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HCM 234

Facility Maintenance

Module 2

HCM 234 Facility Maintenance Module 2

Course Developer/Writer
Dr. J.C. Okafor (Course Developer/ Writer)-Federal Polytechnic, Ilaro

Course Editor
Dr. Olusegun O. Onabanjo (Course Editor)-Federal University of Agriculture, Abeokuta

Course Coordinator
Mr. S. O. Israel-Cookey (Course Coordinator)-NOUN

Programme Leader
Dr. (Mrs.) A. O. Fagbemi (Programme Leader) - NOUN

Credits of cover-photo: Henry Ude, National Open University of Nigeria

National Open University of Nigeria - University Village, 91 Cadastral Zone, Nnamdi Azikiwe Express Way, Jabi Abuja, Nigeria

www.nou.edu.ng centralinfo@nou.edu.ng
oer.nou.edu.ng oerunit@noun.edu.ng OER repository
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Module 2

Unit 1Hotel Buildings

1.0 Introduction

Buildings are structures that serve as shelters for man, his properties and activities. They must be properly planned, designed and constructed to obtain desired satisfaction from the environment. The factors to be observed in building construction include durability, adequate stability to prevent its failure or discomfort to the users, resistance to weather, fire outbreak and other forms of accidents.

2.0 Objectives

At the end of this unit, you should be able to:

- describe different roof problems
- discuss emergency roof repair
- explain the handling of exterior walls.

3.0 Main Content

3.1 Roof Problems

Typical causes of roof problems

Lack of Maintenance
The failure to find and correct minor roof deterioration in the earliest stages is probably the greatest cause of premature roof problems. This is particularly true of roofing materials applied on relatively low-sloped roofs.

Weathering
All roofing materials deteriorate from exposure to the weather at rates determined largely by the kind of material and the conditions of exposure. In general, inorganic roofing materials tend to deteriorate less rapidly from exposure than organic roofing materials. All types of roofing materials may be damaged by hail. exposure to air pollutants and industrial or salt-laden atmospheres may accelerate the deterioration process of some roofing materials.

Wind damage
Roofing materials are subject to damage from strong winds and flying debris. Generally, roofs are not designed to withstand winds of hurricane and tornado intensity. However, roofs may also be damaged by winds of moderate intensity, with gust that may reach 50 to 75 miles per hour. The primary cause of wind damage is from the partial vacuum created by wind blowing over the edge of the roof. Nature tries to neutralize the low-pressure area by bringing in air from a higher pressure area, usually from inside the building. This air pushes up on the bottom side of the roof assembly and, over time, loosens fasteners and breaks the adhesion making the roof susceptible to damage from the next moderate or strong wind.

To counteract the effects of wind-uplift forces, the roofing and insulation should be adequately fastened to the roof deck, and a securely-fastened perimetre detail should be provided.

Improper design
Troublesome and costly roofing problems are often the result of faulty initial design of the roof system. Design deficiencies are costly to correct, and usually can only be corrected during roof replacement. However, unless design deficiencies are discovered and corrected during roof repair or re-roofing, the problems relating to them most likely will recur. Some examples of faulty design are:

- Weak roof structures that deflect excessively under load, causing splitting of the roof membrane
- Inadequate roof slope, sagging roof structure, or insufficient number or location of drains, resulting in ponding water
- Inadequate provision for expansion and contraction at changes in deck material or direction, causing membrane splits.
- Incompatible roof materials - i.e. the use of asphalt to adhere a torch-on material (APP).

Flashing failures
The function of flashings is to provide a watertight junction between roofing materials and roof projections or other parts of the structure, and between roof sections. Flashings should be designed to furnish service for at least as long as the materials used in the field of the roof. Flashings are the most vulnerable part of any roof. Their importance and the importance of maintaining them properly cannot be overemphasised.

Many early roof problems are actually flashing problems. Often, repairing the flashings or providing new flashings is all that is needed to make the roof watertight again. Most flashing problems result from inadequate flashing design or faulty construction. Many flashing problems can be reduced or eliminated by careful examination by competent inspectors during roof installation, and by regularly scheduled inspection and maintenance.

In many instances, leaks occur at flashings where there are no flashing defects. These leaks may be the result of open joints in a masonry wall or coping cap, which permits water to enter behind the flashings and into the building. This problem may be eliminated by "through-wall" flashings.

Base-flashing problems
Some common causes of base-flashing problems are:

- Insufficient number of base-flashing plies.
- Improper base-flashing height.
- Insufficient protective coating, resulting in accelerated weathering and deterioration.
- Omission of cant strips, making the base flashing more susceptible to damage.
- Open vertical end laps or seams caused by insufficient sealing.
- Insufficient adhesion or movement between vertical surfaces and the roof deck, resulting in separation of base flashings from vertical surfaces.

- Loose insulation, causing base flashings to separate from vertical surfaces.
- Improper fastening of base flashings to walls or curbs, resulting in sagging or separation of the flashing from the vertical surface.
- Deteriorating substrates, causing base flashings to separate from the surface, or permitting water to enter behind base flashings.

Metal base flashing and bituminous counter flashing problems
The use of metal base flashings in the construction of built-up roofs is not recommended. Metal base flashings easily separate from bituminous materials and stripping felts crack at the edge of the metal because of the difference in expansion coefficients between the materials. Open joints between metal pieces and deterioration of the metal are also sources for water entry. Inside and outside corners are particularly vulnerable areas. For these reasons, metal base flashings should be replaced with bituminous base flashings whenever possible.

Metal counter flashing problems
Metal counter flashings protect the top of bituminous base flashings from water entry. The most common metal counter flashing problems are:

- Counter flashings located too high above the base flashing.
- Metal deterioration caused by a lack or loss of protective coating.
- Cracks and open joints between metal pieces.
- The separation of counter flashings from vertical surfaces.
- Reglets not being sealed.
- Counter flashings not tightly fit to base flashings.

Penetration flashing problems
Penetrations through the built-up roof membrane are usually flashed in one of two ways. Individual pipes and small vents usually use flat, metal flange flashings that are placed directly on the last ply of roofing material and are stripped in with felts and mastic or felts and bitumen.

Larger penetrations and groups of smaller penetrations usually use curbs constructed of wood, metal or concrete, flashed with bituminous base flashing and metal counter flashings.

Common penetration flashing problems are:

- The failure to properly design the flashing for the penetration.
- Open or broken seams in metal curbs caused by expansion and contraction.
- Standing water behind penetration curbs caused by the omission of crickets.
- Sagging or separating base flashings caused by omission of top wood nailers.
- Missing or deteriorated counter flashing.
- Splitting or separation of the felt stripping over the edge of metal flanges.
- Improper priming and stripping of metal surfaces.
- Fastener backout and separation of the metal flashing flange from the roof around penetration flashings.

- Movement between stack vents or pipes and the flashing.

Drain flashing problems

A roof's drainage system includes the gutters, leaders, drain openings and scuppers, as well as the slope provided by the structural deck, tapered insulation, crickets and sumps. The primary function of the drainage systems is to prevent the retention of water on the roof by removing water from the roof as quickly as possible. Every roof, including so-called "dead-level" roofs, must have some provision for drainage. Further, it is important that the drainage system be kept free from debris that might interfere with the proper flow of surface water.

Many roof problems can be traced directly to inadequately designed or improperly installed drainage systems; for example, the use of only one drain; the failure to install overflow scuppers in parapet walls; the placement of drains next to support columns instead of at points of maximum deflection; loose or missing drain clamping rings. Ponded water is the principal indication of inadequate drainage, and may indicate the presence of structural defects.

Gravel stop and metal edge strip problems

The primary function of gravel stops (for aggregate-surfaced roofs) and metal roof edge strips (for smooth-surface roofs) is to close off the edges of the roof to prevent wind damage or blow-offs. Another important function of gravel stops is to prevent the loss of aggregate surfacing near the edge of the roof.

The principal problems with gravel stops and metal edge strips are leakage through open or broken joints between metal pieces, and splitting of the stripping felts at metal edges. For these reasons, gravel stops and metal edge strips should be raised out the water line whenever possible by using raised wood nailers and tapered edge strips. The use of interior drainage is preferred. However, where water must drain over the metal edge, scupper cutouts are preferable to continuous edge drainage.

Problems with rooftop equipment, signs, braces and supports

Often, the rooftop is used as a platform for all types of mechanical equipment, ladder struts, antennas, flag poles, signs, bracing, etc. These items should not be placed on the rooftop except when absolutely necessary. They should never be mounted or placed directly at the top of the roof membrane, as leaks beneath or adjacent to the supports for this equipment are impossible to repair. Rather, they should be mounted to a support structure or to raised curb-type supports. Flat flange or curb flashings can then be used to keep the roof watertight, and roof replacement and recovering can be done without disturbing or removing the equipment. Pitch pans, however, should not be used to keep supports watertight, and should be avoided where possible. Refer to the ARI/NRCA/SMACNA Guidelines for Roof-Mounted Outdoor Air- Conditioner Installations, and the roof membrane manufacturer for recommendations concerning the proper mounting and flashing of these items

3.2 Emergency Roof Repairs

General
Emergency repairs may be required after severe weather because leakage into a building can occur at any time (nights, holidays, weekends, etc.). Caution: It is generally not advisable to attempt roof repairs until after the severe weather has ceased, due to the danger of high winds and the possibility of a lightning strike. Caution should be exercised when inspecting a roof after there has been severe weather, or when there is suspect damage to the roofing assembly, because storm damage may have left the roof in a hazardous condition. If the roof condition is questionable, have a professional roofing contractor perform the inspection and necessary repairs.
In the event a professional roofing contractor is not available, and to minimise damage to the interior building finishes and contents, emergency repairs may be performed.

