ERGONOMICS

Ergonomics is defined as the science of confirming (fit or be suitable) the work place and all its elements to the worker. The word 'Ergonomics' is derived from the Greek word 'Ergon' means to work and 'Nomos' means laws or studies. Therefore, ergonomics means "work laws". In practical it consists of the scientific principles applied in minimizing the physical stress associated with the work place.

Benefits of Ergonomics

Some of the accepted benefits of ergonomics are:

- Improved health and safety for worker.
- Higher discipline or moral throughout the workplace.
- Improved quality.
- Improved productivity.
- Improved competitiveness.
- Fever, work place injuries and health problems.

ERGONOMIC TASK ANALYSIS

Task analysis can be defined as the study of what an operator is required to do in terms of action or cognitive processes to achieve a system goal.
Specific ergonomic problems are identified by conducting a task analysis of the job. National safety council recommends one or more of the following approaches for conducting a task analysis.

1. **GENERAL OBSERVATIONS**
   General observation of a worker or workers performing the task can be an effective technique for task analysis. The effectiveness is enhanced if the workers are not aware that they are being observed. While observing employees at work, especially attentive to task require manual material handling and repetitive movements.
2. **QESTIONNAIRES AND INTERVIEWS**
   This method can be used for identifying ergonomic problem. Questionnaires are easier to distribute, tabulate and analyse in short period of time but interviews generally provide more in depth information's.
3. **VIDEOTAPING AND PHOTOGRAPHY**
   Videotaping technology has simplified the process of task analysis considerably. Videotaping records the work being observed as it is done; it is silent process so it is not intrusive. If photography is used be aware that photo flash can be disruptive. High speed film will allow making photographs without flash.
4. **DRAWING AND SKETCHING**
   Making a neat sketch of a work station or a drawing showing work flow can help to identify problems. Before using a drawing or sketch make sure that it is accurate.

5. **MEASURING THE WORK ENVIRONMENT**
   Measurements can help identifying specific ergonomic problem. How far must a worker carry the material, how much does an object weight, how high does a worker have to lift the object, how often is a given motion repetitive? Answer to these similar questions can enhance the effectiveness of analysis process.
6. **UNDERSTANDING THE ERGONOMIC OF AGING**
   When identifying specific ergonomic problems in the work place a special challenges presented mainly by aging workers. Usually nearly 30% of the work force is 45 years of age or older. Organizations must be prepared to adopt work stations to employees whose physical needs are different from those of their younger ages. In adopting work stations and process for employees who are older, keep the following thumb rules in mind.
   - Nerve conduction velocity, hand grip strength, muscle mass, range of motion and flexibility all begin to diminish about age 45.
   - Weight and mass tend to increase through the age.
   - Height begins to diminish beginning age around 30.
   - Lower back pain is more common in people of 45 years age and older.
   - Visual acuity at close range diminishes with age.

ERGONOMIC PROGRAMS

Ergonomic programs are best performed by a professional ergonomist. The ergonomic team or any qualified person can use analysis program to conduct work site analysis and identify stressors in the work place. The work site analysis program is divided into four main categories.

1. Gathering information from available sources.
   - **Records analysis and tracking**
     The essential first step in the work site analysis is records analysis and tracking to develop the information necessary to identify ergonomic hazards at workplace. Existing medical, safety and insurance records should be analysed for the evidence of injuries and disorders associated with cumulative trauma disorders (CTD). Health care providers should participate in this process to track the patient records.

   - **Incidence rate**
     Incidence rate for upper extremity disorders, back injuries should be calculated by counting the incidence of CTD'S and reporting the number of each 100 full time workers per year by the facility. Incidence is calculated by using the following formula.

     $$\text{Incident rate} = \frac{Number\ of\ new\ cases\ per\ year \times 200000\ workers/facility}{Number\ of\ hours\ worked/facility/year}$$

2. Conducting baseline screening surveys to determine which job need closer analysis.

   The second step in worksite analysis is to conduct baseline screening surveys identify jobs that put employees at risk of developing CTD'S

   - **CHECKLIST**

     The survey is performed with an ergonomic checklist. This check list should include components such as posture, materials handling and upper extremity factors.

