ft of storage space holds 560000 B.T.U of potential heat. The bunker must be closed to boiler.
Anthracite	As above	As above	smokeless	1 cu.ft of storage space holds 700000 B.t.u of potential heat. The bunker must be closed to boiler.
Coke	As above	As above	smokeless	1 cu.ft of storage space holds 300000 B.t.u of potential heat. The bunker must be closed to boiler.
Oil	Very good	Fairly clean	Normally smokeless except when being started up or when incorrectly fired	1 cu.ft of storage space holds 10,000,00 B.t.u of potential heat. The need to provide a special tank increases capital cost of the plant. The tank can be sited wherever convenient.
Gas	Very good	Completely clean	smokeless	No storage required
Electricity	Excellent	Completely clean	Smokeless	No storage required

Note: From above study we can select gas and electricity are best fuels for hotel and catering industry but we should also remember that if any breakdown happens in case of electricity than specialist attention is required which might not be immediate available. The price varies of gas and electricity in proportion to the cost of solid fuel.

Combustion: Combustion, process of rapid oxidation or burning of a substance with simultaneous evolution of heat and, usually, light. In the case of common fuels, the process is one of chemical combination with atmospheric oxygen to produce as the principal products carbon dioxide, carbon monoxide, and water, together with products such as sulfur dioxide that may be generated by the minor constituents of the fuel. The

term *combustion,* however, also embraces oxidation in the broad chemical sense, and the oxidizing agent may be nitric acid, certain perchlorates, or even chlorine or fluorine.

Problems associated with fossil fuels :Acid rain and global warming are two of the most serious environmental issues related to large-scale fossil fuel combustion. Other environmental problems, such as land reclamation and oil spills, are also associated with the mining and transporting of fossil fuels.

When fossil fuels are burned, sulfur, nitrogen, and carbon combine with oxygen to form compounds known as *oxides.* When these oxides are released into the air, they react chemically with atmospheric water vapor, forming sulfuric acid, nitric acid, and carbonic acid, respectively. These acid-containing water vapors—commonly known as acid rain—enter the water cycle and can subsequently harm the biological quality of forests, soils, lakes, and streams.

Ash Particles: Combustion of fossil fuels produces unburned fuel particles, known as ash. In the past, coal-fired power plants have emitted large amounts of ash into the atmosphere. However, government regulations also require that emissions containing ash be scrubbed or that particles otherwise be trapped to reduce this source of air pollution. While petroleum and natural gas generate less ash than coal, air pollution from fuel ash produced by automobiles may be a problem in cities where diesel and gasoline vehicles are concentrated.

Global Warming : Carbon dioxide is a major by-product of fossil fuel combustion, and it is what scientists call a greenhouse gas. Greenhouse gases absorb solar heat reflected off the earth's surface and retain this heat, keeping the earth warm and habitable for living organisms. Rapid industrialization through the 19th and 20th centuries, however, has resulted in increasing fossil fuel emissions, raising the percentage of carbon dioxide in the atmosphere by about 28 percent. This dramatic increase in carbon dioxide has led some scientists to predict a global warming scenario that could cause numerous environmental problems, including disrupted weather patterns and polar ice cap melting.

5.5.2 Calorific Value of Fuels

Approximate higher heating values of common fuels are:

Solid fuels (Btu per lb):

- Coal 12,000 to 15,000
- Lignite 6000 to 7400
- Coke 12,400
- Dry wood 8500

Liquid fuels (Btu per lb):

- Alcohol 11,000
- Fuel oil 19,000
- Gasoline 20,750

- Kerosene 19,800

Gaseous fuels (Btu per cu ft):

- Acetylene 1480
- Blast-furnace gas 93
- Carbon monoxide 317
- Coke-oven gas or coal gas about 600; hydrogen 319
- Natural gas 1050 to 2220
- Oil gas 516
- Producer gas 136.

Comparative Fuel Cost: Fuel cost can be calculated by using the following formulae, inserting current prices of all four fuels and arriving at the cost of a useful "therm" in each case.

