SAFETY MANUAL

NHPC Limited
(A Government of India Enterprise)
एन एच पी सी लिमिटेड
(भारत सरकार का उद्यम)

NHPC LIMITED

FARIDABAD

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Prepared BY

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- National Safety Council

C O N T E N T S

INTRODUCTION

As per E No. CEA/TETD/MP/R/02/2011- In exercise of the powers conferred by section 177 read with clause (c) of section 73 of the Electricity Act, 2003 (36 of 2003), The Central Electricity Authority makes the following regulations, namely:-

These regulations may be called the Central Electricity Authority (Safety Requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines) Regulations, 2011.

Safety provisions relating to Owner-

The owner shall make safety an integral part of work processes to ensure safety for employees including employees of contractor, sub-contractor as well as visitors.

The owner shall obtain accreditation of electric plants and electric lines with IS-18001 certification.
The owner shall obtain above mentioned certification for all the existing electrical plants and electric lines and those under construction within two years from the date of coming into force of these regulations and for new installations within two years from the date of commencement of construction.
The owner shall set up a sound and scientific management system which shall include –

Preparing detailed safety manual complying with the statutory requirements and manufacturers' recommendations;

Safety manual referred to in clause (c) of sub-regulation (4) of regulation 4 shall be site specific but for similar installation, common safety manual may be prepared and made applicable to such installations and these safety manuals shall cover the matters identified in schedule-I and schedule-II annexed to these regulation.

The intent of this safety manual is to prepare a responsible and workable safety document to safely execute NHPC's project and operation scope. Employees (and contractors) of NHPC have the right to expect that they will be provided with a safe place of work.

It is also NHPC's practice and responsibility to follow operating policies that will safeguard all employees (and contractors) and result in safe working conditions and efficient operations

These safety procedures have been drawn up to ensure that the working environment of the Company's operations is effectively controlled.

The procedure thus established in this safety manual shall become standard operating practice at all NHPC's Engineering and Construction projects throughout the country and will be applicable to all NHPC employees and their sub-contractor employees.

General Safety Rules

It is forbidden to bring on site, firearms or unauthorized explosives.

It is forbidden to possess or consume alcohol, drugs or other intoxicants on site or to be under their influence such that the safety of work is jeopardized.

Safety devices (such as: Valves, Hatches, LOTO devises ect.) must not be interfered with. These can only be modified or bypassed with approval of authorized NHPC personnel.

It is prohibited to indulge in horseplay, fighting or malicious damage.

Smoking is forbidden other than in designated areas identified by smoking permitted signs.

Approved eye protection, safety helmets and foot protection must be worn at all times except in areas designated by NHPC.

Safety equipment will be used as specified by work permits, procedures and operating area notices.

All equipment must be used in accordance with manufacturer's instructions, applicable procedures, and/or good engineering practice.

The rules applying to the wearing of breathing apparatus must be strictly complied with and equipment worn only by trained personnel.

Drivers of vehicles must obey the road signs and site traffic rules.

Seat belts must be worn at all times when ridding in or operating any vehicle equipped with them.

No one shall be permitted to ride on any flat bed truck or trailer.

Applicable laws, regulations, permit conditions and written procedures must be followed.

Road closure and barricade notices must be obeyed.

Equipment will be operated or repaired only by competent personnel.

Incorrect or faulty tools must not be used and, when identified, tagged out of service and removed from the site.

Upon entering or leaving operating areas, personnel must report to the Site Security Checkpoint.

CHAPTER 1: NHPC INTEGRATED MANAGEMENT SYSTEM POLICY

As per E No. CEA/TETD/MP/R/02/2011- In exercise of the powers conferred by section 177 read with clause (c) of section 73 of the Electricity Act, 2003 (36 of 2003), The Central Electricity Authority makes the following regulations, namely:-

The owner shall set up a sound and scientific management system which shall include:

Formulation of a written statement of policy in respect of safety and health of employees;

Policy Statement

OUR AIM

A world class, diversified & transnational organization for efficient development of power in all aspects through conventional and non conventional sources in India and abroad with strong environment conscience and Occupational Health & Safety measures and to establish, maintain and continually improve Integrated Management System with a focus on Quality, Environment and Occupational Health & Safety.

OUR COMMITMENTS

Quality towards all Stakeholders, Safety for all Human lives involved, being Environment friendly and meeting all applicable legal and other requirements.

OUR ENDEAVOUR

To make optimum gestation period for projects with Quality consciences, Cost effectiveness, Optimum utilization of natural resources & effective Occupational Health & safety system by adopting best Practices/Tech niques to maintain in a leading position in Power Sector

The Company gives its full support and commitment to all employees to achieve the objectives of this Policy.

CHAPTER 2: SAFETY ORGANIZATION

As per E No. CEA/TETD/MP/R/02/2011- In exercise of the powers conferred by section 177 read with clause (c) of section 73 of the Electricity Act, 2003 (36 of 2003), The Central Electricity Authority makes the following regulations, namely:-

Safety Officer

The owner shall appoint one qualified safety officer where the number of employees, including contract workers, exceeds five hundred, a suitable officer shall be designated as safety officer:

Provided that where number of employees exceeds one thousand one more safety officer shall be appointed for every additional one thousand employees. A person shall not be eligible for appointment as a safety officer unless he is qualified –

(i) under section 40-b of the Factories Act, 1948 (63 of 1948) and rules made thereunder; o

(ii) under sub-section (2) of sections 38 of the Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 (27 of 1996) and rules made thereunder.