   - **ERGONOMOC RISK FACTORS**

     It includes conditions of a job process work station or work method that contribute to the risk of developing CTD'S.

   - **CTD RISK FACTOR**

     1. Repetitive or prolonged activities
     2. Forceful exertion
     3. Prolonged static postures
     4. Awkward postures of the upper body including reaching above the shoulders or behind the back and the twisting the wrist and other joints to perform task
     5. Inappropriate / inadequate hand tools
     6. Continued physical contact with work surface
     7. Excessive vibrations from power tools
     8. Cold temperatures

   - **BACK DISSORDER RISK FACTOR**

     Risk factor for back disorders include items such as the following

     1. Bad body mechanics such as the following bending over at the waist, continued lifting from below the knees from above the shoulders and twisting at waist while lifting.
     2. Lifting or moving objects of excessive weight.
     3. Prolonged sitting especially with poor posture.
     4. Lock of adjustable chairs footrests body supports in work surface at work stations.
     5. Poor grips on handles.
     6. Slippery foots.

3. Performing ergonomic job hazard analysis of those work station with identified risk factor and after implementing control measures.

   The job hazard analysis should be routinely performed by a qualified person for jobs that put workers at risk of developing CTD'S. This type of analysis helps to verify risk factors at light duty of restricted activity and at work positions.

   - **WORK STATION ANALYSIS**

     An adequate work station analysis could be expected to identify all risk factors present in each studied job or work station. Tools should be checked for excessive vibration, the tools, PPE'S and dimensions and adjustability of the work station should be noted for each job hazard analysis.

   - **LIFTING HAZARDS**

     For manual material handling the maximum weight lifting values should be calculated.

- **VIDEOTAPE METHOD**

The use of video tape were feasible is suggested as a method for analysis of the work process. Slow motion video tape or equivalent visual records of workers performing their routine job tasks should be analysed to determine the demands of the task on the worker and how each worker actually performs each task.

4. Conducting periodic surveys by taking feed backs and follow up studies to evaluate changes.

The 4th step in work site analysis is to conduct periodic preview. Periodic surveys should be conduct to identify previously unnoticed factors or failures or deficiencies in work practices or engineering controls. The periodic preview process should include feedback, follow up and trend analysis.

- **FEED BACK AND FOLLOW UP**

A reliable system should be provided for employees to notify management about conditions that appear to be hazardous and to utilize their insight and experience to determine work practice and engineering controls. This may be initiated by ergonomic questionnaire and maintained through an active and safety and health committee or by employee participation with the ergonomic team. Reports of ergonomic hazard or signs and symptoms of potential CTD'S should be investigated by screening surveys and ergonomic hazard analysis in order to identify risk factors.

- **TREND ANALYSIS**

Trends of injuries and illness related to actual or potential CTD'S should be calculated using several years of data, trends should be calculated for several departments and process units and work stations. These trends may be used to determine which work position are most hazardous and need to be analysed by the qualified person.

PREVENTING ERGONOMIC HAZARD

There are many ways to reduce ergonomic risk factors and help fit the workplace to the worker. Solutions can be grouped into three main categories: eliminate the hazard, improve work policies and procedures, and provide personal protective equipment. Often the best solution involves a combination of approaches.

1. **ELIMINATE THE HAZARD**

The most effective way to control ergonomic hazards is to eliminate the risk factors altogether. Sometimes you can change the tools, equipment, job design, or work area to remove the hazard completely. This is called using "engineering controls."

These are some examples of engineering controls:

- Redesign workstations and work areas to eliminate reaching, bending, or other awkward postures.
- Provide adjustable tables and chairs that can be used by workers with a range of sizes and shapes, and that allow neutral postures.
- Provide carts for transporting material and mechanical hoists to eliminate lifting.

- Use tools that fit the hand, have no sharp edges, and eliminate awkward hand and wrist positions.
- Change where materials are stored to minimize reaching.
- Design containers with handles or cut-outs for easy gripping.

Improving the workplace is the heart of ergonomics: changing the work to fit the worker. The design should accommodate the wide range of people assigned to the task.

2. IMPROVE WORK POLICIES AND PROCEDURES

The next most effective solution is to develop work policies, procedures, and practices that change how the job is done. This is called using "administrative controls."