1 Therm= 1 00 000 Btu (Btu is a measure of heat)

Coke

If coke cost Rs.12000 per ton
Therefore 1 lb costs Rs.4.00
Coke produces 12 000 Btu per lb
Therefore 1 therm costs – cost per lb x 1 00 000 / 12000

$$\frac{4X100000}{12000} = \text{Rs. } 33.33$$

A useful therm is the amount of heat output to good use. Coke is calculated to be 60% efficient.

Therefore a useful therm costs= cost per therm x 100/ 60
33.33 x 100 / 60 = Rs. 55.55

Gas: To change cubic feet into therms you must know the heating power or calorific value (CV) of the gas. This will be shown on the gas cylinder and the simple calculation for working out the amount of heat supplied is:

Therms = Calorific value x hundreds of cubic feet / 1000

A useful therm is the amount of heat output to good use. Gas is calculated to be 80% efficient.

Therefore a useful therm costs= cost per therm x 100/ 80 = Rs. X

Electricity:

1 unit of electricity produces 3412 Btu
Electricity is calculated to be 100* efficient
Therefore 1 therm costs = cost per unit x 100 000/ 3412 = Rs x

Oil:

1 gallon produces 165000 Btu
Oil is calculated to be 75% efficient

Therefore 1 therm costs= Cost per gallon x100000 / 165000
1 useful therm = cost per therm x100 / 75 = Rs. X

The devices used to burn gas for either heat or illumination consist of a burner nozzle and some means of mixing air with the gas before it reaches the nozzle, as, for example, in the Bunsen burner invented by British chemist and physicist Michael Faraday improved and popularized by German chemist Robert Wilhelm Bunsen. It works on the principle on which gas is now used in stoves and lights. By arranging more supply of air to the gas fuel perfect combustion resulted inside the burner. The non luminous flame is very hot and does not give off any smoke. Hottest part of the flame of burner is the outside edge of the outer cone.

Burners may be high and low pressure gas supply type. Maximum pressure is 14 inches water column pressure and 16000 B.T.U units per hour.. Heat output depends on pressure. Low pressure is 4 inch water column and have 18000 B.T.U. units per hour, output, so, low pressure burners output is more than high pressure burners. Gas burner: it is the part of the gas stove, which mixes proper amount of air with the gas and thus help proper combustion of the mixture at the top. The body is made of cast iron, while the burner top is made of cast iron or brass.

The parts of the burner and their function are listed below:

- ***Gas Receiving Tube****:* it is fixed in front of the gas nozzle opening of the manifold. Holes are provided on the tube surface for the sucking of air.

- ***Venturi Section:*** when the bore of a tube is restricted in a specially designed curved manner. A specially designed restricted bore of a tube is a Venturi. When a fluid flows in the tube, Venturi creates a low-pressure zone and out side fluid is sucked in the Venturi tube. When the gas flowing in the tube reaches the Venturi section low pressure is created. This helps suction of the out side air through the holes at the Venturi section.

- ***Mixing Section:*** further extension of the gas tube helps the mixing of the gas and air. This extension is known as mixing tube. The mixing tube opens in a gas uptake pipe.

- ***Gas Uptake Pipe:*** this is a double cylinder construction with a full-length hole in the center. The cavity between the cylinders is closed at the bottom and open at the top.

- ***Burner Top:*** a burner top is placed on the top of the uptake pipe. The burner-top has holes on its surface. Gas and air mixture comes out through these holes and burns when ignited.

- The central opening supplies extra air to the inside of the flame for proper burning. It also keeps cool the uptake pipe to prevent 'BACK FIRING' due to overheating of the gas-air mixture in the uptake pipe.

Pressure Regulator: the pressure regulator reduces the high pressure of the cylinder gas to a constant low-pressure supply to the gas appliance. The following are the main parts of the regulator:

Regulator Body: the body of the regulator is divided in two sections:

Lower Section: the lower sections is made up of the following parts:

- ***An extended neck*** at the bottom to fix the regulator on the cylinder valve assembly.