Where number of safety officers appointed exceeds one, one of them shall be designated as chief safety officer who shall have higher ranking than the others and he shall be in-charge of the safety functions and the other safety officers shall work under his control. The chief safety officer or the safety officer, as the case may be, shall be give the status of a senior executive and he shall work directly under the control of the chief Executive.

The safety officer shall be appointed before start of construction activities and the safety set-up chart shall be prepared and properly displayed at a conspicuous place.

Electrical safety officer

All suppliers of electricity including generating companies, transmission companies and distribution companies shall designate an Electrical Safety Officer for ensuring observance of safety measures specified under these regulations in their organization for construction, operation and maintenance of power stations, sub-station, transmission and distribution lines.

The Electrical safety officer shall be an Electrical Engineering degree holder with at least ten years of experience in operation and maintenance of electricity plants or an Electrical Engineering Diploma holder with at least fifteen years of experience in operation and maintenance of electrical plant.

The electrical Safety Officer designated under sub-regulation (1), shall ensure periodic inspection of such records shall be made available to the Electrical Inspector if and when required.

For every factory registered under Factory Act, 1948, where more than 250 kw of electrical load is connected, the management of the factory shall designate a person having qualification specified in sub-regulation (2), for ensuring the observance of the safety provisions laid under the act and the regulations made thereunder, who shall periodically

inspect such installation get them tested and keep a record thereof and such records shall be made available to the electrical Inspector if and when required.

Safety Committee

Where the number of employees, including contract workers exceeds two hundred and fifty, the owner shall constitute a safety committee comprising of equal number of representatives of the management and the employees and during construction, the safety committee shall also include representative of contractors and their employees with equal representative and the representatives of the management shall include the safety officer and medical officer:

Provided that where number of employees, including contract workers, is two hundred and fifty or less, the safety committee shall be constituted by the owner for a group of electrical plants or electric lines, as the case may be.

The safety committee shall promote co-operation between the workers and the management for maintaining proper safety and health at work place.

The safety committee shall meet at least once in a month during construction stage and once in three months during operation and maintenance of electrical plants and electric lines and the decisions and recommendations of the safety committee shall be complied with by the owner within the time limit as decided by the safety committee. The main function of Safety Committee is:

To identify probable causes of accident and unsafe practices in the building or other construction work and to suggest remedial measures.

To develop interest of employer and building workers in safety organizing safety weeks, safety competitions, talks and other safety promotional activities such as film shows on safety, preparing safety posters or taking similar other measures at regular intervals.
To take construction site rounds with a view to detect unsafe acts and conditions and to recommend remedial measures for their rectification. Also the availability of necessary first aid, medical and welfare facilities shall be checked for their adequacy and orderliness.
Identifying workers not using protective devices or required safety measures and report to the Safety Officer and respective department for necessary action to look into the health hazards associated with handling different types of explosives, chemicals and other construction material handled at site and compatibility of personal protective equipment used.

To suggest measures for improving welfare amenities in the construction site and other worksite aspects of safety, health and welfare.

The Committee will bring to the notice of construction manager / in-charge the hazards observed related to use, handling and maintenance of equipment at construction site.

The Safety Committee shall hold monthly meetings chaired by a senior person of site having overall control to discuss over the safety issues and recommend time bound implementation plan with duties assigned to respective responsible persons engaged at site.

CHAPTER 3: RESPONSIBILITIES OF EMPLOYEES

General Responsibilities

NHPC Management and NHPC site personnel will ensure that site conditions within their scope of work conform to the safety requirements.

It is the responsibility of all site personnel; Contractors and Subcontractors to act in accordance with the procedures and policies described in the site safety manual and Customer requirements. Individuals who are found to be in violation of these procedures and policies may have action taken against them up to and including removal from the project site. Safety responsibilities for specific positions are described in the following subsections.

NHPC shall have the right to stop work or any activity that, in its opinion, may impact the safety of employees or the environment. Review by NHPC of any aspect of the Contractor's program, plans or activities shall not relieve the Contractor of their obligation to fully meet the requirements of applicable law and these requirements.

Project Manager/General Manager

Ensure adequate and suitable resources are allocated to the project to enable the project to be completed, while complying fully with the requirements of this safety plan, and all applicable regulatory requirements.

Ensure that a Safety Plan is prepared or approved by the Project Safety officer for the project.

Consult the Project Safety officer whenever an EHS or compliance issue requires resolution (including shipping and receiving of hazardous materials). Also ensure that the resolution of any issues are incorporated into the Site safety plans and communicated to site personnel.

Ensure that all potential contractors have been approved and receive a copy of this safety plan before they submit an offer for work to be completed on site.

Safety Officer

The safety officer shall advise and assist the owner in fulfillment of his responsibilities concerning prevention of personal injuries and maintaining a safe working environment.

The safety officer shall be authorised to stop the execution of any work which in his judgment is unsafe and may result in injury to any person and he shall also have the power to remove the employees or contract workers from the site, if they are found not using personal protection equipment or in unsafe practice or procedure.

The safety officer shall develop and organize safety training programmes at regular intervals in order to impart proper safety training and shall also create safety awareness among the employees.

Develop a Project Safety Plan, or approve a plan developed by others. The Plan shall be Project specific. Moreover, the plan will identify all safety requirements that need to be implemented to ensure compliance with applicable regulatory requirements.