Emergency repair procedures should be as simple as possible so they may be performed safely by non-roofing professionals. These repairs should be considered temporary. Permanent repairs should be made by a professional roofing contractor as soon as weather permits.

If the roofing system is under a manufacturer's warranty, the roofing material manufacturer, and the installing contractor should be contacted as soon as possible. The following are emergency repair guidelines that may be performed by non-roofing professionals, or by professional roofing contractors.

Leak repair procedures
There are too many different types of roofing membranes to tailor emergency repair procedures for each. However, if literature cannot be located and/or if procedures are not detailed for emergency repairs, the following guidelines are suggested:

Protect the interior: Control the spread of water in the interior by collecting the water in containers or by using plastic sheeting to protect the building contents.

Remove excess water from the roof: Check roof drains and scuppers to be certain that they are open and functional. A frequent cause of roof leakage and roof collapse is excessive pounding on the roof surface due to clogged drains and/or scuppers.

Caution should be exercised when clearing debris from drains. Significant suction forces can be created by draining water, which can suck tools, hands, or arms placed within these vortices quickly into the drain.

Locate the source of a leak: In attempting to determine the source of a leak, locate the point on the roof surface above the area of leakage in the building interior. From this point, first check the condition of rooftop mechanical equipment, and then check all flashings at terminations and penetrations. Second, if the system is ballasted remove ballast from the immediate leak area, and then check the membrane surface for cuts, splits, or punctures. Finally, check the seams (laps) in the roofing membrane.

Perform emergency repairs: Once the source of a leak is located, the materials and procedures which will cause the least amount of damage to the roofing membrane should be chosen.

Storm and wind damage repair procedures

If roof damage is observed during a storm, it is generally not advisable to attempt repairs or damage control until after the storm because of the danger of high winds and the possibility of a lightning strike.

In some instances, however, repairs during a storm may prevent or minimize further wind damage.

Ballasted Systems: After high winds, the roof should be inspected to determine if ballast (aggregate or pavers) has been scoured (scattered), leaving areas of bare, unprotected membrane. If so, the exposed membrane should be inspected for open seams, punctures, and tears from flying debris (from rooftop mechanical equipment or from adjacent buildings). Membrane damage should be temporarily repaired before redistributing the ballast.

Temporary repairs made to the membrane should be marked on a roof plan to aid in locating them for later permanent repair. Except for areas less than 50 square feet (e.g. five feet by ten feet), inspection and permanent repairs should be performed by a professional roofing contractor.

Temporary Ballast: On ballasted single ply systems, bare areas greater than 50 square feet should be temporarily ballasted using sandbags, tires, concrete blocks, or concrete pavers. When applying temporary ballast, use caution to avoid overloading the structure.
If lightweight concrete pavers were used for the ballast and were displaced, use concrete blocks, heavy concrete pavers, or sandbags to achieve a minimum load of about 40 pounds per linear foot around the perimetre of the bare area. (The width of the temporary ballast around the perimetre to achieve the 40 pound load will depend on the weight of the ballast being used.) Place the temporary ballast on top of the remaining lightweight pavers to provide temporary protection against further wind damage until permanent repairs are made. In conjunction with setting temporary ballast of 40 pounds per linear foot around the perimetre of a bare area, also apply temporary ballast to secure the membrane when the bare area exceeds 50 square feet.

In some instances, insulation boards below the membrane are displaced. Displaced boards should be repositioned prior to final redistribution of ballast. If membrane cutting is required to reposition the boards, it should be performed by a professional roofing contractor.

When bare areas exceed 50 square feet or when ballast is blown off the roof consult with the manufacturer because, in either of these cases, design enhancements may be advisable.

Installation of new penetrations or equipment

One of the most common causes of leakage is the improper installation of new roof penetrations or equipment. To avoid roofing problems associated with new penetrations or equipment, consult with a local roofing contractor qualified to apply the type of roofing system in place, to recommend temporary tie-in steps prior to the installation of rooftop penetrations or equipment. This would include such items as TV Antennae, sign or equipment supports, skylights, plumbing soil stacks, HVAC equipment, and electrical conduits.

If the roof system is under warranty, the name and telephone number of the roofing membrane manufacturer should be written down and kept in a safe place for future reference. Notification prior to installation will allow the contractor or manufacturer to recommend how to incorporate the new penetration or equipment and how to protect the membrane warranty, if one exists.

The permanent addition of penetrations or equipment to the roofing system should be undertaken by a professional roofing contractor qualified to perform such work. The name, address, and telephone number of a roofing contractor qualified to perform the work can usually be obtained from the roofing membrane manufacturer if the original roofing contractor is not available. Improper installation of penetrations or equipment may void the roof warranty. If the building maintenance person is forced to install temporary flashings, set the flashing flange(s) into a continuous layer of plastic roofing cement and follow the procedures set forth above.

Permanent repair requirements
The emergency repair procedures described in the previous sections are strictly temporary in nature and must be replaced with permanent and complete repairs by a professional roofing contractor in a timely manner. If the roofing system is covered by a warranty, notify the manufacturer of the roofing membrane as soon as possible to obtain instructions and recommendations to facilitate a permanent repair.

3.3 Exterior Walls

Separating the outside from the inside
The exterior walls of a house have several functions. Not only do they define the shape of a house, they also support the floors, walls, and roof. Equally important is their role in separating the house's interior from the outdoors, and to do this effectively they have to block the weather with systems that insulate, shed water, and repel moisture and air infiltration.

While it is important to understand the different roles walls play, if we treat them and their functions separately, we miss great opportunities to improve material efficiency, operating efficiency, and overall building performance. Green building integrates them all.

Wood-frame walls
This has been the predominant choice for houses in the United States for more than three centuries, with masonry walls a distant second. But today's alternative products and techniques are more energy efficient and have lesser environmental effects.

A lot of time and materials go into building a house's walls, and with the exception of a timber frame, all that structure is covered up when the project is finished — out of sight and out of mind. Yet decisions about wall construction have consequences that last as long as the building does, including how much maintenance it will need, how energy efficient the envelope will be, and how difficult the structure will be to repair or modify.

Choosing a type of wall

Green factors

Energy efficiency
Where will the insulation go? Will the R-value (Measure of resistance to heat flow) of the completed wall be high enough? How will the wall be sealed against air leaks? A focus on energy efficiency pays dividends over time.

Sustainability issues
Can the resources used to build the structure be produced on a sustainable basis?

Local building requirements
Areas prone to hurricanes or earthquakes, for example, may have specific rules to help structures withstand extreme natural events that affect specific areas of the country.

Durability and initial cost
Keep in mind that differences in initial cost may not seem quite as dramatic when weighed against the expected life span of the house.

Combined functions
Wall systems that combine structure with finish have an inherent material efficiency advantage and should be seriously considered.

Add more foam for a better wall
The performance of almost any wall, in any climate, can be improved by adding a layer of exterior foam. If the wall already has exterior foam, it can be made greener by making the foam thicker. Remember, depending on the type of foam and thickness, foam-sheathed walls may need to dry only to the interior. For walls with more than three inches of any foam or with any thickness of foil-faced polyisocyanurate foam, never include interior polyethylene or other impermeable interior finishes.

Siding is the first line of defense
Walls are a house's "skin," and as such must protect the building from rain, wind, and sun. Siding is the first line of defense, but how siding is applied and the kind of water-resistive barrier (WRB) installed beneath it have a lot to do with how durable the walls will prove to be. The skin also includes doors and windows, important components of a home's thermal envelope but also sources of damaging air and water leaks if not properly installed.

Interior walls define spaces and affect livability
Floors and interior walls don't keep weather out, but they often do more than just define spaces. How you lay out partitions can affect airflow, solar heat gain, natural lighting, and even how efficiently pipes, wires and ducts are laid out. Structural demands may dictate where interior walls and floors go, which is why you should plan your mechanical systems and framing at the same time.

Doors can help or hinder
Exterior wood doors just less than 2 inches thick do not offer much in the way of insulation, just R-2 or less. When weather stripping is of poor quality or worn out, the effects are magnified. Doors do not represent a huge amount of wall area, but they can help nullify all the effort of insulating outside walls carefully. Insulated doors will help, along with high quality weather-stripping. Window area in doors, along with sidelights, should be kept on the small side or eliminated altogether.

Storm doors may seem like an antiquated idea, but they can be helpful in reducing energy losses while providing an extra weather barrier. They are especially useful when the primary door is exposed to the elements and not protected by a roof overhang or porch.

3.4 Causes of Building Collapsed in Nigeria

The causes of structural failure in Nigeria are numerous, and can be complex depending on the type and complexity of the structure. The inability of the engineer to carry out proper site investigations, inability to calculate design loads accurately, inability to prevent the use of substandard building materials, inability of the engineers/planning authority to have good design layout and inability of the engineers to understand structural analysis and design principles lead to structural failures.

The possible causes of building collapse in Nigeria are listed below:

- the absence of soil test report
- structural designs and details handled by quacks
- absence of co-ordination between the professional bodies and the local town planning authority
- lack of adherence to specifications by the unqualified and unskilled personnel;
- poor and bad construction practices
- the use of substandard building materials
- lack of proper supervision by professionals
- inadequate enforcement of the existing enabling building regulations
- illegal conversion of buildings which often lead to structural deficiencies
- flagrant disobedience of town planning regulations by developers/landlords
- the compromising attitude of some workers of the town planning authority
- Lack of sanctions against erring professionals and landlords.

