



WINTER-14 EXAMINATION
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Important Instructions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.



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| Q No. | Answer | marks | Total marks |
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| 1a-i | <p>Physiological effects of electricity:</p> <p>The primary effect of electric shock is due to current actually flowing through the body. Electrical burns occur when the body completes a circuit connecting the power source with the ground. Although the resistance of dry, unbroken skin to electric current is relatively high, the amount of current necessary to kill person is small. Therefore it is necessary to exceed lethal levels of current flow, especially if the skin is broken, wet or damp with sweat.</p> <p>Four different kinds of damage can result from the passage of of an electric current through the body. First is burning close to the contact point particularly at high voltages. Second effect is that breathing becomes increasingly difficult or suffocation. The third and fourth type directly concerns the heart and may rapidly become fatal.</p> | 4 | 4 |
| 1a-ii | <p>Industrial noise is a health hazard.</p> <p>High sound levels pose serious health risk to the people who work long hours around the equipment which generate high noise levels. Hearing damage results from an exposure to loud noises over an extended period of time. Deafness and loss hearing usually occur with the high frequency sound and not be lower frequency sound. Hearing is lost as auditory nerve endings are exposed to the same frequency of sound for extended time periods. The nerves lose their ability to recover from that hostile frequency. The ability to hear that sound frequency is then decrease for ever. Hearing loss accumulates over time and can not be revers. Hearing aid assistance may be necessary.</p> <p>Legislative measures:</p> <p>1. Administrative:</p> | 2 | 4 |



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| | <p>a. Use protective devices.</p> <p>b. Do proper maintenance of equipment from time to time.</p> <p>c. If level crosses the allowable limit, take proper measures to minimize it.</p> <p>Un wanted sound is called noise. Sound levels that cause hearing loss begin at 85 db. Hearing loss occurs more quickly with louder noise. High sound levels cause serious health risks. Hearing damage results from an exposure to loud noises over an extended period of time.</p> <p>Health Hazard associated with noise: Sound waves have pressure. High frequency sound waves have greater pressure than lower frequency sound waves. This pressure pushes on the ear drum. Deafness and loss of hearing occur with the high frequency sounds. Hearing is loss as auditory nerve endings are exposed to the same frequency of sound for extended time periods. The nerve lose their ability to recover from that hostile frequency. The ability to hear that sound frequency is then decrease for ever.</p> <p>Hearing loss accumulates over time and can not be reversed.</p> | 2 | |
| 1a-iii | <p>Aspects to be considered in selecting eye protection equipment:</p> <p>Protecting eyes and faces from physical, chemical and radiation hazards are of prime importance. Selection should be made depending upon the nature of hazards involved.</p> <p>Welding shield are made up of non-flammable material, are opaque to dangerous radiation and are poor conductor of heat. Face shields protect face and neck from flying particles, chemical splashes, etc. Tinted transparent plastic shield protect against glare. The head band of the face shield should be adjustable and its design should be such that the face piece can be pushed upwards when so required.</p> <p>In face and eye protection equipment, laminated lens should never be used. The</p> | 2 | 4 |