Prepare an Audit schedule for the project, and ensure audits are carried out by appropriately trained persons, with the knowledge and experience required to identify compliance issues. Where applicable, document the inspections in accordance with the defined standards.

Advise and assist in the investigation of serious accidents and dangerous occurrences. Where required assist in the reporting of all such cases to regulatory agencies. Liaise with the representatives of enforcement agencies.

Provide EHS support to the Project Manager, Site Manager, Site Safety Representative, and other project staff as required.

Establishing a fire prevention programme, supervising and training a fire brigade. Approve suitably qualified Site safety representatives.

Site Manager/Chief Engineer

Ensuring implementation of this project safety plan and updates are implemented to the plan, as changes and working practices require. Ensure all works, acts and emissions on site under the responsibility of NHPC, comply fully with all applicable regulatory requirements.

Correct or cause to have corrected, noted or reported any EHS deficiencies. Insure Persons under the control of NHPC or Contractors are not assigned tasks, or asked to operate equipment; they are not trained or competent to undertake.

Coordinate all activities with Contractors/Subcontractors on the project site. Ensure implementation and execution of the Lock Out Tag-Out (LOTO) program, including training, development and revision of procedures, and periodic auditing of program compliance.

Ensure all work on site only proceeds when required Job Safety Analysis/Risk assessments have been completed, and reviewed by a competent person and communicated to those who can be impacted by the hazards identified. Ensure all staff and visitors have the required safety orientation training.

Support or participate in the investigation of all accidents and reportable occurrences. Ensure adequate facilities, procedures and trained personnel are available for all foreseeable emergencies.

Ensure all personnel under NHPC control wear all required PPE for the environment they are in and the tasks they are performing.

As applicable to site activities, support obligations to protect adjacent property, ensure safety of third party employees, and ensure the safety of the public.

Require NHPC/Contractor and Subcontractor superintendents and job foreman to be thoroughly familiar with the provisions of the locally applicable safety and health regulations for construction and have access to up-to-date regulations. Not knowingly permit any

construction means, methods, techniques, or activity which compromises safety and health in the workplace.

Take responsibility for the project's environmental performance and ensure that all operations comply with NHPC environmental policies and all relevant regulatory requirements.Where applicable, personally deliver a Weekly Safty Communication to employees under their supervision.

Where applicable, ensure Weekly Safety Inspections are conducted and documented in accordance with the standard checklist.

Enforce the Project Safety Program including documentation of disciplinary actions taken for violations of established rules, regulations, procedures, and programs.

Site Safety Representative Responsibilities

Coordinate the NHPC site safety programs and assist the Site Manager in implementing the Site safety plan.

Conduct frequent and regular scheduled safety inspections of NHPC / Contractors / Subcontractor's construction activities to monitor compliance with there own EHS program, applicable regulations and the Project safety. The Weekly safety inspection will be scheduled, completed, and documented.

Issue a work stoppage directive where conditions exist which is Immediately Dangerous to Life or Health (IDLH) or damaging to the environment. The work stoppage will remain in effect until the condition has been corrected. In conjunction with a work stoppage, refer as appropriate to the Hazard Identification/Notification Process.

Advice the management of appropriate NHPC/Contractor/Subcontractor of unsafe acts/conditions observed on the project site for prompt corrective action to eliminate the unsafe act/ condition. Either conduct safety orientations or assist the Contractor/Subcontractor's safety representative with conducting orientations for all construction personnel and visitors reporting to the project site.

Attend a sample of NHPC/Contractor/Subcontractor's weekly safety meetings and "tool box" safety talks, and verify that personnel signature sheets are properly completed for later reference. Either conduct, or assist with conducting accident investigations, analyzing causes, and formulating recommendations for corrective/preventative actions.

Liaise with Contractors/Subcontractors, representatives, local medical services, and local regulatory agencies, on EHS related matters.

Verify that NHPC and each Contractor/Subcontractor is providing adequate and proper record keeping as required by local regulatory agencies and maintaining documentation of EHS training, EHS audits and inspections and occupational safety and health monitoring activities. Maintain record keeping for the project and as required by regulatory agencies.

Note: If no Site Safety Representative is assigned, the responsibilities of the Site Safety Representative are assumed by the Site Manager.

CHAPTER 4: RESPONSIBILITIES OF CONTRACTOR

Responsibilities

As per E No. CEA/TETD/MP/R/02/2011- In exercise of the powers conferred by section 177 read with clause (c) of section 73 of the Electricity Act, 2003 (36 of 2003), The Central Electricity Authority makes the following regulations, namely:-

Safety provision relating to contractor- (1) The owner shall incorporate the safety provisions in the contract document which are required to be complied by the contractor's employees during execution of the contract to facilitate safe working during execution of the work.

The contractor shall observe the safety requirements as laid down in the contract and in case of sub-contract, it shall be the responsibility of main contractor that all safety requirements are followed by the employees and staff of the sub-contractor.

The contractor employing two hundred employees or more, including contract workers, shall have a safety co-ordinator in order to ensure the implementation of safety requirements of the contract and a contractor with lesser number of employees, including contract workers, shall nominate one of his employees to act as safety co-ordinator who shall liaise with the safety officer on maters elating to safety and his name shall be displayed on the notice board at a prominent place at the work site.

The contractor shall be responsible for non-compliance of the safety measures, implications, injuries, fatalities and compensation arising out of such situations or incidents.