These are some examples of administrative controls:

- Rotate workers among different tasks to rest the various muscle groups of the body, reduce repetition, and ease mental demands.
- Improve work scheduling to minimize excessive overtime or shift work which can cause fatigue.
- Increase staffing to reduce individual workloads.
- Provide sufficient breaks, since adequate recovery time can reduce fatigue.
- Assign more staff to lifts of heavy objects.
- Encourage proper body mechanics and use of safe lifting techniques.
- Require all loads to be labelled with their weight.
- Store heavy objects at waist height.
- Follow good housekeeping practices. Keep floors free of slipping or tripping hazards. Maintain power tools properly to reduce vibration. Keep cutting and drilling tools sharp to reduce the force required.
- Provide workers with training on safe working postures, lifting techniques, ergonomics policies and procedures, and the safe use of lifting and carrying devices.

Training is a critical element of nearly any solution and provides an important opportunity for worker participation. However, it is not a substitute for reducing risk factors and should be used in combination with engineering and administrative controls.

3. PROVIDE PERSONAL PROTECTIVE EQUIPMENT

While more permanent solutions are being found and implemented, or if you are unable to redesign the job or equipment to eliminate risks, personal protective equipment (PPE) can be used.

PPE that can help address ergonomic problems includes:

- Knee pads for kneeling tasks.
- Shoulder pads to cushion loads carried on the shoulder.
- Gloves to protect against cold, vibration, or rough surfaces.

4. ESTABLISH A COMPREHENSIVE ERGONOMICS PROGRAM

Employers should establish an ergonomics program to minimize musculoskeletal disorders. Elements of a good program include:

- Management commitment.
- Worker involvement.

- An organizational structure to get the work done, such as an ergonomics team or committee.
- Training and education of workers and supervisors.
- Job evaluation to identify risk factors.
- Hazard prevention and reduction or elimination of risk factors.
- Early detection and treatment of ergonomic injuries, and medical management of injury cases.
- A system for workers and supervisors to report ergonomic problems, symptoms, and injuries without reprisal.
- On-going evaluation of the ergonomics program.

WORK SPACE ENVELOP

Workspace is the space within which you perform the tasks that add up to your job. Physical design of a workspace includes working out how much space needed, and positioning of furniture, tools, equipment and any other items needed to perform the tasks, in respect of posture, access, clearance, reach and vision of the user.

A poorly designed workspace, or a bad arrangement of furniture or equipment, may result in injuries and strains due to adoption of uncomfortable working postures, less 'spare' capacity to deal with unexpected events or emergencies, the increased possibility of errors or accidents, and inefficiency.

A 'workspace envelope' is a 3-dimensional space within which you carry out physical work activities when you are at a fixed location. The limits of the envelope are determined by your functional arm reach which, in turn, is influenced by the direction of reach and the nature of the task being performed. Most of the things that you need to use to carry out your tasks should be arranged within this area. Workspace envelopes should be designed for the 5th percentile of the user population, which means that 95% of users will be able to reach everything placed within the envelope.

SEATED WORKSPACE

In general, the maximum work area is the area within comfortable reach of your extended arm, while the normal work area is within the limits of a comfortable sweeping movement of your arm, with your elbow bent at a right angle or less. You should also consider any potential restraint caused by clothing that you might have to wear, as well as personal factors such as age, gender (women have greater flexibility than men), and any disabilities.

The type of task being performed also affects the boundary of the workspace envelope. For tasks that require the activation of a switch, it is common to use anthropometric measurements from the fingertip reach of the users to set the envelope boundary. However, where a grasping action is involved, the reach of the user is reduced as your fist has to be clenched.

Some general principles for seated work:

- Working with relaxed upper arms and elbows at approximately 90° provides comfort and helps maintain straight wrists, which reduces the strain of repetitive tasks.
- Adjustable height work surfaces allow each user to fit the work surface to their own needs. If this is not possible, fix the work surface height to be at a level that places the working item, for example, a keyboard, at elbow height.
- Make sure that there is adequate clearance for your thighs under the work surface.
- Small users whose feet do not touch the floor when seated should have a footrest.
- For fine work, requiring better visibility, the work surface can be raised, but elbow support must be provided.