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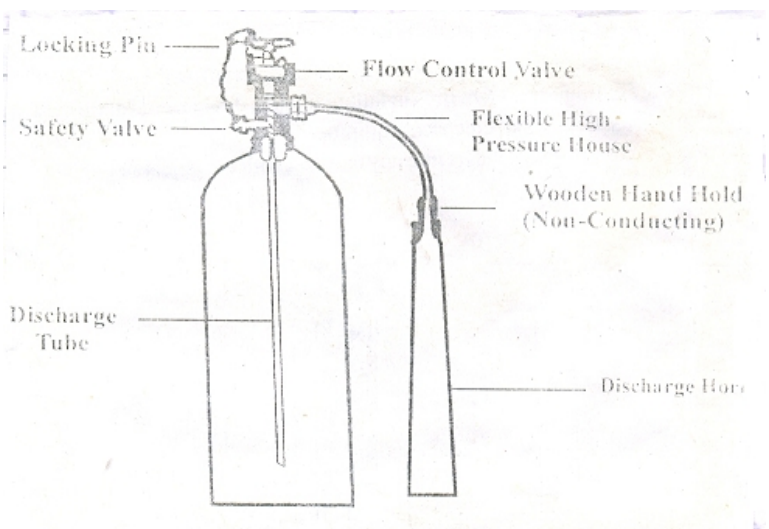
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| | most important thing in eye protective devices is that the lens, whether glass or transparent plastic, should be optically correct and completely free from flaws and distortions. These should be comfortable for wear. These should be cleaned and kept in a good state of repair regularly and all workers should be trained for proper use of such devices. | 2 | |
| 1a-iv | Maintenance of personal protective equipment: <ol style="list-style-type: none">1. The employer is obliged to maintain the equipment provided or replace equipment that becomes worn or defunct. Hard hats, being made of plastic will deteriorate over time. Their age of life expectancy will be advised by the maker so that the employer can budget and arrange to have them replaced at the end of their life.2. Some personal protective equipment is for on-off use, eg. Paper boiler suits, disposable gloves or disposable respiratory protective equipment such as face masks.3. Some equipment will have a life expectancy of a few years. If this is the case then employers should arrange for it to be adequately cleaned and sterilized so as to reduce cross infection between users.4. Non disposable equipment must be stored in adequate accommodation to protect it from deterioration, damage, or harmful effects such as damp, sunlight, fungal attacks or general abrasion. | 1 mark each | 4 |
| 1b-i | Controlling methods of toxic chemical-Cl₂ Chlorine should be stored in cool, dry, well ventilated area in tightly sealed container that are labeled. Containers should be protected from exposure to weather, extreme temperature changes and physical damage and they should be stored separately from flammable gases and vapours, combustible substances, reducing agent, finely divided metals, arsenic, boron, calcium, activated carbon, H ₂ S, SO ₂ , CO etc. | 3 | 6 |



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| | <p>To control hazards of ammonia:</p> <ol style="list-style-type: none">1. Provide information pertaining to the hazards of ammonia.2. Design and install receiving/ storage vessels according to generally accepted good engineering practices.3. Ensure that safety relief valves and relief systems for storage vessels are properly designed and installed.4. Place barriers around receiving and storage vessels and other equipment.5. Conduct a process hazard analysis.6. Provide training specific to the operation of a receiver and storage vessel.7. Maintain proper oxygen and water content in vessel to avoid stress corrosion and cracking in welds of vessels.8. Routinely inspect for corrosion of the receiving and storage vessels. | 3 | |
| 1bii | <p>CO₂ type fire extinguishers:</p>  <p>The diagram shows a CO₂ fire extinguisher with the following labeled parts: Locking Pin, Safety Valve, Discharge Tube, Flow Control Valve, Flexible High-Pressure Hose, Wooden Hand Hold (Non-Conducting), and Discharge Horn.</p> | | 6 |



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| | <p>Principle</p> <p>In CO₂ type fire extinguishers CO₂ gas is stored in the cylinder under pressure. The gas is discharged through a horn. These extinguishers are operated by removing the safety pin and operating a simple wheel valve through which the rate of discharge can be regulated. CO₂ extinguishes fire primarily by reducing the oxygen content below that which will support combustion, normally between 35 and 75% in air. There is also some cooling effect.</p> <p>Working:</p> <p>On fires involving either liquids in containers or spilled liquids, direct the jet towards the near edge of the fire and with rapid sweeping motion, drive the fire towards the far edge until all the flames are extinguished. On fires in falling liquids, direct the jet at the base of the flame and sweep upwards. On fires in electrical equipment, direct the jet straight at the fire. Where the equipment is closed, direct the jet into any opening with the object of penetrating the interior.</p> | 3 | |
| 2-a | <p>Causes of explosion hazard:</p> <ol style="list-style-type: none">1. External source of energy2. Internal exothermic reaction in which large volume of gases are produced.3. The result of the release of internal energy during an uncontrolled reaction.4. High pressure inside the vessel due to heating.5. Dust explosion | 1 mark each for any 4 | 4 |
| 2-b | <p>Factors to be considered for selection of proper respiratory devices :</p> <ol style="list-style-type: none">i) The nature of the hazardous operation or process.ii) Type of the contaminant and its properties.iii) Duration for which the protection will be needed.iv) Location of the hazardous area. | 1 mark each for any four points | 4 |