In case of any accident, the contractor shall immediately submit a statement of the same to the Owner and the safety officer, containing the details of the accident, any injury or casualities, extent of property damage and remedial action taken to prevent recurrence and in addition, the contractor shall submit a monthly statement of the accidents to the Owner at the end of each month.

The Contractor shall be solely responsible for carrying out all activities in their scope while complying with the requirements of this safety plan, maintaining safe and healthy work conditions, and preventing environmental impacts.

The Contractor will be responsible for identifying and communicating all requirements to Subcontractors. Overall responsibility for the safety performance of contractor personnel will rest with the Contractor's Site Manager.

The Contractor's Site Manager will be responsible for the effective implementation of the mitigation measures during the project by assigning a competent person in the role of Safety Representative and supervising the execution of this plan.

Record keeping

The Contractor will be required to keep all records and documentation required to comply with local regulatory requirements and this plan, on site, and available for review by NHPC Management.

Supervision

The Contractor will co-operate with instructions from NHPC Site Safety representative, where these require correction of identified non-compliance with regulatory requirement or this plan.

The Contractor shall assign qualified supervision and Competent Persons to perform work, as required by applicable law and these instructions.

Contractor Safety Orientation, Training and Staffing

The Contractor shall provide employees with the training and orientation necessary to enable them to perform work assignments in a safe manner. All safety orientation and training conducted shall be documented and made available upon request.

The Contractor Safety officer will designate a Competent Person as Site Safety Representative responsible for administration of Contractor site safety activities. NHPC shall have right to refuse or approve site competent personnel.

If the Contractor's work force on the project site is 25 or more (or a lesser number as hazard or regulations dictate), the competent safety representative shall be a full time position

For Contractor's with less than 25 people on site, a competent safety representative must be nominated or designated but need not serve full time in this position. The contractor may be required to mobilize other safety specialists to site for specific tasks needing such support.

Contractor Safety Meetings

Weekly Contractor Supervisor Safety Meetings shall be held by the Contractor Site Manager with supervisors to coordinate related activities among craft/subcontractor and facilitate EHS training.

Each Contractor Supervisor shall hold at minimum one weekly Tool Box talk with their crew. Topics discussed should be pertinent to the work being performed and workers shall have the opportunity to ask questions regarding safety. All attendees shall sign the attendance record so that documentation reflects attendees and topics discussed. Records shall be kept at the project.

Contractor Program Audits and Inspections

The Contractor shall inspect their work areas daily for hazardous conditions and environmental risks and take required corrective actions immediately.

The Contractor Site Safety Representative shall conduct a documented weekly inspection of the Contractors work areas.

Audits/Inspections findings will be reported to the Contractor Site Manager for corrective actions to be tracked to closure. The Contractor Site Manager will be responsible for providing prompt corrective measures to eliminate any and all unsafe acts/conditions as they are reported.

CHAPTER 5: ACCIDENT REPORTS AND RECORD KEEPING

All accidents involving personal injury/illness (first aid and recordable), spills of oil/hazardous materials, fires, explosions, serious near misses or property damage shall be immediately reported verbally to the NHPC Site Manager and the Site Safety representative, where applicable. A written notification of the accident/incident will be provided within 24 hours of the accident/incident to the local authority.

Accidents/incidents shall be investigated by the Contractor and corrective action implemented to prevent recurrence. Accident investigations shall be initiated within 24 hours of the accident and forwarded to NHPC upon completion.

The Contractor shall maintain accurate accident and injury reports. Copies of all correspondence related to an accident shall be made available to the NHPC Site Manager or designee upon request.

The Contractor shall complete and forward a Monthly Summary of Occupational Injury and Illness form related to his employees and employees of his subcontractors to the NHPC Site Manager or designee no later than five calendar days following the end of each month.

CHAPTER 6: ACCIDENT REPORTING, INVESTIGATION AND RECORD KEEPING

Accidents resulting in a fatality, amputation, injury to more than one employee, hospitalization, or investigation by regulatory authorities shall be reported to the Site Manager or designee the Project Manager and the Safety officer immediately. A written notification of the accident/incident will be provided within 24 hours of the accident/incident to the local authority.

Note: NHPC will identify local recordability requirements here & plan will recognize reporting requirements for in their villages).

The NHPC Safety officer will be responsible for ensuring all required internal and external reporting obligations are met to include monthly reporting of hours and site safety status.

Accidents resulting in fires, explosions, oil/hazardous material spills shall be investigated and reported to the NHPC Site Manager or designee, the Project Manager and Safety officer immediately.

All other accidents including, injuries (accidents involving company vehicles, property damage and significant near misses and hazards shall be reported to the NHPC Site Manager or designee immediately and to the Safety officer within 24 hours.

All Accidents shall be investigated and documented using the Accident Investigation Report. Sites staffed with full time Safety personnel shall report all injuries and first aids using the online reporting tool. Sites not manned with Safety staff are required to send a written report from the Site Management to responsible Safety officer.

Accident investigations must be initiated as soon as possible after the accident occurs and no later than 24 hours after the accident. Completed Accident Investigation Reports will be forwarded to the NHPC Site Manager or designee, Project Manager and the responsible Safety officer.

Information on the cause of the accident and corrective actions to be taken will be communicated to site personnel through postings, EHS meeting, or toolbox talks. The anonymity of personnel involved in the accident or who provided information during the investigation will be maintained.

Corrective actions identified by the accident investigation will be tracked to closure. Safety Corrective Action Reports CAR be issued following completion of the accident investigation. Documentation of completed corrective actions will be maintained in the site Safety files.