Report of soil test of any site is very useful to the architect and the structural engineer. This will enable them to specify what type of foundation is to be used. And also they will know what precaution to take in order to avoid collapse of the structure because of settlement and other foundation problems. In some cases, buildings that are above the ground floor level do not have structural designs and details, and often times lead to failure of the structure. On the whole, the professional bodies such as Nigerian Institute of Architects, the Nigerian Society of Engineers, the Nigeria Institute of builders and the Planning Authorities, who represent the government share in the blame that cause collapse of buildings in Nigeria.

Self-Assessment Exercise

1. State the causes of roof problems
2. Itemise the possible causes of building collapse in Nigeria.

4.0 Conclusion

This unit has shown the typical causes of roof problems in buildings, as well as the cause of building collapse in the nation. It has also looked into the issues of walls and procedures for handling roof problems.

5.0 Summary

Buildings are structures that serve as shelters for man, his properties and activities.

Typical causes of roof problems are lack of maintenance, weathering, wind damage, improper design, flashing failure, base flashing problems and metal base flashing.

6.0 Self-Assessment Exercise

1. Discuss the causes of roof problems in buildings.
2. Itemise the causes of building collapse in the nation.
3. Explain the factors to consider when choosing a type of wall.

7.0 References/Further Reading

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Unit 2 Water Supply Systems

1.0 Introduction

In unit one we looked at problems associated with roofs and the issue of roof repairs. We also discussed exterior walls and causes of building collapse in Nigeria. In this unit, we will be looking at water supply systems.

It has been observed that lack of attention to the important aspect of Operation and Maintenance (O and M) of water supply schemes in several towns often leads to deterioration of the useful life of the systems necessitating premature replacement of many system components. As such, even after creating such assets by investing millions of Naira, they are unable to provide their services effectively to the community for which they have been constructed, as they remain dysfunctional or underutilised most of the time.

2.0 Objectives

At the end of this unit, you should be able to:
- state the objectives of operation and maintenance of sources of water supply
- identify the sources of water supply
- outline causes of water quality problems
- state the factors affecting water quality
- explain storm water drainage

3.0 Main Content

3.1 Maintenance of Sources of Water Supply

3.1.1 Objectives

The objectives of operation and maintenance of sources of water supply schemes are:

1. The water sources should be able to supply water which is safe to drink after treatment.
2. The water sources should be perennial and should ensure sustainable yield.
3. The quality of water should not be allowed to deteriorate.
4. There should be least or no disruption in water supply systems due to depletion of water sources.
5. There should be least possible expenditure on the repair and maintenance of the water sources.
6. Proper record of the water sources should be maintained so that their time to time performance could be known.
7. A methodical long-range programme of source inspection and monitoring should be introduced to identify problems so that a regular programme of preventive maintenance can be put in place to guarantee reliability and continuity of the source.

8. Survey maps should be obtained or prepared for all possible sources of water like rivers, reservoirs, lakes, canals, wells, and springs etc. Any maps already available should be updated from time to time**.**

3.1.2 Sources

Natural sources
Rain, snow, hail and sleet are precipitated upon the surface of the earth as meteorological water and may be considered as the original source of all the water supplied. Water, as source of drinking water, occurs as surface water and ground water. Three aspects should be considered in appraising water resources e.g. the quantity, the quality, and the reliability of available water.

Surface water
Surface water accumulates mainly as a result of direct runoff from precipitation (rain or snow). Precipitation that does not enter the ground through infiltration or is not returned to the atmosphere by evaporation, flows over the ground surface and is classified as direct runoff.

Direct runoff is water that drains from saturated or impermeable surfaces, into stream, channels, and then into natural or artificial storage sites (or into the ocean in coastal areas). The amount of available surface water depends largely upon rainfall. When rainfall is limited, the supply of surface water will vary considerably between wet and dry years.

Surface water supplies may be further divided into river, lake, and reservoir supplies. Dams are constructed to create artificial storage. Canals or open channels can be constructed to convey surface water to the project sites. The water is also conveyed through pipes by gravity or pumping.

In general, the surface sources are characterised by soft water, turbidity, suspended solids, some colour and microbial contamination.

Ground water
Part of the precipitation that falls infiltrates the soil. This water replenishes the soil moisture, is used by growing plants or returned to the atmosphere by transpiration. Water that drains downward (percolates) below the root zone finally reaches a level at which all the openings or voids in the earth's materials are filled with water. This zone is called the zone of saturation. The water in the zone of saturation is called the ground water.

Ground waters are generally characterised by higher concentrations of dissolved solids, lower levels of colour, higher hardness (as compared with surface water), dissolved gasses and freedom from microbial contamination.

1. A well that penetrates the water table can be used to extract water from the ground basin. The extraction of ground water is mainly by:

a. Dug well with or without steining walls
b. Dug/bore wells
c. Cavity Bore
d. Radial collector wells

e. Infiltration galleries

f. Tube wells

g. Ground water that flows naturally from the ground is called a spring.

3.1.3 Surface Water Management and Major Sources of Pollution

Use of surface reservoir
Methods of managing lakes and reservoirs used for domestic supplies vary widely depending on local conditions. In addition to serving domestic water needs, a reservoir may be used for flood control purposes, for hydroelectric power generation, for regulating releases, for recreational purposes or for providing water for agricultural, municipal and industrial uses.

The amount and type of public use allowed on reservoirs also varies according to individual situations. The methods of treating water depend upon raw water quality and range from disinfection only to complete treatment.

3.1.4 Factors Affecting

Water Quality
Some of the factors affecting water quality within the Reservoirs and Lakes are:

- Waste water
- Agricultural runoff
- Grazing of livestock
- Drainage from mining areas
- Runoff from urban areas
- Domestic and industrial discharges.

All these may lead to deterioration in physical, chemical, or biological/bacteriological water quality within a reservoir.

- Farming practices
- Fish die off.
- Natural factors:

Climate:
temperature, intensity and direction of wind movements as well as the type, pattern, intensity and duration of precipitation,

Watershed and drainage areas:
geology, topography, type and extent of vegetation, and use by native animals;

Wild fires;

Reservoir Areas:
geology, land form including depth, area and bottom topography and plant growth at the time the reservoir is filled.

3.1.5 Causes of Water Quality Problems

Nutrients
Moderate or large quantities of nutrients such as phosphates, nitrates and organic nitrogen compounds may act as a fertilizer in a reservoir to stimulate the growth of algae which may cause algal bloom.

The problems related to algal blooms are:

- Taste, odour and colour
- Increased pH
- Shortened filter runs of treatment plants
- Dissolved oxygen variation
- Organic loading.

Thermal stratification
Thermal stratification develops in lakes and reservoirs when the surface water begins to warm. The warm surface waters expand and become lighter than the lower waters. The water temperature difference causes variation in water densities, which create resistance to mixing. This ultimately results in anaerobic conditions in lower zones.

Anaerobic conditions
Anaerobic conditions make water unpalatable due to colour and odour which are difficult to treat. Another major problem in anaerobic water occurs when iron and/or manganese exist in bottom sediments in the reduced state and pass into solution. Due to the presence of either iron or manganese in appreciable quantities within the domestic supply the water looks reddish, brown or just plain dirty and may stain clothes during washing and stain porcelain fixtures.

3.1.6 Ground Water Management and Major Sources of Pollution

Use of ground water
Important requirements of managing ground water are:

- Regulation of Ground Water,
- Prevention of pollution of ground water,
- Conservation of ground water,
- Effective preventive maintenance,
- Artificial recharge of ground water.
- Major sources of pollution
- Landfills
- Mining activities
- Abandoned sites
- Abandoned wells
- Agricultural practices

- Underground storage tanks and pipeline
- Increased salinity and salt water encroachment
- Septic tank and soakage pit system
- Petroleum exploration
- Radioactive wastes.

3.1.7 Sanitary Survey of Water Sources

The sanitary survey should include the location of all potential and existing health hazards and the determination of their present and future importance. The information furnished by a sanitary survey is essential to evaluating the bacteriological and chemical water quality data. It is desirable to:

- identify potential hazards and
- Determine factors which affect water quality.

Following are some of the probable essential factors, which should be investigated in a sanitary survey.

Surface water

- Proximity to watershed and character of sources of contamination including industrial wastes, oil field brines, acid waters from mines, sanitary landfills, and agricultural drain waters.
- Population and wastewater collection, treatment and disposal on the watershed.
- Closeness of sources of fecal pollution to intake of water supply.
- Wind direction and velocity data; drift of pollution; algal growth potential in case of lake or reservoir supplies.
- Character and quality of raw water.
- Protective measures in connection with the use of watershed to control fishing, boating, swimming, wading, ice cutting, and permitting animals on shoreline areas.
- Efficiency and constancy of policing activities on the watershed and around the lake.

Ground water

- Nature, distance and direction of local sources of pollution.
- Possibility of surface-drainage water entering the supply and of wells becoming flooded.
- Drawdown when pumps are in operation, recovery rate when pumps are off.
- Methods used for protecting the supply against contamination from wastewater collection and treatment facilities and industrial waste disposal sites.
- Presence of an unsafe supply nearby and the possibility of cross connections causing a danger to the public health.
- Disinfection: equipment, supervision, test kits, or other types of laboratory control.