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| | <p>v) State of health of the personnel involved .</p> <p>vi) Functional and physical characteristics and limitation of the protective devices available.</p> | | |
| 2-c | <p>Objectives of Safety Audit :</p> <p>Safety audit is a proactive process by which an organization is able to continually evaluate and monitor the progress of its safety and health programs. Audits are designed to rate an organization's total safety and health program, identify its strength and weakness , show where improvement are needed , and obtain commitment and target dates for correcting problems.</p> <p>Objectives are:</p> <ol style="list-style-type: none"> 1. Confirm that safety, health, fire and environmental program activities and controls are in place and functioning. 2. Verify that the facility is in compliance with internal benchmarks and government regulations. <p>Assess past and current practices to identify and correct safety impediments which may result in personal injuries, property damage or business interruption.</p> | 2 | 4 |
| 2-d | <p>The diagrams illustrate two types of bucket elevators. The left diagram shows a bucket elevator with a 65-degree discharge angle, and the right diagram shows a bucket elevator with a 45-degree discharge angle. Labels include 'chain', 'bucket', 'feed', and 'discharge'.</p> | 4 | 4 |



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| 2-e | Class | Description | 4 | 4 |
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| | A | Fires involving ordinary combustion materials like wood , paper, cloth etc where effect of water is essential to extinguish. | | |
| | B | Fires in flammable liquids like oil, solvents, petroleum prod, varnish paint where blanketing effect in essential | | |
| | C | Fires involving gaseous substances under pressure where it is necessary to dilute burning gas at a very high rate with an inert gas or powder. | | |
| | D | Fires involving metal like Mg, Al K etc. where its burning is reacting to water and which require special extinguishing media or technique | | |
| | E | Fires involving electrical equipment where the electrical non conductivity of the extinguishing media is of prime importance | | |
| 3-a | Every employer shall take all practical steps to ensure the safety of employees while at work and in particular and shall take all practicable steps to a) Provide and maintain for employees a safe working environment; and b) Provide and maintain for employees while they are at work facilities for their safety and health; and c) Ensure that plant used by employee at work is so arranged, designed, made and maintained that it is safe for the employee to use d) Ensure that while at work employees are not exposed to hazard arising out of the arrangement, disposal, manipulation, organization, processing, storage, transport, working or use of things- i) in their place of work, or ii) near their place of work and under the employer's control; and e) develop procedure for dealing with emergencies that may arise while | | 04 | 04 |



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| | employees are at work. <i>Specific point 'Safety Act' is not mention in the curriculum of G scheme due advantage be given to examinee.</i> | | |
| 3-b | Causes of poor material handling are : i) Large number of unskilled contract labour to handle materials. ii) Bad housekeeping. iii) Over crowded floor areas with blank overhead space. iv) Badly damaged floors and narrow passages. v) Excessive loading/unloading time of jobs at the place of processing or testing. vi) Too frequent cases of rework and rejection due to handling defects. vii) Frequent breakdown of materials handling equipment. viii) Difficulties in locating things when required. ix) Evidence of spillage, wastage, customers returns. x) Too frequent and too many aisles and passages blocked. xi) Frequent cases of material mix up and assembly being supplied wrong items. | Any 4Points maybe given1 mark each | 04 |
| 3-c | Objectives of Plant Maintenance : 1. To achieve minimum breakdown and to keep the plant in good working condition at the lowest possible cost. 2. Machines and other facilities should be kept in such a condition which permits them to be used at their optimum capacity without any interruption. 3. Maintenance division of the factory ensures the availability of the machines, buildings and services required by other section of the factory for the performance of their function. | 04 | 04 |
| 3-d | Advantage of preventive maintenance : 1. Reduced break down and connected down time. | ½ mark each for | 4 |



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| | <p>2. Lesser odd time repairs and reduced over time to be maintenance work force.</p> <p>3. Greater safety for workers.</p> <p>4. Fewer large scale and repetitive repairs.</p> <p>5. Low maintenance and repair cost.</p> <p>6. Less stand by or reserve equipment and spare parts.</p> <p>7. Identification of equipment requiring high maintenance cost.</p> <p>8. Lower unit cost of manufacture.</p> <p>9. Increased equipment life.</p> <p>10. Better product quality.</p> <p>Applications of Preventive maintenance are: The preventive maintenance should be applied to key items whose breakdown seriously interrupts production and production schedule. The preventive maintenance applied for key items such as :</p> <p>i) material handling equipment such as cranes, conveyors etc.,</p> <p>ii) safety equipment such as vacuum and pressure relief valves, safety alarms etc.,</p> <p>iii) process equipment such as reactors, furnaces, pumps, compressors, etc.</p> <p>iv) water, air and fuel lines.</p> | <p>any 4</p> <p>½ mark each</p> | |
| 3-e | <p>Disadvantages of breakdown maintenance :</p> <p>1) Breakdown generally occurs at inopportune time. This leads to poor, hurried maintenance and excessive delays in production.</p> <p>2) Reduction of output.</p> <p>3) Faster plant deterioration</p> <p>4) Increased chances of accidents and less safety to both workers and machines.</p> <p>5) More spoilt material.</p> <p>6) Direct loss of profit.</p> | <p>One mark each for any four</p> | 04 |