All accidents involving injury or property damage to members of the public resulting from work related activities shall be documented using the Accident Report form
and immediately reported verbally to the NHPC Site Manager, Project Manager and the responsible Safety officer. .

First Report of Injury - Any time a worker is sent to a physician for treatment of a work-related injury, a copy of the First Report of Injury form shall be sent to the Site EHS Representative.

Lost Time Injury Report - Any time a worker is injured on the job and loses time from work beyond the date of the injury, a Lost Time Injury Report must be completed and sent to the Site Safety Representative. Sites staffed with full time Safety personnel shall report all injuries using the online reporting tool. Sites not manned with EHS staff are required to send a written report from to the responsible Safety officer.

A first aid log shall be maintained at the project. Every injury or illness reported, no matter how slight, must be recorded. Entries shall be made promptly following treatment.

For NHPC/NHPC Contract employees, requiring medical treatment from a physician, hospital, or clinic off the jobsite, must be given to the Attending Physician for a worker is to receive treatment. Supervisory employees are responsible for ensuring that this form is properly completed. When a worker returns from the physician, hospital, or clinic, the worker must present the completed Clinic Referral Form prior to being allowed to return to work.

CHAPTER 7: OCCUPATIONAL HEALTH & MEDICAL FACILITIES

Arrange for Competent medical/first aid care to be available to anyone who may be injured in connection with his or her work. Where Emergency Medical Response Services are not immediately available, establish a trained, properly equipped medical response available during work hours to respond to a medical emergency on the project. First aid centre. Where accidents resulting in suffocation, severe bleeding, or other life threatening injury or illness can reasonably be expected, a 3 to 4 minute response time, from time of injury to time of administering first aid, is required.

Medical facilities – As per CEA guidelines

The owner shall provide medical facilities –

(a) to prevent and control occupational diseases;

(b) to prevent and reduce disability;

(c) to provide immediate relief to accident victims.

An occupational health centre with the services and facilities as per scale laid down hereunder shall be provided for all electrical plants and electric lines and maintained in good order:-

Where number of employees, including contract workers, working at one premises are fifty or less –

the services of a medical officer on retainer-ship basis, in his clinic shall be arranged and the said medical officer shall carry out the pre-employment as well as periodical medical examination(Annexure OCP -32) and render medical assistance during any emergency;

there shall be a minimum of five persons trained in first-aid procedures amongst whom at least one shall always be available during the working hours;

a full equipped first-aid box shall be maintained;

Where number of employees, including contract workers, working at one premises are between fifty-one and two hundred, then the owner shall arrange for –

an occupational health centre having the facilities for health examination, diagnosis, treatment and maintenance of health records;

a part-time medical officer as overall in-charge of the said centre who shall visit the premises at least twice a week and whose services shall be readily available during medical emergencies;

one qualified and trained dresser-cum-compounder on duty throughout the working hours;
a full equipped first aid box in all the departments;

where number of employees, including contract workers, working at one premises are more than two hundred, than the owner shall arrange for –

an occupational health centre having the facilities for health examination, diagnosis, treatment and maintenance of health records;

one full-time medical officer for premises employing upto five hundred workers and one more medical officer for every additional one thousand workers;

one nurse, one dresser-cum-compounder and one sweeper-cum-ward boy through out the working hours;

the occupational health centre shall be suitably equipped to manage medical emergencies.

The medical officer of occupational health center shall be involved in planning the emergency handling of large number of injured employees in the event such as fire, explosion, natural calamities and man-made disasters and all the equipment required for providing immediate relief to the injured during emergencies shall always be kept in readiness in occupational health center.

The owner shall ensure that a fully equipped ambulance van is provided at the site for transportation of serious cases of accident or sickness to the hospital promptly and said ambulance van is maintained in good condition and equipped with necessary facility.

the owner shall put in place programme for periodic medical check-up of employees and at least the following periodic medical check-ups shall be carried out and records maintained namely –

once before employment to ascertain physical fitness of the person to do the particular job; medical check-ups of all employees at intervals not exceeding twelve months;

colour vision tests and eye sight examination for drivers, skilled workers, technicians, supervisors and crane operators annually for those who are less than forty-five years old and every six months for those who are more than forty-five years old;

First aid

Display of instructions for resuscitation of persons suffering from electric shock – (1) Instructions, in English or Hindi and the local language of the District and where Hindi is the local language, in English and Hindi for the resuscitation of persons suffering from electric shock, shall be affixed by the owner in a conspicuous place in every generating station, enclosed sub-station, enclosed switching station, mines and every factory as defined in clause (m) of section 2 of the Factory act,1948 (63 of 1948) in which electricity is used and in such other premises where electricity is used as the Electrical Inspector may, by notice in writing served on the owner, direct.

The owner of every generating station, enclosed sub-station, enclosed switching station and every factory or other premises to which these regulations apply, shall ensure that all designated persons employed by him are acquainted with and are competent to apply the instruction referred to in sub-regulation (1)

In every manned generating station, sub-station or switching station of voltage exceeding 6520 V, an artificial respirator shall be provided and kept in good working condition.

First aid refers to the emergency treatment given to a person suffering from an accident or sudden illness, until a doctor arrives. First aid has important aims viz;
To preserve life,
To prevent worsening of condition,
To promote recovery,
To arrange transportation to get proper and quick medical aid.