STANDING WORKSPACE

The limit of the workspace envelope for a standing user can be seen as the space in which an object can be reached and gripped comfortably, when you are standing up straight. Your arms and hands are most powerful when your elbows are close to your sides and bent at right angles or more, that is, extended slightly. The work surface should allow this kind of posture for manual work requiring strength. For precise, fine work, as well as for writing, drawing and reading, the work surface should be higher so that the elbows can be rested on it. This will also bring the work closer to your eyes.

Some general principles for standing work:

- For work that requires the application of force from the shoulder and back muscles, the work surface should be about 100-250mm lower than the level of the elbows.
- For normal tasks that do not require much strength, the worktop should be about elbow height or just below.
- For precision work, the work surface should be about 50-100mm above elbow height.
- Precision work should preferably be done sitting, when the back muscles should be supported and relieved by suitable seating and elbow support. The provision of high stools allows users to alternate between a standing and a 'perched' position.
- Adjustable height work surfaces allow each user to fit the work surface to their own needs. If this is not possible, design for the largest user, and supply platforms to those that are smaller.

VISUAL ERGONOMICS

Visual ergonomics is the multidisciplinary science concerned with understanding human visual processes and the interactions between humans and other elements of a system.

Guidelines for monitor placement and lighting at work place:

- Eye-to-screen distance: Locate the monitor at least 25 inches from the eyes, preferably more.

- Vertical location: Locate the entire viewing area of the monitor between 15° and 50° below horizontal eye level.
- Monitor tilt: Tilt the monitor back so that the top is slightly farther away from the eyes than the bottom.
- Lighting: Ceiling suspended indirect lighting. Control outside light with blinds and shades. Keep ambient light levels low and supplement with task lighting.
- Screen colours: Dark letters on a light background.
  Fig 1 shows Visual Ergonomics in the Office and Fig 2 shows Horizontal line of sight and preferred viewing area.

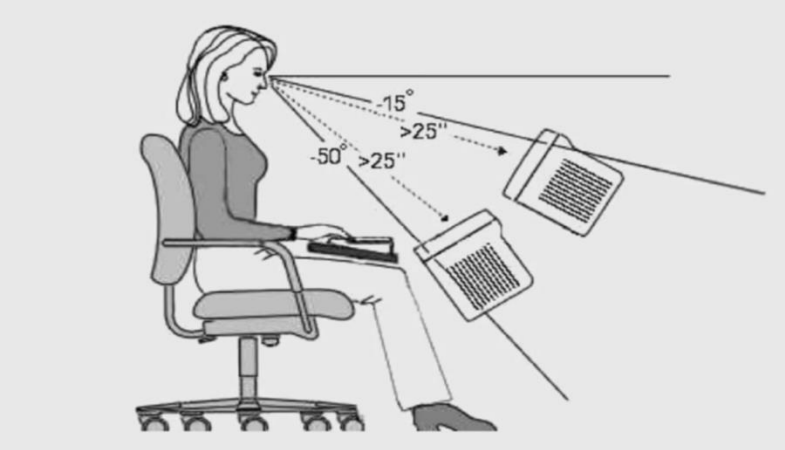


Fig 1: Visual Ergonomics in the Office

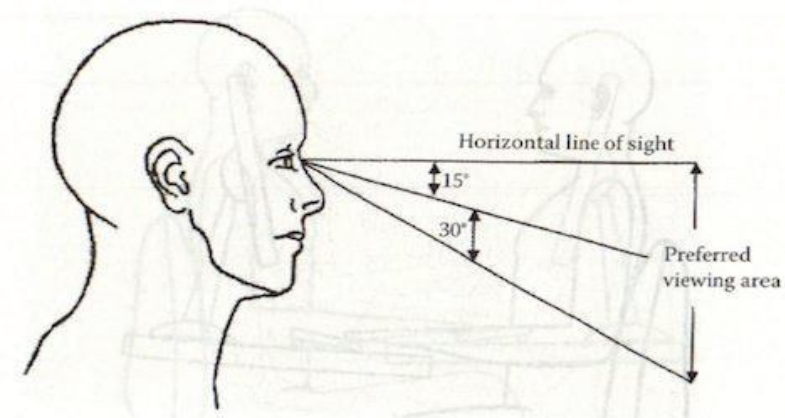


Fig 2: Horizontal line of sight and preferred viewing area.