3.2 Storm Water Drainage

A storm drain, storm sewer or storm water drain (Australia and or drainage well system or simply a drain or drain system) is designed to drain excess rain and ground water from paved streets, parking lots, sidewalks and roofs. Storm drains vary in design from small residential dry wells to large municipal systems. They are fed by street gutters on most motorways, freeways and other busy roads, as well as towns in areas which experience heavy rainfall, flooding and coastal towns which experience regular storms

There are three principal ways to dispose of rain water from roots, courtyards and paved areas. They include storm water sewers, water soak away and collection in storage tanks. Storm sewers, which may consist of open channels, are more common in urban or densely built-up areas, and they normally serve to take the drainage from high ways as well as from buildings.

3.2.1 Discharge into Storm Water Channels or Pipes

Where a storm water pipe or ditch exists within reasonable distance of the property on a building site, the drainage from the roof and from any paved or enclosed areas must be collected and discharged into the storm water pipe or ditch. In many cases, the ditches or channels are laid alongside the road just outside the boundary of the property and are the responsibility of the highway authority, which may have its own connection requirements that should be incorporated into the plumbing code of practice.

For piped sewers, any connecting drains will need to comply with requirements similar to those that apply to drains carrying wastes to the soil sewer. The saddle or junction connection must be made under the direction of a licensed plumber or qualified person and must not obstruct the flow of the sewer or the drain. The drain itself must be laid to a self-cleansing gradient and must be properly jointed to prevent the access of tree roots or of the surrounding soil. However, the materials may not need to be of as high a quality and the drain may not need to undergo a test for water tightness.

Discharges into an open drainage channel may be through a pipe or through a subsidiary channel. Care must be taken to prevent erosion and damage to the channel lining. Subsidiary channels and pipes will usually be required to discharge in the direction of flow of the main channel at a level above that of the normal drainage flow. If the main channel is unlined and the discharge into it is through a pipe, a protective concrete apron may be required at the point of discharge. Subsidiary channels should be laid to a self-cleansing gradient, but this, together with requirements relating to diameter, may be modified according to soil conditions.

Discharges into storm water sewers or channels must not contain any human waste, sullage water or other substances that may cause a nuisance or injury to health. In tropical countries having a long dry season, small discharges, such as a drain from a single tap, may increase the risk of infestation because protozoan or other parasites may breed in shallow pools or waterlogged ground. Where a channel or drain may remain virtually dry for perhaps months at a time, small discharges may cause considerable nuisance, especially if they contain deleterious matter such as oil or grease. The authority may make special provisions to avoid this by requiring that a paved area where cars might be washed should be provided with a petrol, sand or oil trap and plate separator.

These dangers must be balanced against the desirability of dealing with clean water discharges without requiring their being connected to human waste sewers. Such instances as the drainage from air-conditioning units and of cooling water from a dairy or small industry, or the hosing down of a warehouse floor, should not call for disposal treatment, but the volume of water may be too great to be dealt with by soak-away.

3.2.2 Combined Sewers

Some sewerage authorities operate systems of combined sewers into which both sewage and rain water may be admitted. These systems were installed in the past but are not currently recommended. Combined sewers are not economical because much greater flows must be provided for in the sewers and in the sewage disposal plant. These systems are also hazardous to health because storm over-flow must be provided to handle heavy downpours. Those overflows are necessary to relieve surcharge of the system at peak flows, and they may permit untreated sewage waste to discharge into open watercourses.

Combined sewers are rarely installed today, but they are often found in congested areas of older cities where physical and financial constraints may prevent the laying of a second system of pipes to carry off rainwater. Wastewater authorities provide separate sewerage facilities for new developments, as every additional connection to a combined sewer makes its ultimate replacement more difficult and expensive.

3.2.3 Soak-away

Rain water from sloping roofs must be collected in gutters and carried to ground level by downpipes or down spouts. Flat roofs should be drained by vertical pipes and the drainage should be conveyed by pipe to a surface water sewer or to a suitable soak-away. Except when a roof is thatched, gutters and downpipes or downspouts should always be considered essential because they prevent roof runoff falling from a height in concentrated sheets or streams, which can cause erosion close to the foundations of the building. If guttering cannot be installed a concrete path or apron should be laid immediately under the caves, and should be sloped to carry the water away from the foundations.

The sizes of gutters and downpipes or downspouts will depend on the area of roof to be drained, the slope of the gutter and the intensity of rainfall expected. To insist on guttering capable of dealing with the worst storms would be unreasonably expensive in many areas, and would be of little overall benefit when the entire surrounding ground was being subjected to a downpour. The authority should calculate the average storm intensity expected and fix their standards accordingly.

Whether or not the use of soak-away is a practical option will depend to a great extent on the nature of the soil. Soak-away should be well clear of the building foundations, and should consist of holes deep enough to penetrate the subsoil, filled almost to the surface with hard material such as broken stone, concrete or brick that will not soften when wet. Where the water table is high, it may be preferable to use shallow ditches filled with hard rubble instead of soak-away pits.

3.2.4 Rainwater Tanks

When rainwater is being stored for domestic use the tanks should be of water-tight construction, covered with material that is weather-proof, insect-proof and vermin-proof, ventilated, and supplied with access for regular inspection and cleaning. There are many standards throughout the world. For more technical detail on this subject, please check your area for its standards. Rainwater storage tanks are a valuable supplement to mains supplied in arid areas and may even substitute for a mains supply. A system of gutters and collector piping must also be watertight, and the contents must be protected against pollution from dust and refuse blown by the wind, entry by birds and vermin, and mosquito breeding. If the rainwater is supplementary to a mains supply it may be lifted from the principal storage tank via a pump, from where it is piped to all fixtures. If there is no mains drinking-water supply then water for all purposes will need to be taken from the rainwater storage tank. Strict precautions should be observed in such cases to maintain the quality of the stored water. A wash-out drain tap or diverter should be included in the collector pipe so that the first washings of the roof at the beginning of the rains can be run to waste (these washings will be contaminated with bird droppings, windblown dust, etc.). It is at this time that the storage tank should be given its annual cleaning, a process that is much easier if the tank is built in two sections that can be emptied and cleaned in turn.

3.2.5 Rainwater Intensity and Roof Drainage

The variable factors in selecting the size of rainwater guttering are:

- The anticipated intensity of the rainfall
- The slope at which the gutters are to be fixed
- The area of the roof surface drained by each gutter.

From a practical point of view an upper limit of rainfall intensity must be assumed. During downpours of higher than the assumed concentration, surplus rainwater will overflow the guttering but will add comparatively little to the general deluge.

The slope of gutter will be limited by the vertical gap between the caves and the gutter at the lower end of the run. If this gap is much greater than the diameter of the channel, small discharges will be blown clear of the gutter by quite moderate winds. A slope of 1% (0.125 inch per 1 foot run) may be taken as an average, in which case a caves length of 10 metres will result in a vertical gap of 10 centimetres. Lengths well over this will require two or more vertical downspouts with consequent increase in cost.

3.3 Operation and Maintenance Scenario

Some of the key issues contributing to the poor Operation and Maintenance have been identified as follows:

- Lack of finance, inadequate data on Operation and Maintenance
- Inappropriate system design; and inadequate workmanship
- Multiplicity of agencies, overlapping responsibilities
- Inadequate training of personnel
- Lesser attraction of maintenance jobs in career planning

- Lack of performance evaluation and regular monitoring
- Inadequate emphasis on preventive maintenance
- Lack of operation manuals
- Lack of appreciation of the importance of facilities by the community
- Lack of real time field information etc.

Therefore, there is a need for clear-cut sector policies and legal framework and a clear demarcation of responsibilities and mandates within the water supply sub-sector.

It has been observed that in the case of pumping schemes, about 20 to 40% of the total annual Operation and Maintenance cost goes towards the personnel (Operation and Maintenance Staff), 30 to 50% of the cost is incurred on power charges and the balance is utilized for consumables, repairs and replacement of parts and machinery and miscellaneous charges. In most cities, the tariffs are so low that they do not even cover the annual Operation and Maintenance cost. Measures such as control of unaccounted for water (UFW) and metering of the water connections may help reduce the wastage of water and increase the revenue to the local body to the maximum extent.

Self-Assessment Exercise

1. Mention the various ways of extracting ground water
2. List the factors that affect water quality.

4.0 Conclusion

It has been shown that it is very necessary to drain excess water off pavements, parking lots, sidewalks and roofs. It is also important to maintain our sources of water supply to avoid water quality problems.

5.0 Summary

- Sources of water supply are surface water, ground water and natural water.
- The causes of water quality problem are nutrients, thermal stratification and anaerobic conditions.
- Factors to be investigated in sanitary survey are surface water and ground water.
- A storm water drainage is simply a drain or drain system designed to drain excess rain and ground water from paved streets, parking lots, sidewalks and roofs.

6.0 Self-Assessment Exercise

Explain the terms:

1. Storm water drainage and ground water.
2. State the objectives of the maintenance of water supply sources.
3. Discuss the causes of water quality problem.

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Unit 3 Fuels Used In Hotels

1.0 Introduction

In the last unit, we discussed water supply systems with regard to maintenance of sources of water supply, storm water drainage and operation and maintenance scenario. In this unit 3, we will be looking at fuels used in the hospitality industry. Any source of heat energy is termed as fuel. The term fuel includes all combustible substances obtainable in bulk. Fuel is a substance which produces a large amount of heat when burnt with oxygen or atmospheric air. Thus, the substances classified as fuel must necessarily contain one or several of the combustible elements: carbon, hydrogen, sulphur, etc. In the process of combustion, the chemical energy of fuel is converted into heat energy. Fuels are primarily used for heating purposes.