Tips for Cardiac Pulmonary Resuscitation (CPR):

Artificial Respiration (Mouth to Mouth):

If breathing has stopped, artificial respiration can be performed but former method will be carried out by an experienced person. Basic life supports: Airway, Breathing, and Circulation

Airway:

Lay victim on his back. Clear his airway.
Open his mouth & clean with a cloth to remove any food material, denture, vomits.
Straighten his airway by lifting head and tilting chin.
If by these measures respiration doesn't start, then there is a need to start artificial respiration.

Breathing:

Lift the head and maintain this position by pressing his forehead with heel of your palm, pinch victim's nose with your thumb and index finger. Tilt the chin with your right hand.
Take deep breath, hold it.
Cover the victim's mouth completely with your lips and blow the air inside his lungs.
Watch for his exhalation, by the time you inhale the air then repeat the same procedure to give 10-12 breaths per minute.
During entire procedure maintain the "lift the head & tilt the chin" position to maintain clear and straight airway.
Watch for patient's breathing, if it starts give recovery position till medical help arrives.

Circulation:

While giving artificial respiration check for pulse.
If pulse is absent start external cardiac massage.
Place the casualty over hard flat surface.
Feel the lower half of sternum of the victim. The pressure site is slightly towards the left side.
Place heel of your one hand over this site, put other hand over it, interlocking fingers and lean forward without bending elbows, give pressure upto one and half inches to press the victim's heart against the spinal column.
Give approximately 100 cardiac massage (compression) per minute.
Continue the procedure till you feel the pulsation or till the doctor arrives.
If respiration and circulation both are absent, maintain 30:2 (compression: breaths) cycle so as to complete 5-6 cycles per two minute.

If pulse and respiration starts, place the victim in recovery position and call for Ambulance to transfer him to hospital.

Other First Aid Tips:

Electric shock:
Remove the casualty from the source of danger taking care of you.
Make rapid examination for airway, breathing, and circulation and act accordingly.
Get medical aid immediately.

Cuts and wounds:
Stop bleeding by direct pressure on the wound with gauze or handkerchief and elevate the part above the heart level.
In case of profuse and arterial bleeding give indirect pressure on particular pressure points.
Tourniquet must be used as a last resort.
Don't remove the embedded foreign body.
Clean the wound away from the centre to prevent the infection.
Dressing of the wound with readymade dressing or clean cloth.

Burns:
Act quickly and remove the victim from the source.
Put the affected part in cold water or pour water over burnt area if that cannot be immersed.
Don't break blisters.
Do not peel off the clothes stuck to the skin.
Remove the jewellery if possible.
Don't apply any ointment.
Cover the burnt area with sterile or clean cloth.
Give plenty of oral fluids.
Get the medical aid immediately.

Suffocation:
Remove the victim from the source of danger.
Observe for airway, breathing and circulation.
Restore the breathing, if it has ceased.
Get medical aid immediately.

Eye Injury:
In case of foreign body- if it is floating, easily removable then only can be removed with help of clean wet cloth or handkerchief. If it is papillary or embedded foreign body then don't try to remove it.
Instruct the victim not to rub the eyes.
In case of chemical burns of the eyes, wash the eyes with clean water for 15 minutes and cover it with eye-pad or bandage. Don't put any ointment in the eyes.
Send the victim to the doctor.

Poisoning:
Remove the victim from the source, taking care of you.
Reassure the casualty & make him lie down.
Observe for respiration, circulation.
Remove the contaminated clothing and wash affected skin with plenty of water.

Seek medical aid as early as possible.
Preserve any evidence of poison, if available.

Fracture:
Remove the casualty from danger.
Give comfortable position.
Control bleeding, if wound is there.
Apply splint of proper size, weight to the affected part to immobilize the joint above and below the facture site to restrict the movement of the affected part.
Observe the blood circulation of the affected part.
Steady and speedy transport of the victim to the hospital.

Snake Bite
Treatment for snakebite should always be prompt.
Arrange for medical help immediately.
In the meanwhile, arrest circulation in the snake bitten limb by using constrictive bandage between shoulder and elbow or between hip and knee joint (as the case may be) till the pulse is not felt beyond the constrictive bandage. Constrictive bandage should be kept in a position for 20 minutes, then released for 1 minute or until skin becomes pink and again tightened. Repeat the procedure till the arrival of the doctor.
Immediately after the constriction is applied, wash the wound with a solution of potassium permanganate, in order to remove any venom that may have dried on the skin.
Make a deep cut with a sharp knife or razor blade at the bitten site in order to bleed the bitten site.
Assure the patient and keep him warm by means of blanket.
Patient should be absolutely still.
If he is able to swallow, give him strong tea or coffee.
If breathing stops, give artificial respiration by mouth to mouth or Hoger-Nielson Method.

Heat Exhaustion
Heat exhaustion occurs among the workers in stuffy atmosphere or in overheated, poorly ventilated room. There may be feeling of giddiness or fainting, skin is always cold and moist. Prevention by wearing loose clothing, drinking large quantities of water is possible.
Remove patient to cooler conditions in the fresh air.
Lay him down and loosen all clothing around the neck
Dash cold water around the neck to stimulate
Fan him vigorously.
If severe shock is present, use stimulants.

Heat Stroke
Heat stroke proper is an entirely different reaction in the human body, to the same conditions which favour heat exhaustion. It is serious and often fatal condition. Hot, still humid atmosphere and inadequate drinking of water favours development of heat stroke. Alcohol consumption and constipation also favour its onset.