- ***Locking And Gas Opening Knob***: The knob is provided on the extended neck. A quarter clockwise-turn of the knob locks the regulator on the valve assembly. A further quarter-turn of the knob presses the cylinder pin valve and allows gas to enter the regulator through a specially designed opening known as valve seat at the base of the lower section.

- ***Gas Outlet Nozzle:*** is provided at the side of the lower section. This outlet is connected to the burner manifold pipe inlet with a rubber tube or steel pipe.

Upper Section*:* contains the following parts:

- ***Pressure regulating spring:*** a spring is provided in the upper section to press the diaphragm.

- ***Spring Pressure regulating nut***: is provided at the top of the section. It adjusts the pressure of the spring on the diaphragm. The pressure nut is factory adjusted and sealed.

Rubber Diaphragm: a strong rubberized canvas diaphragm is inserted and tightened between the upper and lower sections of the regulator. The spring presses the diaphragm on the top.

Specially Designed Valve: it is hooded at the lower side of the diaphragm. This valve sits on the underside of the valve seat from where the gas can enter in the lower section below the diaphragm.

Regulator working:

- Turning the regulator knob press-opens the cylinder pin valve, gas enters at full pressure in the lower section presses and lifts the diaphragm against the spring pressure. The lift of the diaphragm pulls up the valve on the seat to close the entry of the gas.
- The opening of the burner knob releases the gas pressure under the diaphragm in the lower section of regulator
- The spring now presses the diaphragm down and opens the valve and allows gas to enter in the lower section from the cylinder.

- The spring and diaphragm then adjust at such a position as to allow required quantity of gas to the burner at constant recommended pressure.

Cleaning of a Gas Burner: The burners on gas stoves often become caked with grease and dirt. They needn't stay this way , as cleaning them is a relatively fast fix. A couple of household staples and some old-fashioned elbow grease will have your gas stove burners looking brand new.

1. ***Step 1*** Turn off the pilot light in the gas stove. Most stoves have a switch that shuts down the pilot. Older stoves may require blowing out the flame. Be sure that all of the burners are shut off prior to turning off the pilot. Check the manufacturer's instructions for your stove if uncertain about how to turn off the pilot.

2. ***Step 2*** Allow about 20 minutes of cooling time before proceeding with cleaning the burners. Some gas stoves have small flames that remain lit even when the burner hasn't been ignited, causing the burner and grates to become warm to the touch.

3. ***Step 3*** Use a potholder just in case the burner and/or grates are still warm. Remove the drip pans and grates from the burner. Prepare a sink full of hot water with a half cup of baking soda and a quarter cup of ammonia added to it.

4. ***Step 4*** Place the drip pans and grates in the baking soda and ammonia solution. Allow them to soak for about an hour. While they are soaking, turn your attention to the burners on the stove. Soak a sponge in the ammonia and baking soda solution and squeeze to rinse. Scrub the indentation of each burner on the top of the gas stove. Repeat as needed. Gently wipe any spills from the top of each flame element.
5. ***Step 5*** Use the steel wool pad to scrub any stubborn stains and build up from the drip pans and burner grates. Rinse and dry them. Dry the burner indentations on the stove top, and replace the drip pans and grates.

5.6 SUMMARY

Safety and security nowadays are a top priority of hospitality industry. Protecting the lives and valuables of guests, employees, suppliers, is a fundamental duty of the hotel management. Various safety and security procedures adopted by the industry and norms of National Fire Protection Act are discussed in the topic. Oil, gas and coal are the most usual fuel for large scale use. Although electricity is used for cooking as well as heating purpose in most of the hotels and catering units of India. The basic idea is to provide information about different types of fuels used in the hotel and catering industry and consumption pattern varies from hotel to hotel as per its location and volume of production of food.

5.7 GLOSSARY

Combustion and burning: are essentially oxidation processes in which a material known as fuel combines with oxygen with the release of energies (heat, light, pressure and sound) and production of its oxide.