2.0 Objectives

At the end of this unit, you should be able to:
- identify the types of fuels in use in the hotel industry
- differentiate between the types of fuels
- explain the advantages and disadvantages of the types of fuels.

3.0 Main Content

3.1 Types of Fuel

3.1.1 Solid Fuels
Coal, peat, lignite, wood, coke, anthracite, bituminous.

Advantages of solid fuels

Low running costs
Solid fuel is an efficient and economical method of heating your home 24 hours a day.

The healthy option
Solid fuel heating can greatly reduce condensation, eliminating household mould often associated with 'on/off' fires. Medical research has also shown that solid fuel heating can reduce the risk of hay fever, asthma and eczema.

Homes with solid fuel heating are better ventilated than those with other forms of heating; the very use of a chimney will induce ventilation into a home drawing in fresh air and removing the 'polluted' air.

Wide range of fuels
From coal to smokeless, there is a solid fuel to suit your appliance in all parts of the country.

Convenient and easy to use
Modern pre-set controls keep your home at the desired temperature throughout the day.

Guaranteed heat
With solid fuel heating you can hold stock, ensuring that your home will be warm even in the most adverse weather conditions. Whatever the weather, you do not need to worry about supply failures or power cuts. You can even boil a kettle on a flat-top stove.

Disadvantages of solid fuels

- Their ash content is high
- Their large proportion of heat is wasted during combustion, combustion efficiency is low.
- They burn with clinker form
- Their cost of handling is high
- Their combustion operation cannot be controlled easily.
- Their caloric value is higher
- They require excess air for complete combustion
- They are dirty
- Large space is required for storage
- Require huge chimney for the gases.

3.1.2 Liquid Fuels

(Petrol, Diesel, Kerosene, Coal tar, Molasses, Spirit, Shale Oil).

Advantages
- Low excess gas is used
- It is possible to build high capacity plants for burning oil
- Storage space is small
- Handling during transportation is easy
- Liquid fuels do not deteriorate during storage
- Change in load can be suitably made
- Ash and refuse are small; they burn without forming ash and clinker.
- Operational labour is less
- System is neat and clean
- They have higher caloric value
- They are readily available
- Their flame can be controlled
- Loss of heat to chimney is low in these gases.

Disadvantages

- Heat produced is costly
- The cost is high
- Costly storage tanks can be needed.
- Greater chances of fire hazard
- They give bad odour.
- Burners: choking is possible

3.1.3 Gaseous Fuels

Methane, Coal gas, Producer gas, compressed blast furnace gas, town gas, cock oven gas, water gas, compressed butane. Gaseous fuels occur in nature, besides being manufactured from solid and liquid fuels. The advantages and disadvantages of gaseous fuels are given below:

Advantages

- They can be conveyed easily through pipelines to the actual place of need, thereby eliminating manual labour in transportation
- They can be lighted at ease
- They have high heat contents and hence help us in having higher temperatures
- They can be pre-heated by the heat of hot waste gases, thereby affecting economy in heat
- Their combustion can readily by controlled for change in demand like oxidizing or reducing atmosphere, length flame, temperature, etc
- They are clean in use
- They do not require any special burner
- They burn without any shoot, or smoke and ashes
- They are free from impurities found in solid and liquid fuels.

Disadvantages

- Very large storage tanks are needed.
- They are highly inflammable, so chances of fire hazards in their use are high.

Electricity
Some see electric cooking as a smart choice for today's energy efficient kitchen.

Advantages

- Increased productivity
- Faster preheat and recovery
- Superior, even heating
- Reduced shrinkage
- Longer service life
- Lower maintenance cost
- Reduced ventilation requirements
- Cooler working environment
- Reduced cleanup time

Other classification of fuels

- Naturally occurring/primary fuels:
- Wood, Peat, lignite, Anthracite, oils, shale, petroleum
- Prepared/Secondary/derived gas fuels:

Charcoal, semi coke, coke, coal tar, spirit, kerosene, diesel, gasoline, producer gas, water gas, compressed butane.

Good/ideal fuel

- Has low ignition point
- Has high calorific value
- Produces minimum quantity of smoke
- Should be easy to store, convenient for transportation and economic
- Has moderate rate of combustion
- Has low content of non-volatile material
- Produces no poisonous products on combustion
- Is readily and plentifully available

3.1.4 Alternative, Renewable Energy

It is no secret that alternative energy is more popular when oil and electric prices are high. Perhaps it should be popular all of the time. Environmental studies on power generation have shown that renewable energy is the most dynamic of today's global energy market. Power generators using renewable, sustainable energy sources do not burn fuels in the production of electricity, thus reducing atmosphere- harming emissions. Renewable energy sources, such as biomass, small hydro, solar, wind, geothermal, tidal energy and photovoltaic conversion systems, allow you a broader freedom of operation. The concept of alternative energy excludes fossil fuels.

Alternative energy is cleaner than fossil fuel energy, is renewable, gives you independence from foreign oil, helps control rising electric bills, and allows development of new venues in more areas. Even if you only use alternative energy as back-up during outages or peak hours, it is a good option to provide for your property.

3.1.5 Synthetic Fuel

Synthetic fuel or synfuel is a liquid fuel obtained from coal, natural gas, oil shale, or biomass. It may also refer to fuels derived from other solids such as plastics or rubber waste. It may also (less often) refer to gaseous fuels produced in a similar way. Common use of the term "synthetic fuel" is to describe fuels manufactured via Fischer Tropsch conversion, methanol to gasoline conversion, or direct coal liquefaction.

Security considerations
A central consideration for the development of synthetic fuel is the security factor of securing domestic fuel supply from domestic biomass and coal. Nations that are rich in biomass and coal can use synthetic fuel to off-set their use of petroleum derived fuels and foreign oil.

Environmental considerations
The environmental footprint of a given synthetic fuel varies greatly depending on which process is employed, what feedstock is used, what pollution controls are employed, and what the transportation distance and method are for both feedstock procurement and end-product distribution.

In many locations, project development will not be possible due to permitting restrictions if a process design is chosen that does not meet local requirements for clean air, water, and increasingly, lifecycle carbon emissions.

Sustainability
One concern commonly raised about the development of synthetic fuels plants is sustainability. Fundamentally, transitioning from oil to coal or natural gas for transportation fuels production is a transition from one inherently depletable geologically limited resource to another.

One of the positive defining characteristics of synthetic fuels production is the ability to use multiple feed stocks (coal, gas, or biomass) to produce the same product from the same plant. In the case of hybrid BCTL plants, some facilities are already planning to use a significant biomass component alongside coal. Ultimately, given the right location with good biomass availability, and sufficiently high oil prices, synthetic fuels plants can be transitioned from coal or gas, over to a 100% biomass feedstock. This provides a path forwards to a renewable fuel source and possibly more sustainable, even if the plant originally produced fuels solely from coal, making the infrastructure forwards-compatible even if the original fossil feedstock runs out.

Some synthetic fuels processes can be converted to sustainable production practices more easily than others, depending on the process equipment selected. This is an important design consideration as these facilities are planned and implemented, as additional room must be left in the plant layout to accommodate whatever future materials handling and gasification plant change requirements might be necessary to accommodate a future change in production profile.

Home fuel cell
A home fuel cell, also called micro combined heat and power (microCHP) and micro generation, is a residential-scaled energy system. A home fuel cell is an alternative energy technology that increases efficiency by simultaneously generating power and heat from one unit, on-site within a home. This allows a residence to reduce overall fossil fuel consumption, reduce carbon emissions and reduce overall utility costs, while being able to operate 24 hours a day.

Combined heat and power (CHP) fuel cells have demonstrated superior efficiency for years in industrial plants, universities, hotels and hospitals. Residential and small-scale commercial fuel cells are now becoming available to fulfill both electricity and heat demand from one system. Fuel cell technology in a compact system converts natural gas, propane, and eventually biofuels—into both electricity and heat, producing carbon dioxide (and small amounts of NOx) as exhaust. In the future, new developments in fuel cell technologies will likely allow these power systems to run off of biomass instead of natural gas, directly converting a home fuel cell into a renewable energy technology.

Uses
Most home fuel cells fit either inside a mechanical room or outside a home or business, and can be discreetly sited to fit within a building's design. The system operates like a furnace, water heater and electricity provider—all in one compact unit. Some of the newer home fuel cells can generate anywhere between 1 to 5 kilowatts (1.3 to 6.7 hp)—optimal for larger homes (370 square metres (4,000 sq ft) or more), especially if pools, spas and radiant floor heating are in plans. Other uses include sourcing of back-up power for essential loads like refrigerator/freezers, electronics/computers and wine cellars.

Deploying the system's heat energy efficiently to a home or business' hot water applications displaces the electricity or gas otherwise burned to create that heat, further reducing overall energy bills. Retail outlets like fast food chains, coffee bars and health clubs gain operational savings from hot water heating.

Environmental impacts
Because fuel cells generate electricity and heat on site, the chemical conversion of hydrocarbon fuels into energy is substantially more efficient than comparable grid-connected systems and heating by burning fuel. Fuel cells provide a significant net reduction in CO_2—about one-third lighter carbon footprint is possible when both heat and electricity are used. The system also reduces other harmful emissions produced by burning fuel at conventional power or heat generation sources. The lower carbon footprint supports many state goals and initiatives to address climate change impacts

Installation
Home fuel cells are designed and built to fit in either an interior mechanical room or outside—running quietly in the background 24/7. Connected to the utility grid through the home's main service panel and using net metering, the home fuel cells easily integrate with existing electrical and hydronic systems and are compliant with utility interconnection requirements. In the event of grid interruption the system automatically switches to operate in a grid-independent mode to provide continuous backup power for dedicated circuits in the home while the grid is down. It can also be modified to run off-the-grid, if desired.