Casualty shows mental excitement, restlessness, vomiting, muscular cramps and high temperature in the range of 104 degrees F or above. If temperature reaches 106 degrees F or above, patient may become unconscious.

Treatment for heat stroke:
Send for doctor.
Commence active treatment before temperature reaches 104 f.
Strip the patient naked and wrap him up completely in cold-water soaked bed sheet.
Fan vigorously and when the temperature of body comes down to 102 F, cooling process should be stopped.
Later on, patient should be dried and covered with light blanket.
Water can be given to drink to eliminate poisons.

CHAPTER 8: EMERGENCY PREPAREDNESS PLAN

Why Emergency Planning is required?

After the incident of Bhopal gas disaster, the Factories Act has been amended and a new chapter i.e. Chapter IVA – provision relating to hazardous processes has been added to the Factories Act with addition of new provisions sec 41A, 41B, 41C, 41D, 41E, 41G & 41H covering all hazardous process industries. Under the provision of Sec 41B(4) every occupier shall with the approval of the Chief Inspector of Factories draw up an On-site Emergency Plan and detailed disaster control measures for his factory and make known to the workers employed therein and to the general public living in the vicinity of the factory the safety measures required to be taken in the event of an accident taking place. This is the statutory provision laid down in the act for preparation of On-site Emergency Plan to control disaster in the factories. Major accidents may cause emergency and it may lead to disaster, which may cause heavy damage to plant, property, harm to person and create adverse affects on production. Many disasters like Bhopal gas tragedy, Chernobyl nuclear disaster etc. have occurred at many places in the world causing heavy loss of life and property. Emergency situation arises all on a sudden and creates havoc and damage to person, property, production and environment. Therefore such situations and risks should be thought in advance and it should be planned before hand to tackle them immediately and control them within the shortest time.

What is emergency?

A major emergency can be defined as an accident/ incident that has potential to cause serious injuries or loss of life. It may cause extensive damage of property, serious disruption both in production and working of factory and may adversely effect the environment. The following factors may cause major emergency.

Plant failure.
Human error.
Vehicle crash.
Sabotage.
Earthquake.
Natural Calamities.

***On-site Emergency*:-**

If an accident/ incident takes place in a factory, its effects are confined to the factory premises, involving only the persons working in the factory and the property inside the factory it is called as On-site Emergency.

***Off-site Emergency*:-**

If the accident is such that it affects inside the factory are uncontrollable and it may spread outside the factory premises, it is called as Off-site Emergency.

Objectives:- The main objectives of an emergency plan are-

to control and contain the incident/ accident and if possible, eliminate it and

to minimize the effects of the incident on person, property and environment.

Each major hazardous factory should prepare an emergency plan incorporating details of action to be taken in case of any major accident/ disaster occurring inside the factory. The plan should cover all types of major accident/ occurrences and identify the risk involved in the plant. Mock drills on the plan should be carried out periodically to make the plan foolproof and persons are made fully prepared to fight against any incident in the plant. The plan will vary according to the type of industry and emergency.

Statutory Provision:-

After the Bhopal gas tragedy (1984) and Supreme Court direction in case of M/S. Sriram Foods and Fertilizers, the Govt. of India has made some important amendments to the Factories Act 1948 in the year 1987 with incorporation of special provisions relating to hazardous process. Under Section 41(B)(4) every occupier is to prepare On-site Emergency Plan and detailed disaster control measures for his factory. Again under provision of Rule 13 of the Manufacture, Storage and Import of Hazardous Chemicals Rules 1989, the occupier shall prepare and keep up to date On-site Emergency plan containing details how major accidents will be dealt with on the site on which the industrial activity is carried on and that plan shall include the name of the person who is responsible for safety on the site and names of those who are authorized to take action in accordance with the plan in case of emergency.

In States Major Accident Hazard Control Rules 1992 under Rule 13 provision for preparation of On-site Emergency Plan by the occupier has been laid down in the same line stated above. The occupier shall ensure a mock drill of the on site emergency plan is conducted at least one in every six months. A detailed report of the mock drill conducted under rule shall be made immediately available to the Inspector and Chief Inspector.

Main elements of On-site Emergency plans:-
Leadership and Administration.
Role and Responsibilities of Key Personnel.
Emergency action.
Light and Power.
Source of energy control.
Protective and rescue equipment.
Communication.
Medical care.
Mutual Aid.
Public relation.
Protection of vital records.
Training.
Periodical revision of plan.

Emergency Action Plan:- The Action Plan should consist

Designated Emergency Control Centre/Room.
Key Personnel.
Emergency Control Centre:- This is the main center from where the operations to handle the emergency are directed and co-ordinated. Maximum facilities to be made available in the emergency control are –

Internal and external communication.
Computer and other essential records.
Daily attendance of workmen employed in factory.
Storage of hazardous material records and manufacturing records.
Pollution records.
Walky-talky.
Plan of the plant showing-

Storage area of hazardous materials.
Storage of safety equipments.
Fire fighting system and additional source of water.
Site entrance, roadway and emergency exist.
Assembly points.
Truck parking area.
Surrounding location.

Note Book, Pad and Pencil.
List of Key Personnel with addresses, telephone number etc.

***Assembly Points*:-**

A safe place far away from the plant should be pre determined as assembly point where in case of emergency personnel evacuated from the affected areas are to be assembled. The plant workers, contract workers and visitors should assemble in assembly point in case of emergency and the time office clerk should take their attendance so as to assess the missing person during emergency.