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| 4-a-i | <p>Safety precautions in the transportation of inflammable liquids:</p> <ol style="list-style-type: none">1. Inflammable liquids shall be transported in rugged pressure resistant safety cans.2. Original containers of inflammable liquids shall be placed in an outside container or acid carrying bucket.3. Not more than five gallons of inflammable liquids in glass container shall be transported on the freight elevator unless the original shipping carton is used and the material are on an appropriate cart.4. Before transportation details of the packing requirements should be obtained from the hazard data sheet. The packing group for which the chemical belongs will decide the amount which can be transported at any one time. | 1 mark each | 04 |
| 4-a-ii | <p>The storage bins are generally classified based upon flow pattern of the bulk material discharged, as</p> <p>i) core flow (funnel flow or plug flow</p> <p>ii) mass flow and</p> <p>iii) composite flow.</p> <p>A typical mass flow bins having basic conical and plane flow shapes. Mass flow bins are characterized by a shallow angle of the converging section. Different shapes of mass flow bins are conical hopper, wedge hopper plane flow hopper and transition hopper.</p> | 03 (1 mark each) | 04 |
| 4a-iii | <p>Safety Instruction during Maintenance</p> <ol style="list-style-type: none">1. Know and obey all safety rules currently in effect, read instructions2. Follow safety rules3. Properly lock out the machine for repair and adjustment4. Never leave a machine in an unsafe condition | ½ mark each for any 8 | 04 |



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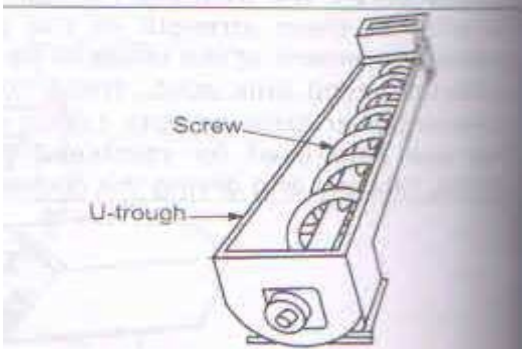
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| | <ol style="list-style-type: none">5. Prevent accidents by an active planned programme of frequent inspection and prompt preventive maintenance procedures6. Do not allow equipment to put into production until it is in good operating condition.7. Do not trouble shoot, clean, adjust or repair a machine while it is running8. Replace all guard and safety devices after maintenance work and before start up or test9. Do not allow equipment to be tested, adjusted or put into operation with a guard or other safety device removed or otherwise defeated | | |
| 4a-iv | <p>Important points to be observed for fire prevention are:</p> <p>A fire can be caused and sustained by simultaneous presence of a fuel, oxygen / oxidizer and source of heat. For prevention of fire removal of one of the causes is essential.</p> <p>Withdrawal of flammable contents, interrupting flammable flow, isolating fuel from air, heat removal to below reaction temperature.</p> <p>Withdrawal of flammable contents can be accomplished by</p> <ol style="list-style-type: none">1) Blowing down the vessel and piping contents2) Pump out or draining Flammable flow may be interrupted by the shutdown of pumps, closing of valves. <p>Isolation of flammable flow from the air is accomplished by blanketing with steam or water spray, foam, CO₂ etc.</p> | 01 01 01 01 | 04 |
| 4b-i | <p>Construction of screw conveyor:</p> <p>The screw conveyor has helical steel flights cut from flat sheet as circular rings, split on one side and with the two edges then pulled apart to form one helical section of the screw. Number of such sections are riveted together to form a continuous helix of the required length. Now a day, helicoid flight are used, which are formed by rolling a continuous strip of steel into a helix.</p> | 02 | 06 |