Fuel cell and the hospitality industry
Reliable and "green" power sources are invaluable commodities in the hospitality industry because interruptions to the grid can lead to significant loss of revenue. Hotels are turning to on-site fuel cell power plants as a reliable source of base load power. Fuel Cell Energy power plants are ideal for hotel properties, as the Ultra-Clean power plants generate not only electricity for the facility, but also considerable interest from hotel guests who appreciate the "green" aspect of the plant. In addition Fuel Cell (Energy's Direct Fuel Cell) (DFC) power systems are low profile and generate little noise.

As an added benefit to the Ultra-Clean electrical power generation capabilities of the system, waste heat produced within the fuel cell can be used for the hotel's hot water or space heating needs, reducing the need for boilers or water heaters on the property. The heat can even be used to heat large swimming pools that are typical of hotel properties. Review one of Fuel Cell Energy's installation spotlights for more information.

Biofuels
A biofuel is a type of fuel whose energy is derived from biological carbon fixation. Biofuels have been around as long as cars have. At the start of the 20th century, Henry Ford planned to fuel his Model Ts with ethanol, and early diesel engines were shown to run on peanut oil.

But discoveries of huge petroleum deposits kept gasoline and diesel cheap for decades, and biofuels were largely forgotten. However, with the recent rise in oil prices, along with growing concern about global warming caused by carbon dioxide emissions, biofuels have been regaining popularity.

Gasoline and diesel are actually ancient biofuels. But they are known as fossil fuels because they are made from decomposed plants and animals that have been buried in the ground for millions of years. Biofuels are similar, except that they are made from plants grown today.

Much of the gasoline in the United States is blended with a biofuel—ethanol. This is the same stuff as in alcoholic drinks, except that it is made from corn that has been heavily processed. There are various ways of making biofuels, but they generally use chemical reactions, fermentation, and heat to break down the starches, sugars, and other molecules in plants. The leftover products are then refined to produce a fuel that cars can use.

Countries around the world are using various kinds of biofuels. For decades, Brazil has turned sugarcane into ethanol, and some cars there can run on pure ethanol rather than as an additive to fossil fuels. And biodiesel—a diesel-like fuel commonly made from palm oil—is generally available in Europe.

On the face of it, biofuels look like a great solution. Cars are a major source of atmospheric carbon dioxide, the main greenhouse gas that causes global warming. But since plants absorb carbon dioxide as they grow, crops grown for biofuels should suck up about as much carbon dioxide as comes out of the tailpipes of cars that burn these fuels. And unlike underground oil reserves, biofuels are a renewable resource since we can always grow more crops to turn into fuel.

Unfortunately, it is not so simple. The process of growing the crops, making fertilizers and pesticides, and processing the plants into fuel consumes a lot of energy. It is so much energy that there is a debate about whether ethanol from corn actually provides more energy than is required to grow and process it. Also, because much of the energy used in production comes from coal and natural gas, biofuels do not replace as much oil as they use.

For the future, many think a better way of making biofuels will be from grasses and saplings, which contain more cellulose. Cellulose is the tough material that makes up plants' cell walls, and most of the weight of a plant is cellulose. If cellulose can be turned into biofuel, it could be more efficient than current biofuels, and emit less carbon dioxide.

Self-Assessment Exercise

1. Enumerate the advantages of solid fuel.
2. State the qualities of a good/ideal fuel.

4.0 Conclusion

This unit has discussed the types and importance of fuels in the hotel industry as well as their various applications.

5.0 Summary

Fuel is a substance which produces a large amount of heat when burnt with oxygen or atmospheric air. The types of fuels are: solid fuel, liquid fuels, and gaseous fuels. Others include synthetic fuel, biofuels, home cell fuel, etc. Synthetic fuel is a liquid fuel obtained from coal, natural gas, oil shale, or biomass. A biofuel is a type of fuel whose energy is derived from biological carbon fixation.

6.0 Self-Assessment Exercise

1. What is alternative renewable energy?
2. Discus Fuel Cell in relation to the hotel industry.

3. Itemise:

a. the disadvantages of solid fuel.
b. the types of fuel.

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Unit 4 Fire and Firefighting

1.0 Introduction

In unit 3, we discussed the fuels that are used in the hospitality industry. In this unit, we shall be discussing fire and firefighting. Hotels do not highlight fire safety like they do dining facilities and similar features. Apparently, this is out of concern that references to fire safety will accentuate the negative - the possibility of a fire. But fire safety is a bona fide concern. For one thing, individual travelers have concerns about their fire safety. For another, people who arrange travel and meetings for employees or organisations may take on a liability if they neglect to confirm the level of fire safety equipment. Therefore, the issue of fire safety in hotels should be taken very seriously, and all precautionary measures put in place.

2.0 Objectives

At the end of this unit, you should be able to:

- define fire firefighting
- identify the classes of fire
- state the hazards caused by fire
- discuss firefighting, the equipment and duties of firefighting personnel.

3.0 Main Content

3.1 Classes of Fire

Ordinary combustibles
Ordinary combustible fires are the most common types of fire, and are designated **Class A** under both systems. These occur when a solid, organic material such as wood, cloth, rubber, or some plastics become heated to their ignition point. At this point the material undergoes combustion and will continue burning as long as the four components of the fire tetrahedron (heat, fuel, oxygen, and the sustaining chemical reaction) are available.

Flammable liquid and gas
These are fires whose fuel is flammable or combustible liquid or gas. The US system designates all such fires **Class B**. These fires follow the same basic fire tetrahedron (heat, fuel, oxygen, chemical reaction) as ordinary combustible fires, except that the fuel in question is a flammable liquid such as gasoline, or gas such as natural gas.

Electrical
Electrical fires are fires involving potentially energised electrical equipment. The US system designates this **Class C**; the Australian system designates them **Class E**. This sort of fire may be caused by, for example, short-circuiting machinery or overloaded electrical cables. These fires can be a severe hazard to firefighters using water or other conductive agents: Electricity may be conducted from the fire, through water, the firefighter's body, and then earth. Electrical shocks have caused many firefighter deaths.

Metal

Certain metals are flammable or combustible. Fires involving such are designated **Class D** in both systems. Examples of such metals include sodium, titanium, magnesium, potassium, uranium, lithium, plutonium, and calcium. Magnesium and titanium fires are common. When one of these combustible metals ignites, it can easily and rapidly spread to surrounding ordinary combustible materials.

With the exception of the metals that burn in contact with air or water (for example, sodium), masses of combustible metals do not represent unusual fire risks because they have the ability to conduct heat away from hot spots so efficiently that the heat of combustion cannot be maintained. This means that it will require a lot of heat to ignite a mass of combustible metal. Generally, metal fire risks exist when sawdust, machine shavings and other metal 'fines' are present. Generally, these fires can be ignited by the same types of ignition sources that would start other common fires.

Metal fires represent a unique hazard because people are often not aware of the characteristics of these fires and are not properly prepared to fight them. Therefore, even a small metal fire can spread and become a larger fire in the surrounding ordinary combustible materials.

Cooking oils and fats (kitchen fires)

Fires that involve cooking oils or fats are designated **Class K** under the American system, and **Class F** under the European/Australasian systems. Though such fires are technically a subclass of the flammable liquid/gas class, the special characteristics of these types of fires are considered important enough to recognize separately.

3.1.2 Hazards Caused by Fire

The primary risk to people in a fire is not the flames themselves, but rather smoke inhalation which, contrary to popular belief, is the most common cause of death in a fire. The risks of smoke include:

- suffocation due to the fire consuming or displacing all of the oxygen from the air
- poisonous gases produced by the fire as products of combustion
- aspirating heated smoke that can burn the inside of the lungs and damage their ability to exchange gases during respiration

To combat these potential effects, firefighters carry self-contained breathing apparatus (SCBA; an open-circuit positive pressure compressed air system) to prevent smoke inhalation. These are not oxygen tanks; they carry compressed air. SCBA usually hold 30 to 45 minutes of air, depending upon the size of the tank and the rate of consumption during strenuous activities.

Obvious risks are associated with the immense heat. Even without direct contact with the flames, conductive heat can create serious burns from a great distance. There are a number of comparably serious heat-related risks: burns from radiated heat, contact with a hot object, hot gases (e.g., air), steam and hot and/or toxic smoke. Firefighters are equipped with personal protective equipment (PPE) that includes fire-resistant clothing (Nomex or polybenzimidazolefibre (PBI)) and helmets that limit the transmission of heat towards the body. No PPE, however, can completely protect the user from the effects of all fire conditions.

Heat can make flammable liquid tanks violently explode producing what is called a BLEVE (Boiling Liquid Expanding Vapor Explosion). Some chemical products such as ammonium nitrate fertilizers can also explode. Explosions can cause physical trauma or potentially serious blast or shrapnel injuries.

Heat causes human flesh to burn as fuel, causing potentially severe medical problems. Depending upon the heat of the fire, burns can occur in a fraction of a second.