Explosion: The process in which a material oxidizes at an extremely high rate to release vast amount of heat, light, flames, pressure and sound. The vast amount of heat released in the very short period expand the released gases and the surrounding air, which in turn generate a loud sound and the high pressure damages the objects in the surrounding space.

Fire: is defined as the rapid rate of combustion with release of heat, light and flames.

Smoldering: Smoldering is comparatively slow process of combustion with release of heat and light but no flames.

TYPE 'A' FIRE: This type of fire is causes by burning of solid organic materials, for example wood, plastic, paper, cloth and rubber etc. Type 'A' fire is also known as 'General fire'.

TYPE 'B' FIRE: caused by burning of liquid organic materials, for example petrol, diesel, kerosene oil, alcohol and other oils, cause the type of the fire. This 'B' fire is also known as 'Oil Fire'.

TYPE 'C' FIRE: burning of inorganic materials causes this fire, for example Potassium, Sodium, sulfur etc. This fire is also known as 'Chemical fire'.

TYPE 'D' FIRE: This fire is caused by the combustion of both organic and inorganic gases, for example Methane, petroleum gases and Hydrogen gas etc. This fire is known as 'Gaseous fires'.

TYPE 'E' FIRE: Electrical sparks or short circuit initiates the fire and it is maintained by the burning of combustible materials used as indicated above. This fire is known as 'Electrical fire' and requires different preventive techniques.

Rusting or Decay: Rusting or Decay is a very slow process of combustion or oxidation organic and inorganic materials accompanied with very slow evolution of heat only.

Heat: It is a form of energy and can be converted to other forms of energy i.e, steam, mechanical etc.

Temperature: It indicated hotness or coldness and also a measure of heat intensity. It is measured by using degree *Celsius* or degree *Fahrenheit*.

Striking Back: This applies to aerated type gas burners and is caused by the gas being ignited at the air vent hole of the burner, causing the flame at the burner head to be luminous with disturbed combustion.

Conduction: It means traveling of heat through a solid, or from one solid to another, provided they are in contact. You can experience it by keeping your frying pan on fire, after some time you will find that frying pan is becoming hot. All metals are good conductors of heat. Bad conductors of heat are cork, plastic, chinaware, wood; cotton and these materials are used for manufacturing of certain articles or parts of articles which require to be kept cool.

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5.9. TERMINAL QUESTIONS

1. Why should the management bother about safety of guests in their hotel?
2. What are the common unsafe conditions for which you will give a thought as a manager of a hotel?
3. Classify fire and recommend procedures for extinguishing.
4. Prepare a write up how you will ensure safe and secure conditions in mechanical workshop.
5. Why staff training is necessary for safety and security of hotel building. 1. Enlist types of fuels used in hotel and catering industry.
6. Being a manager of a catering unit on what basis you will take decisions about utilization of fuels.
7. Explain safety precautions while handling with solid fuels.
8. Discuss Advantages of electricity as a fuel on liquid fuel.

Numerical Problems

1. Consumption pattern of different types of fuels used in a catering unit are as follows. Determine costs of these fuels and recommend how you can control cost of the fuels as a chef of this catering unit.
   - LPG commercial cylinder 60 / month
   - Electricity consumption in kitchen 2200 KwH/ Month
   - Coal consumption 4500 Kgm / month

Project Assignments

A. Visit a five star hotel and prepare a project on guest safety and security.

B. Do the comparative analysis of safety and security procedures adopted in a catering unit with club facilities.

C. Determine the extent to which life safety is, or has been, a problem in the following types of facilities in your city:

a. Hotel
b. Food service
c. Health-care
d. Club
e. Institutional buildings

D. Discuss with the chef of a hotel about their installed kitchen equipment and submit a report with its merits and demerits on the basis of utilization fuels and cost aspect.

E. Survey various large institutional and industrial catering units of your city and submit a report how they can reduce fuel costs by using latest techniques of food production.