HAZARD COGNITION AND ANALYSIS

Hazard can be defined as a work place condition which exists or can be caused in combinations with other variables, which has the potential for accidents, serious injuries, diseases or property damage.

Cognition is the mental action or process of acquiring knowledge and understanding through thought, experience and the sense.

Analysis is a detailed or systematic examination and evaluation of data or information. Analysis is a careful study of all components of a work system. In order to detect problems and then to understand the relationship between the system and the problem, in order to eliminate the problem and its potential consequences. There are two reasoning procedure used in the analysis they are.

1. Inductive reasoning
2. Deductive reasoning

Inductive reasoning is based upon observed phenomenon such as failure of machine or worker or combinations. Whereas, deductive reasoning is based upon an undesirable event, then working backwards to identify specific components or actions which might cause the event. The analysis made by following methods.

- Preliminary Hazard Analysis (PHA)
- Failure mode effect analysis (FMEA)
- Hazard and operability review (HAZOP)
- Human Error Analysis (HEA)
- Fault Tree Analysis (FTA)

PRELIMILARY HAZARD ANALYSIS (PHA)

It is a hazard review conducted all information is not necessarily available for a system. This may enables recognize hazards early; it serves as a guide for more in depth analysis. As more information becomes available PHA focuses on about the process, product or change. It often consists of formulating a list of hazard which might be related to materials, plant, equipment's, work environment maintenance and safety equipment's etc. PHA depends on the experience and expertise of the staff members involved. A team should be involved rather than a single person, to avoid biased errors each team members should have a basic knowledge of intentions and effects of possible deviations. PHA can often serve to provide check lists for formal safety review committee to examine many complex systems on a routine basis and to provide guidelines for future PHA'S.

FAILURE MODE EFFECT ANALYSIS (FMEA)

Failure modes and effects analysis (FMEA) is a step-by-step approach for identifying all possible failures in a design, a manufacturing or assembly process, or a product or service.
"Failure modes" means the ways, or modes, in which something might fail. Failures are any errors or defects, especially ones that affect the customer, and can be potential or actual. "Effects analysis" refers to studying the consequences of those failures. Failures are prioritized according to how serious their consequences are, how frequently they occur and how easily they can be detected. The purpose of the FMEA is to take actions to eliminate or reduce failures, starting with the highest-priority ones.
Failure modes and effects analysis also documents current knowledge and actions about the risks of failures, for use in continuous improvement. FMEA is used during design to prevent failures. Later it's used for control, before and during on-going operation of the process.

Ideally, FMEA begins during the earliest conceptual stages of design and continues throughout the life of the product or service.
Begun in the 1940s by the U.S. military, FMEA was further developed by the aerospace and automotive industries. Several industries maintain formal FMEA standards.

When to Use FMEA

- When a process, product or service is being designed or redesigned, after quality function deployment.
- When an existing process, product or service is being applied in a new way.
- Before developing control plans for a new or modified process.
- When improvement goals are planned for an existing process, product or service.
- When analysing failures of an existing process, product or service.
- Periodically throughout the life of the process, product or service.

HAZARD AND OPERABILITY REVIEW (HAZOP)

The HAZOP has been widely adopted by chemical processing plant identify operation problem. It was originally developed to anticipate hazards and operability problems for new process was past experience were limited but have been found to be helpful in every stage.
HAZOP concepts are simple using brainstorming technique for a multi-disciplinary team with 5-7 members. The purpose of brain storming is the generation of ideas. A HAZOP requires detailed planned and equipment description as well as full understanding of the process and controls, therefore team members must be experts of that area. Each team members is provided with a set of blueprints of equipment's flow sheets and equipment's manuals. The most common approach for HAZOP review is guide word approach which is recommended by AICHE (American Institute of Chemical Engineers) the guide words are given in the following table.