3.2 Firefighting

What is firefighting?
Firefighting is the act of extinguishing fires. A firefighter fights fires to prevent loss of life, and/or destruction of property and the environment. Firefighting is a highly technical skill that requires professionals who have spent years training in both general firefighting techniques and specialised areas of expertise.

3.2.1 Firefighters' Duties

Firefighters' goals are to save life, property and the environment. A fire can rapidly spread and endanger many lives; however, with modern firefighting techniques, catastrophe is usually, but not always, avoided. To prevent fires from starting, a firefighter's duties include public education and conducting fire inspections.

Because firefighters are often the first responders to people in critical conditions, firefighters provide many other valuable services to the community they serve, such as:

- Emergency medical services, as technicians or as licensed paramedics, staffing ambulances
- Hazardous materials mitigation (HAZMAT)
- Vehicle rescue/extrication
- Search and rescue
- Community disaster support
- Fire risk assessments.

Additionally, firefighters also provide service in specialised fields, such as:

- Aircraft/airport rescue
- Wild land fire suppression
- Shipboard and military fire and rescue
- Tactical paramedic support ("SWAT medics")
- Tool hoisting
- High angle rope rescue
- Swift water rescue.

3.2.2 Firefighting Equipment

Some firefighting equipment include:

Fire extinguishers
The fire extinguishers are classified to correspond with various kinds of fire. Colour code decides the kind of the extinguisher and corresponding function. The types of fire extinguishers include:

Water fire extinguishers
These are the cheapest and most widely used fire extinguishers. They are used for Class A fires. Not suitable for Class B (Liquid) fires, or where electricity is involved.

Foam fire extinguishers
These are more expensive than water, but more versatile. They are used for Classes A and B fires. Foam spray extinguishers are not recommended for fires involving electricity, but are safer than water if inadvertently sprayed onto live electrical apparatus.

Dry powder fire extinguishers
These are often termed the 'multi-purpose' extinguishers. They can be used on classes A, B and C fires. They are best for running liquid fires (Class B). They will also efficiently extinguish Class C gas fires, but it can be dangerous to extinguish a gas fire without first isolating the gas supply. Special powders are available for class D metal fires.

Note that when this extinguisher is used indoors, powder can obscure vision or damage goods and machinery. It is also very messy.

CO2 Fire extinguishers
Carbon Dioxide is ideal for fires involving electrical apparatus, and will also extinguish class B liquid fires, but has no post fire security and the fire could re-ignite.

Wet chemical specialist extinguisher
This is a specialist fire extinguisher for use on Class D fires - metal fires such as sodium, lithium, manganese and aluminum when in the form of swarf or turnings.

Colour coding
Prior to 1st Jan 1997, the code of practice for fire extinguishers in the UK was BS 5423, which advised the colour coding of fire extinguishers as follows:

- Water - Red
- Foam - Cream
- Dry Powder - Blue
- Carbon Dioxide (CO2) - Black

Personal equipment
The set of the personal protection equipment is given to each firefighter. The personal protection equipment primarily comprises of the protective gear like jackets, pants and boots. Generally, jacket and pant consists of the 3-layer design with the reflective stripes on heat and tear resistant shell. Boots contain the steel insole that helps to prevent firefighter's foot from getting cut by the nails and other debris.

Self-contained apparatus
One more important equipment that is a must have for firefighter is "self-contained breathing apparatus". Self-contained apparatus constitutes the canister that allows the firefighter to breathe 15 - 60 minutes, based on the level of the activity that he is involved at. This apparatus has an Alarm Safety System that gets activated after thirty seconds of the non-movement. The device also helps the firefighters to call for help if there is urgency, and they are not able to make it to the radio.

Fire truck
The fire truck is vital equipment, which generally helps in collection and distribution of water. It transports firefighters and holds their requisite equipment like first aid gear, hoses, water fittings, as well as ancillary gear.

Gear
Other kinds of gear that are used by the firefighters comprise of axes, shovels and pipe poles to actually examine ceilings and walls of buildings for the rolling fires. The firefighter as well carries around 150 feet of rope that is used to transport the equipment for search and rescue operations.

Accessories
The firefighters use various protective accessories like leather work gloves or heat resistant gloves, specialized boots, wristlets, hoods, and different types of the goggles. They also use hoses differing in sizes, ranging from one to four inches in diametre depending on circumstances.

Fire safety is implemented fully by installing sufficient number of firefighting equipment that can be relied on during fire emergency cases. The fire will ravage fast and destroy the property within minutes without any appropriate containment and extinguishing measures. Immediate action is vacating that area and prompting the people to go to safer areas outside premises.

Fire safety
Most hotels adopt policies where automatic fire detection and alarm systems are employed. These offer significant advantages in terms of speed of detection and the capacity for orderly evacuation. One of the problems faced by a hotel is the sheer diversity of its guests. There is no such thing as the standardized guest who is predictable and will respond in a very specific and uniform way in the event of a fire.

At the heart of an effective hotel fire safety strategy is an effective fire risk assessment, a point recognised in the seven good practices recommended guidelines:

- Designate a person to be responsible for fire safety in the hotel
- Maintain a fire safety register containing information relating to fire safety systems, management procedures and training
- Prepare an emergency response plan
- Ensure that every member of staff receives information, instructions and training in fire safety in accordance with their duties
- Organise a planned and documented fire evacuation drill in the hotel at least once a year

- Ensure that all the fire safety systems are regularly inspected and maintained by suitably qualified persons

Have a regular fire risk assessment carried out and act on the findings of the risk assessment.

The components of a hotel fire safety system include the following items:

- Fire sprinklers
- Smoke and fire detectors
- Duct Smoke Detectors
- Automatic alarm systems
- Connection between Air handling units and alarm systems
- Manual alarm systems (the pull-boxes you see near stairway doors and elevators)
- Fire department standpipes (the things that you see in stairways)
- Emergency lights
- The emergency egress system
- Fire Resistivity of Construction
- Exits and Exit signs
- Pressurised stairways
- Smoke control systems
- Portable fire extinguishers
- Staff emergency response plans
- Staff training
- Gas Supply Shut-off Devices
- Fire Alarm System Required Hotels/Motels
- High Rise Buildings
- Place for a Helicopter to Land.

By adopting fire safety systems that are matched to the particular requirements of a hotel and recognising that changes in the hotel design or structure may require changes in the system, hotel guests and employees alike will be better protected from the threat of fire.

Self-Assessment Exercise

1. What is firefighting?
2. List firefighting equipment

4.0 Conclusion

This unit has discussed the classes of fire and firefighting equipment. It has also explained fire safety measures and fire risk assessment procedure. It also elaborated on the duties of firefighters.

5.0 Summary

The classes of fire are ordinary combustibles, flammable liquid and gas, electrical, metal, and cooking oils and fat. Firefighting is the act of extinguishing fires. Hazards caused by fire are:

- suffocation due to the fire consuming or displacing all of the oxygen from the air
- poisonous gases produced by the fire as products of combustion
- aspirating heated smoke that can burn the inside of the lungs and damage their ability to exchange gases during respiration.

6.0 Self-Assessment Exercise

1. Discuss the classes of fire.
2. Explain the duties of a firefighter.
3. Itemise the components of fire safety system.

7.0 References/Further Reading

Borsenik, F. D & Stutts, A. T. (2009). *The Management of Maintenance and Engineering Systems in the Hospitality Industry.*(4th ed.). Wiley Service Management Series.

Goyal, N.C. & Arora, K.C. (1996). *A Textbook of Hotel Maintenance*. Delhi: Standard Publishers.

Unit 5 Heating, Ventilation and Air Conditioning

1.0 Introduction

In unit 4, we discussed fire and firefighting. In this unit, we will be looking at heating, ventilation and air conditioning. Heating, Ventilation, Air conditioning and Refrigeration (HVAC) refers to technology of indoor and automotive environmental comfort. HVAC system design is a major sub-discipline of mechanical engineering, based on the principles of thermodynamics, fluid mechanics, and heat transfer. Refrigeration is sometimes added to the field's abbreviation as HVAC and R or HVACR, or ventilating is dropped as in HACR (such as the designation of HACR-rated circuit breakers).

HVAC is important in the design of medium to large industrial and office buildings such as skyscrapers and in marine environments such as aquariums, where safe and healthy building conditions are regulated with respect to temperature and humidity, using fresh air from outdoors.

2.0 Objectives

At the end of this unit, you should be able to:

- explain heating, ventilation and air conditioning systems.

3.0 Main Content

3.1 Heating

Heating can come in two forms:

Central heating
Central heating is often used in cold climates to heat private houses and public buildings. It provides warmth to the whole interior of a building (or portion of a building) from one point to multiple rooms. When combined with other systems in order to control the building climate, the whole system may be an HVAC (heating, ventilation and air conditioning) system.
Central heating differs from local heating in that the heat generation occurs in one place, such as a furnace room in a house or a mechanical room in a large building (though not necessarily at the "central" geometric point). The most common method of heat generation involves the combustion of fossil fuel in a furnace or boiler. The resultant heat then gets distributed: typically by forced-air through ductwork, by water circulating through pipes, or by steam fed through pipes. Increasingly, buildings utilise solar-powered heat sources, in which case the distribution system normally uses water circulation.

Resistive heating
Heat can also be provided electrically by resistive heating. Here, conductive filaments are heated by the passage of electricity. This is used in baseboard heaters, portable heaters, and as backup or supplemental heating for heat pump (or reverse heating) systems.

The heat pump is a form of heating that gained popularity in the 1950's. Heat pumps can extract heat from the air or suck heat from the ground. Heat pumps work well in moderate climates. However, they tend to be more expensive than conventional heating systems and although more energy efficient, a ground extraction system is more costly.