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| | <p>Fig. shows screw conveyor using a U-trough inside which a helical screw mounted in the bearings which are located at the ends of the trough.</p>  <p>Figure: Screw Conveyor</p> <p>Working of screw conveyor:</p> <p>In screw conveyor as screw rotates in the material to be conveyed, the flight advances horizontally into a heap of bulk solid, and thus material is lifted by wedging action. The cylindrical casing resists the rotation of the particulate material in the conveyor. Thus material advances by combination of trumbling and shearing action.</p> | 02 | 02 |
| 4-b-ii | <p>Procedure of safety Auditing :</p> <p>Safety audit is carried out by a team whose members are not involved in the plant or activity being audited. The expertise of the team should be compatible with the type of audit. It is beneficial to include the managers of other plants or units in an audit team as well as one previous auditor of the same unit. Audits are carried out in a formal way using a carefully drawn up checklist of items and descriptive standards for each item. A line manager or supervisor of the plant under audit should be asked to accompany the auditor inspecting it. He should be informed of all corrections and improvements required by the auditors so that he can start taking the necessary steps before the audit report is</p> | 6 | 6 |



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| | submitted to management. The main object of inspection should be to determine whether the layout design and condition of equipment and protective features are upto standard and to ensure that the protective features will work in an emergency. The auditing should give a verbal report to the management on completion of audit followed by a clear and concise written report within two weeks. | | |
| 5-a | <p>Dry Chemical Extinguisher System:</p> <p>These are gas cartridge type and are activated by a plunger and controlled by a simple squeeze grip action thus enabling the discharge of the dry chemical powder, generally sodium or potassium bicarbonate base or ammonium phosphate base. To operate, remove the safety clip and press puncturing lever down. This will release CO₂ gas from the cartridge and pressurize the chamber containing dry chemical. The discharge is controlled by the nozzle located at the end of the hose.</p> <p>Working :On fires involving either liquids in containers or spilled liquids, direct the jet towards the near edge of the fire and with rapid sweeping motion, drive the fire towards the far edge until all the flames are extinguished. On fires in falling liquids, direct the jet at the base of the flame and sweep upwards. On fires in electrical equipments, direct the jet straight at the fire. Where the equipment is closed, direct the jet into any opening with the object of penetrating the interior.</p> | 4 4 | 8 |
| 5-b | <p>Start up procedure of a chemical plant:</p> <p>A chemical plant is started at two different times,</p> <ol style="list-style-type: none">1. When it is constructed, erected and to be commissioned first time for production. The procedure here to be followed is to take water in the plant to check the fluid flowing through equipment and pipelines without any leakage, at the desired flow rate, pressure and temperature. | 4 | 8 |



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| | <p>If any leakage is observed, it can be rectified. This is the safest and cheapest way of checking the functioning of the plant equipment in total.</p> <p>2. When plant is stopped for annual major shutdown, then also above cited procedure is usually followed at the starting of the plant.</p> <p>Once it is assured that fluid flow takes place without any problem, the total plant water is drained off and water is removed and then slowly raw materials are taken into the process equipment. The plant is slowly loaded in stepwise and reached to desire capacity in stepwise manner. It is always advisable to operate the plant with 50% capacity for few days and after full satisfaction of plant working, it is taken up to full capacity.</p> | 4 | |
| 5-c | <p>Types of maintenance:</p> <ol style="list-style-type: none">1. Corrective or breakdown maintenance2. Scheduled maintenance3. Preventive maintenance4. Predictive maintenance <p>Predictive maintenance:</p> <p>Predictive maintenance makes use of human sense or other sensitive instruments such as audio gauges, vibration analyser, amplitude meter , pressure , temperature and resistance strain gauges etc. to predict trouble before the equipment fails. Unusual sounds coming out of a rotating equipment predict a trouble , an electric cable excessively hot at one point predict a trouble. Simple hand touch can point out many unusual conditions and thus predict a trouble. In predictive maintenance , equipment conditions are measure periodically or on a continuous basis and this enables maintenance men to take</p> | 2 6 | 8 |