GUIDE WORDS	MEANING
NO	Negation of the designed content
LESS	Quantitative decrease
MORE	Quantitative increase
PART OF	Qualitative decrease
MORE OF	Qualitative increase
REVERSE	Logical opposite of the intend
OTHER THAN	Complete substitution

These guide words are related to operation of a specific component in the system or specific part of an overall operation. A node is a study point in the process or designed where potential deviations and there causes and effects can be examined. The HAZOP review defines the purpose objectives and scope of study and selections of team. Team leader and record and communicate the results to manager.

HAZOP procedure in step by step manner these steps are summarised as follows:

- Select the process or system to be analysed.
- Form the team of experts.
- Explain the HAZOP Process to all team members.
- Establish goals and time frames.
- Construct brain storming session.
- Summarize all inputs in the HAZOP form.

HUMAN ERROR ANALYSIS

Human Error Analysis provides a systematic method of considering the possible errors and other human failures that may occur when performing a task. Human error analysis is used to predict human error and not as a fact after the process. Although records of past accidents can be studies to identify trends that can or in turn be used to predict accidents. HEA should be used to identify hazards before they cause accidents. Two approaches HEA are:

i) Observing employee's at work and noting hazard (Task analysis approach).
ii) Actually performing job task to get a first and feel for hazards.

Regardless of how HEA is conducted it is good idea to perform it in conjunction with FMEA and HAZOP; this will enhance the effectiveness of all processes.

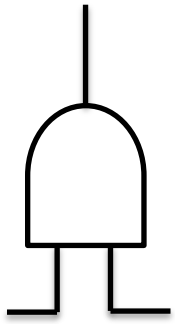
FAULT TREE ANALYSIS (FTA)

A Fault tree analysis is a deductive reasoning method that focuses on one particular event and provides a method for determining basic cause of that event. This method is used to identify combinations of equipment failures and human errors that can result in accident or an initiating event. FTA allows the safety analyst to focus on preventive measures on these basic causes to reduce the probability of an accident.

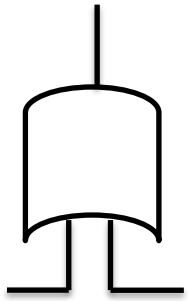
Symbols used in fault tree construction

Top Event (Accident/ Incident)

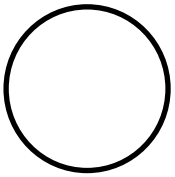
Sub-Event (a fault) caused by a combination of contributing event



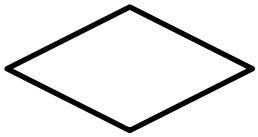
AND gate- the output exists only if all the inputs are present simultaneously



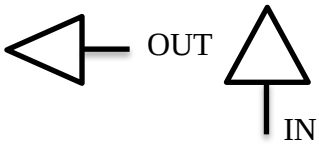
OR gate- the output exists if any (any combinations) of the inputs are present



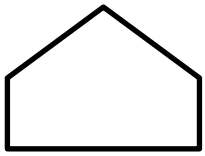
Basic cause (root cause) by a component failure or human error for which a Probability can be assigned.



A fault that is not developed further due to lack of information or due to less importance.



Transfer events- these symbols are used to transfer an entire part of the tree to other locations on the tree.



House event- this symbol represents a normal event (not a fault condition)

There are four steps in performing the fault tree analysis:

1. Problem identification.
2. Fault tree construction.
3. Fault tree solution (determining minimal cut sets).
4. Minimal cut set ranking.

1. **Problem identification** – This consists of a) defining accident event-top event of the fault tree analysis b) defining analysis boundary including an allowed event, systems physical boundary, level of resolution, other assumptions.
2. **Fault tree construction –** It begins with the top event and proceeds level by level using symbols viz. "OR" "AND" etc. until all the fault events have been developed to their basic contribution cause.
3. **Fault tree solution –** The completed fault tree provides us information by displaying the interactions of the equipment failures that could result in an accident. The matrix system of analysis gives the minimal cut sets, which are useful for ranking the ways in which accident may occur, and they allow quantification of the fault tree if appropriate failure data are available.
4. **Minimal cut set ranking –** "Minimal cut set analysis" is mathematical technique for manipulating the logic structure of a fault tree to identify all combinations of basic events that result in occurrence of top event. The ranking of minimal cut sets is the final step for the fault tree analysis procedure. The basic events called the "cut set" are then reduced to identify those minimal cut sets which contain the minimal sets of events necessary and sufficient to cause the top event. Ranking may be based on number of basic events that are minimal cut set example one event minimal cut is more important than three event minimal cut set and so on. This is because of the chance of occurrence of one event is more than of two event to occur. Moreover, the human error is ranked at top, then the active equipment failure, then passive failure.