The heating elements (radiators or vents) should be located in the coldest part of the room, typically next to the windows, to minimize condensation and offset the convective air current formed in the room due to the air next to the window becoming negatively buoyant due to the cold glass.

The use of furnaces, space heaters and boilers as means of indoor heating may result in incomplete combustion and the emission of carbon monoxide, nitrogen oxide, formaldehyde, volatile organic compounds and other combustion by-products. Incomplete combustion occurs when there is insufficient oxygen; the inputs are fuels containing various contaminants and the outputs are the harmful by-products, most dangerously carbon monoxide which is a tasteless and odourless gas that has serious adverse health effects when inhaled.

Without proper ventilation, carbon monoxide can be extremely dangerous and can vary from a small, limited amount to a lethal amount. Carbon monoxide can be lethal at high concentration, usually less than 1000 ppmv. However, at several hundred ppmv, carbon monoxide exposure can induce headaches, fatigue, nausea and vomiting. Carbon monoxide binds with haemoglobin in the blood, forming carboxyhaemoglobin, reducing the blood's ability to transport oxygen. The primary health concerns associated with carbon monoxide exposure are its cardiovascular and neuro-behavioural effects. Carbon monoxide can cause atherosclerosis; the hardening of arteries, and can also trigger heart attacks. Neurologically, carbon monoxide exposure reduces hand to eye coordination, vigilance and continuous performance. It can also affect your time discrimination.

3.2 Ventilation

Ventilation is the process of "changing" or replacing air in any space to control temperature or remove any combination of moisture, odours, smoke, heat, dust, airborne bacteria or carbon dioxide, and to replenish oxygen. Ventilation includes both the exchange of air with the outside as well as circulation of air within the building. It is one of the most important factors for maintaining acceptable indoor air quality in buildings. Methods for ventilating a building may be divided into: mechanical/forced and natural types.

3.2.1 Mechanical or Forced Ventilation

"Mechanical" or "forced" ventilation is provided by an air handler and used to control indoor air quality. Excess humidity, odours, and contaminants can often be controlled via dilution or replacement with outside air. However, in humid climates much energy is required to remove excess moisture from ventilation air.

Kitchens and bathrooms typically have mechanical exhausts to control odours and sometimes humidity. Factors in the design of such systems include the flow rate (which is a function of the fan speed and exhaust vent size) and noise level. Direct drive fans are available for many applications, and can reduce maintenance needs.

Ceiling fans and table/floor fans circulate air within a room for the purpose of reducing the perceived temperature by increasing evaporation of perspiration on the skin of the occupants. Because hot air rises, ceiling fans may be used to keep a room warmer in the winter by circulating the warm stratified air from the ceiling to the floor.

3.2.2 Natural Ventilation

Natural ventilation is the ventilation of a building with outside air without the use of fans or other mechanical systems. It can be achieved with openable windows or trickle vents when the spaces to ventilate are small and the architecture permits. In more complex systems warm air in the building can be allowed to rise and flow out upper openings to the outside (stack effect) thus forcing cool outside air to be drawn into the building naturally through openings in the lower areas. These systems use very little energy but care must be taken to ensure the occupants' comfort. In warm or humid months in many climates maintaining thermal comfort solely via natural ventilation may not be possible so conventional air conditioning systems are used as backups.

Air-side economizers perform the same function as natural ventilation, but use mechanical systems' fans, ducts, dampers, and control systems to introduce and distribute cool outdoor air when appropriate.

An important component of natural ventilation is the concept of air changes per hour (AC/hr). An air change per hour is a rate used to describe the amount of ventilation moving through an area with respect to the size of the space. AC/hr is used to determine room pressure, whether it is positive or negative. Positive pressure occurs when there is more air being supplied than exhausted and conversely, negative pressure occurs when more air is being exhausted than supplied. When contaminants are being kept out, positive pressure is occurring and when things are being kept in, negative pressure is occurring.

3.3 Air Conditioning

Air conditioning and refrigeration are provided through the removal of heat. Heat can be removed through radiation, convection, and by heat pump systems through a process called the refrigeration cycle. Refrigeration conduction media such as water, air, ice, and chemicals are referred to as refrigerants.

An air conditioning system, or a standalone air conditioner, provides cooling, ventilation, and humidity control for all or part of a house or building. The refrigeration cycle uses four essential elements to create a cooling effect. The elements are:

- Refrigerant
- Compressor
- Condenser
- Evaporator

The system refrigerant starts its cycle in a gaseous state. The compressor pumps the refrigerant gas up to a high pressure and temperature. From there it enters a heat exchanger (sometimes called a "condensing coil" or condenser) where it loses energy (heat) to the outside. In the process the refrigerant condenses into a liquid. The liquid refrigerant is returned indoors to another heat exchanger ("evaporating coil" or evaporator). A metreing device allows the liquid to flow in at a low pressure at the proper rate. As the liquid refrigerant evaporates it absorbs energy (heat) from the inside air, returns to the compressor, and repeats the cycle. In the process heat is absorbed from indoors and transferred outdoors, resulting in cooling of the building.

In variable climates, the system may include a reversing valve that automatically switches from heating in winter to cooling in summer. By reversing the flow of refrigerant, the heat pump refrigeration cycle is changed from cooling to heating or vice versa. This allows a residence or facility to be heated and cooled by a single piece of equipment, by the same means, and with the same hardware.

Central, 'all-air' air conditioning systems (or package systems) with a combined outdoor condenser/evaporator unit are often installed in modern residences, offices, and public buildings, but are difficult to retrofit (install in a building that was not designed to receive it) because of the bulky air ducts required to carry the needed air to heat or cool an area. The duct system must be carefully maintained to prevent the growth of pathogenic bacteria such as legionella in the ducts.

An alternative to central systems is the use of separate indoor and outdoor coils in split systems. These systems, although most often seen in residential applications, are gaining popularity in small commercial buildings. The evaporator coil is connected to a remote condenser unit using refrigerant piping between an indoor and outdoor unit instead of ducting air directly from the outdoor unit. Indoor units with directional vents mount onto walls, suspend from ceilings, or fit into the ceiling. Other indoor units mount inside the ceiling cavity, so that short lengths of duct handle air from the indoor unit to vents or diffusers around the room or rooms.

Dehumidification in an air conditioning system is provided by the evaporator. Since the evaporator operates at a temperature below dew point, moisture in the air condenses on the evaporator coil tubes. This moisture is collected at the bottom of the evaporator in a pan and removed by piping to a central drain or onto the ground outside. A dehumidifier is an air-conditioner-like device that controls the humidity of a room or building. It is often employed in basements which have a higher relative humidity because of their lower temperature (and propensity for damp floors and walls). In food retailing establishments, large open chiller cabinets are highly effective at dehumidifying the internal air. Conversely, a humidifier increases the humidity of a building.

Air-conditioned buildings often have sealed windows, because open windows would work against an HVAC system intended to maintain constant indoor air conditions.

All modern air conditioning systems, down to small "window" package units, are equipped with internal air filters. These are generally of a lightweight gauzy material, and must be replaced as conditions warrant (some models may be washable). For example, a building in a high-dust environment, or a home with furry pets, will need to have the filters changed more often than buildings without these dirt loads. Failure to replace these filters as needed will contribute to a lower heat-exchange rate, resulting in wasted energy, shortened equipment life, and higher energy bills; low air flow can result in "iced-up" or "iced-over" evaporator coils, which can completely stop air flow. Additionally, very dirty or plugged filters can cause overheating during a heating cycle, and can result in damage to the system or even fire.

It is important to keep in mind that because an air conditioner moves heat between the indoor coil and the outdoor coil, both must be kept just as clean. This means that, in addition to replacing the air filter at the evaporator coil, it is also necessary to regularly clean the condenser coil. Failure to keep the condenser clean will eventually result in harm to the compressor, because the condenser coil is responsible for discharging both the indoor heat (as picked up by the evaporator) and the heat generated by the electric motor driving the compressor.

Outside, "fresh" air is generally drawn into the system by a vent into the indoor heat exchanger section, creating positive air pressure. The percentage of return air made up of fresh air can usually be manipulated by adjusting the opening of this vent.

Self-Assessment Exercise

1. State the forms of heating.
2. What is ventilation?

4.0 Conclusion

This unit has discussed the heating of buildings and the different types of heating. It has also explained what ventilation is and the types of ventilation. It also discussed air conditioning and the essential elements that create the cooling effect.

5.0 Summary

Heating is often used in cold climates to heat private houses and public buildings. There are central heating, local heating and Resistive heating Ventilation is the process of "changing" or replacing air in any space to control temperature or remove any combination of moisture, odours, smoke, heat, dust, airborne bacteria or carbon dioxide, and to replenish oxygen. There are natural ventilation and mechanical or forced ventilation. The refrigeration cycle uses four essential elements to create a cooling effect:

- Refrigerant
- Compressor
- Condenser
- Evaporator

6.0 Self-Assessment Exercise

Explain the terms:

1. Heating
2. The types of heating
3. Discuss ventilation and air conditioning.

7.0 References/Further Reading

Borsenik, F. D. & Stutts, A.T. (2009). *The Management of Maintenance and Engineering Systems in the Hospitality Industry*. (4th ed.) Wiley Service Management Series.

Goyal, N.C. & Arora, K.C. (1996). *A Textbook of Hotel Maintenance*. Delhi: Standard Publishers.