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| | <p>a timely action such as equipment adjustment , repair or overhaul. Predictive maintenance extends the service life of an equipment without fear of failure.</p> <p>Four senses adopted for predictive maintenance technique (Human senses) :</p> <ol style="list-style-type: none">1. Ear :eg. Unusual sound coming out of rotating equipment.2. Eye :eg. Excessive vibration of equipment or dislocation of moving part.3. Touch :eg. Excessive temperature of equipment.4. Smell :eg. Unusual smoke coming out of equipment. <p>Four sensitive instruments adopted for predictive maintenance technique:</p> <ol style="list-style-type: none">1. Audio gauges :eg. Unusual sound coming out of rotating equipment.2. Vibration analyzor: eg. Excessive vibration of equipment3. Amplitude meter:eg. Excessive temperature of equipment.4. Pressure, temperature and resistance strain gauges: eg. Excessive temperature of equipment. | | |
| 6-a | <p>Relationship between plant layout and material handling</p> <p>Good plant layout and minimum material handling are akin to each other. Only good layout can ensure minimum material handling and as such all studies relating to problems of material handling should be preceded by study of the plant layout.</p> <p>Height of ceiling, width of floors, strength of floor and walls, column and pillars etc. to a great extent influence the choice of material handling equipment. For eg. Low ceiling height may not permit stacking of pelletized material, weak roofs limit the use of overhead conveyors and steps between two floors will not allow trucks to operate.</p> <p>Unnecessary material movement damages the material and causes loss of precious manhours in shifting materials.</p> | 1 1 1 | 8 |



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| | <p>Productive time of workers can go waste if they have to search for a tool or material. Therefore all functional areas should be clearly identified and named and separate areas for raw material, tool, work-in-process, inspection and finished goods should be clearly defined.</p> <p>Public utilities should be located in such a manner that the workmen do not need to travel over long distance to attend to their personal needs.</p> <p>Space cost money and is costly too. Machines and equipment should be located in such a manner that there is no wastage of space and at the same time enough space should be provided for future expansion.</p> <p>Alterations or modifications in the layout at the later date are usually expensive.</p> <p>In a good layout, everything is planned in a manner that duplication of movement , back tracking of materials and distortions in material flow do not take place while introducing economical material handling equipment or expanding production activities at a later date.</p> <p>A grid type of layout is essential, with roads and fire water systems at a maximum of 300 m. centre to centre, serving two sides of each major hazards.</p> <p>The road system should be parallel by pipe ways and electrical services above or below ground. Access ways between equipment which are required for operation and maintenance are available in limiting the spread of fires and should not be less than 5m. in clear width. These unit access ways are usually linked to the overall plant road system at intervals of not more than 100m.</p> | 1 1 1 1 1 | |
| 6-b | Block diagram of organization of maintenance department | 8 | 8 |



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| 6-c | <p>Preventive maintenance Scheduling involves determining calendar inspection dates that will fulfill the frequency requirements in the most efficient way. Schedules should be set in consultation with production department and as per production needs. Maintenance schedule follows similar procedure to that outlined for production. It is desirable to know time duration required for job, this helps us to plan its start. Scheduling system should be clear, precise and ease to operate. It should be based upon accurately determined time standards. It should be finalized in consultation with production department so that the equipments for maintenance purpose can be spared. It should be flexible.</p> <p>Maintenance schedule should:</p> <ul style="list-style-type: none"> Be such that the maintenance work can be carried out during lunch hours, between shifts or at week ends. | 1 | 8 |



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| | <p>Take advantage of planned stoppage such as tool change, loading and unloading of job etc.</p> <p>Plan major repairs and overhauls during holidays</p> <p>Make use of reserve plants if the need arises.</p> <p>Procedure:</p> <p>The steps are:1) preparation of master maintenance schedule 2) Preparation of detailed weekly or daily schedule.</p> <p>1. Master schedule indicates the nature and magnitude of each repair and construction task segment of maintenance for a specified time span.</p> <p>2. Considering total man hours needed for each task segment and manpower available, the distribution of job is done.</p> <p>3. A master schedule is flexible and space always exist to accommodate unanticipated task and jobs which are lagging behind schedule.</p> <p>4. Detailed schedules are prepared by breaking overall time span allocated under master schedule. Detailed weekly work schedule provides information to each craft and shop regarding the task to be carried on each job for each day in the coming week.</p> <p>5. Detailed schedule should be flexible and able to accommodate emergency jobs. It may be issued to concerned persons every day or near the week end.</p> <p>6. Maintenance schedule of each machine may be prepared and it will indicate the list of work which must be carried out together with frequency and will comprise of servicing, adjustments, lubrication details and particulars of replacement work.</p> <p>Importance of Preventive maintenance Schedule in a chemical plant :</p> <p>i) It reduces the overall cost of production</p> <p>ii) It protect man and machinery in a plant</p> | <p>1</p> <p>6</p> | |
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