EXAMPLE

The figure below shows the process of fault tree analysis. The top event must be carefully selected and properly defined because the entire tree stems from this single event. When constructing fault tree, proceed through levels of faults events which must take place alone or in combination to cause the top event, ending with most basic contributing causes. At each level describe precisely what event is and when it occurs. Fault tree should be completed in levels and each level should be completed before beginning the next level.

The below examples depicts that causes B1,B2,B3,B4 and B5 are the basic events, which can lead to top event T, which is "No light in room on demand" and the mathematical expression for the top event is

T=G1'G2

= (B1+B2)' (B3+B4+B5)

= B1B3+B2B3+B2B4+B1B5+B2B5 (6 minimal cut characters)

This indicates the occurrence of either of basic events B1 or B2 along with occurrence of any of the basic events B3, B4 and B5 would lead to top event T.

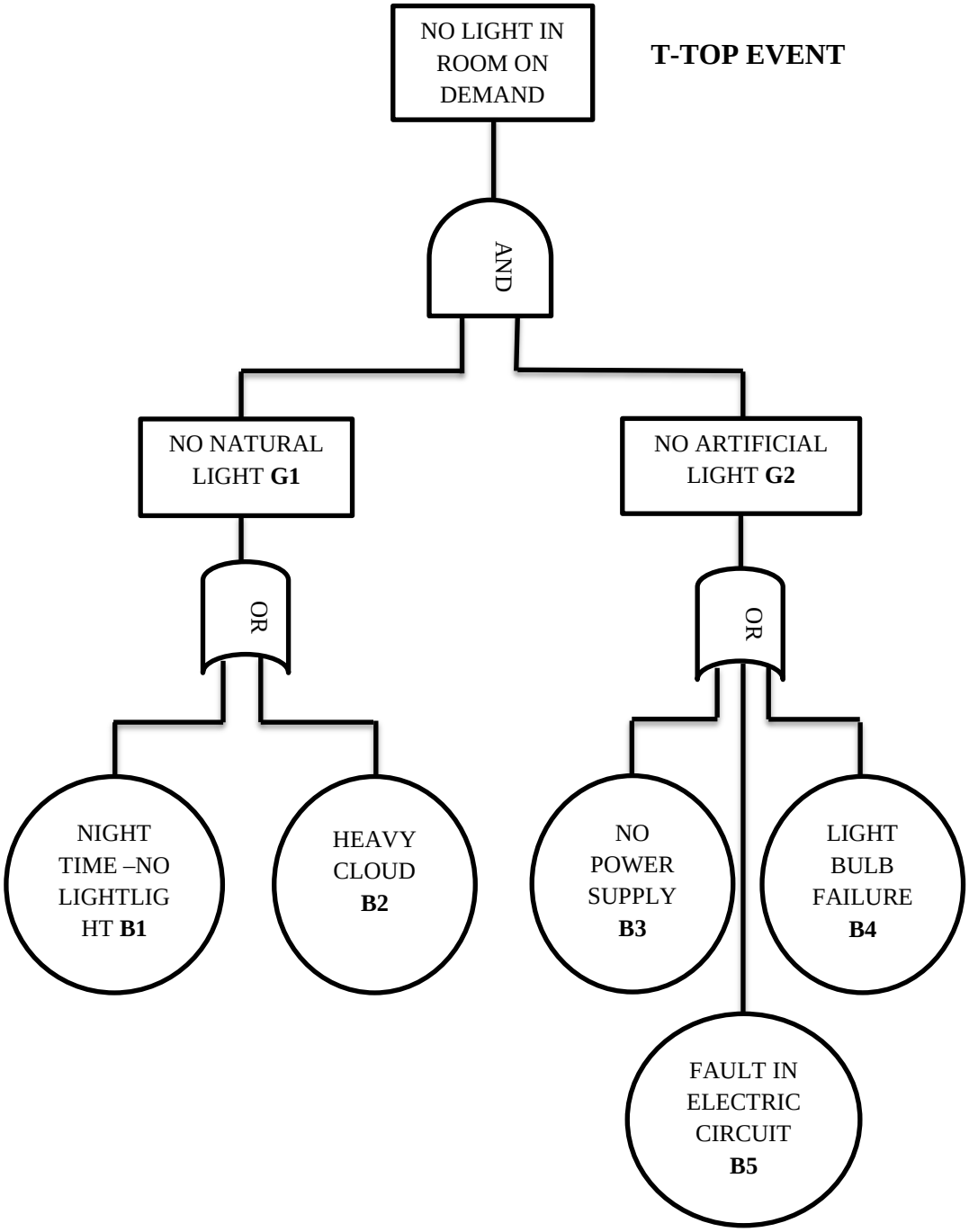


Fig: Flow sheet showing fault tree analysis

EMERGENCY ACTION PLAN

An Emergency Action Plan should have at least the following elements i.e. alarm systems, evacuation plan, a mechanism or procedure for emergency shutdown of the equipment and a procedure for notifying emergency response personal.

EMERGENCY RESPONSE PLAN (ERP)

Companies that opt to respond internally to chemical spills must have an emergency response plan that includes the provision of comprehensive training of employees, OSHA'S standard (29 CFR 1910.120) specifies the type and amount of training required ranging from awareness to in depth technical training for employees who will actually deal with the spill. It is important to note that OSHA refuses to allow the involvement of untrained employees responding to a spill.

ERP is a network system which focuses on emergency centred centres (ECC), the incident controller (IC) and incident site (IS). Personal of emergency response team are:

1. Site main controller (SMC): The top executive in charge of the unit (ECC).
2. Incident controller (IC): Shift in charge.
3. Deputy Incident controller (DIC): Shift person next to incident controller.
4. Essential work men (EWM): Are the shift people from various departments.
5. Other key persons: Includes heads of various departments.

The above personnel will be the people who monitor the emergency plan at the work place. In case of emergency or any incident takes place above personnel will take care of the situations.

The requirement of emergency response plan includes:

1. Emergency organisation / unit.
2. Scenario vulnerability zone and consequences.
3. ECC the locations sirens, assembly points escape evacuation and rescue, first AID, medical and transport faculties.
4. Declaration of emergency and communication system.
5. Check list sequence of emergency shutdown.
6. Atmospheric stability condition and wind velocity orientations.
7. Site and areas map.
8. Roles and responsibilities of essential persons.

DECISION FOR ACTION

In hazard control the first step is hazard identification then this should be communicated to management with recommendation. These recommendations should improve risk assessment, task assessment and alternative solutions. There are 3 basic decisions management can make after reviewing the information and recommendations, i.e., they can do nothing, take action to modify the work system or take action to redesign the work system. The easiest choice is to

do nothing because doing nothing may also be correct when the remedy cannot be finalised. The cost of remedial action is normally associates with the level of risk. For example: Remedial action for low risk hazards is expensive because they occur frequently; on the other hand the costs are also high for high risk hazard because the injuries can be severe. When hazard is identified action is necessary weather the management decides to eliminate it entirely or simply reduces the chance of it causing an incident. Re-design is usually a long term and expensive decision which often involves the purchase of new and safer equipment's. It is important that emphasis given for the modification of the work system because this is the way to control the impact of hazard.

QUESTION BANK

1. Define the term ergonomics and discuss its benefits at work place.
2. What is task analysis? Explain the process of ergonomic task analysis.
3. Write a brief note on preventing ergonomic hazard.
4. What is work space envelop? Explain in brief about sitting workspace and standing workspace.
5. Write short notes on Visual ergonomics and its need at work place.
6. Explain in detail about ergonomic standards and ergonomic programs.
7. Briefly describe the following hazard analysis methodology
   i. Hazard and operability review (HAZOP)
   ii. Fault tree analysis (FTA)
   iii. Human error analysis (HEA)
   iv. Failure Mode Effect Analysis (FMEA)
8. Discuss the application of fault tree analysis method with an example.
9. Explain the process of emergency response plan and decision for action.