***The Key Personnel for onsite emergency*:-**

Works main controller.
Works incident controller.
Communication Officer.
Security and Fire Officer.
Telephone Operators.
Medical Officer.
Personnel/Administrative Officer.
Essential work team leaders.

Works Main Controller:- The General Manager of the Plant should act as main controller. His duties are to -

Assess the magnitude of the situation and decide whether the evacuation of staff from the plant is needed.
Exercise and direct operational control over areas other than those affected.
Maintain a continuous review of possible development and assess in consultation with work incident controller and other Key Personnel.
Liaison with Police, Fire Service, Medical Services, Factory Inspectorate and other Govt. agencies.
Direct and control rehabilitation of affected area after emergency.

Intimate Off-site Emergency controller if the emergency spreads beyond the factory premises and likely to affect the surrounding area.
Ensure that evidence is preserved for enquiries to be conducted by statutory authorities.

The Works Main Controller will declare the emergency and he will instruct gate office to operate the emergency siren after assessing the gravity of the situation.

Work Incident Controller (WIC):- He is the next responsible officer after the Works Main Controller. Generally the plant manager is designated as Work Incident Controller. In case of emergency he will rush to the place of occurrence and take overall charge and report to the Works Main Controller by personal communication system like cell phones or walky talky and inform about the magnitude of emergency. He will assess the situation and considering the magnitude of emergency he will take decision and inform Communication Officer to communicate the news of emergency to different agencies. He will give direction to stop all operations within the affected area. He will take the charge of Main Controller till the Main Controller arrives. He will order for shutdown and evacuation of workers and staffs from affected area. He will inform all Key Personnel and all outside agency for help. He will inform security and fire officers and State Fire Services. He will ensure that all non-essential workers/staff are evacuated to assembly point and areas searched for casualties. He will report all significant development to Communication Officer. Moreover he will advise to preserve evidence of emergency into the cause of emergency.

Other Key Personnel and their duties:

Communication Officer : On hearing the emergency siren/alarm he will proceed to the control center and communicate to work incident controller. He will collect information from the emergency affected area and send correct message to work main controller for declaration of emergency. He will maintain a log book of incident. He will contact all essential departments. He will take stock of the meteorological condition from local meteorological Department. He will communicate all information as directed by Works Main Controller.

Security and Fire Officer: The Security or Fire officer will be responsible for the fire fighting. On hearing the emergency alarm/siren, he will reach the incident area with fire and security staff. Immediately after arrival to the emergency area, he will inform through telephone or walky talky to the communication officer. He will inform to the Work Incident Controller about the situation and requirement of outside help like State Fire Service and other mutual aid members. At the site, the entire fire squad member will respond to the advice and information given by the works incident controller. The security will control the visitors and the vehicle entry.

Telephone Operator : In case of fire is discovered but no emergency siren is operated, he shall ensure the information about the location of the fire/emergency incident from the person discovered/ notices the above and communicate to different Key Personnel immediately with clear message.

Medical Officer: Medical Officer with his team will report to the Works Incident Controller on hearing the fire/ emergency siren immediately. The ambulance will be parked nearest to the site of incident. Name of injured and other casualties carried to the Hospital will be recorded and handed over to Works Incident Controller. The ambulance will carry the injured to the nearest hospital for treatment.

Personnel/ Administrative Officer: He should work as a liaison officer liaisoning with works main controller and other essential departments such as Police, Press and Statutory authorities. His responsibilities shall include-

To ensure that casualties receive adequate attention to arrange additional help if required and inform relatives.
To control traffic movement into the factory and ensure that alternative transport is available when needed.
When emergency is prolonged, arrange for the relief of personnel and organize refreshment and catering facilities.
Arrange for finance for the expenditure to handle the emergency.

Essential Works and Team Leaders: During emergency the plants immediately affected or likely to be affected, as determined by the Works Main Controller, need to be shut down for safety. In the area immediately affected, it may be possible to isolate equipment from which flammable or toxic material is leaking. This work must be immediately carried out by plant supervisors and essential operators.

Workers/ staffs need to be nominated to carry out the following essential works at the time of emergency-

Extra first aid personnel to deal with casualties.
Emergency engineering works, provision of extra or replacement of light, isolation of equipment, temporary by pass electrical lines etc.
Moving tankers or other vehicles from area of risk.
To carry out tests on ambient air quality.
To act as runner in case of communication system fails.
The Works Main Controller will require a task force of suitable trained people for the following works-
Manning of assembly points to record the arrival of evacuated people.
Assistance of casualty arrival areas to record details of casualties.
Manning the factory entrance in liaison with security to direct emergency vehicle containing the gate e.g. ambulance, fire tenders etc.

For these essential jobs designated teams should be made available. The responsibilities of the team and the leader should be given.
The essential work teams are-
Task Force and repair team.
Fire fighting team.
Communication team.
Security Team.
Transport Team.
First aid and medical team.
Safety team.

Alarm System: Alarm system varies and will depend on the size of the works area. Simple fire bell, hand operated siren – break open type, fire alarm etc. Automatic alarm may be needed for highly hazardous nature of plant.

Communication System: Communication is a key component to control an emergency. The following communication system may be provided in the plant-

Walky Talky.
Telephone (internal & external).
Cell phone.
Intercom/paging.
Runners (verbal or written messages).

Siren for Emergency: Siren for emergency should be different from the normal siren. The emergency siren should be audible to a distance of 5 KM radius. The emergency siren should be used only in case of emergency.

Escape Route: The escape route from each and every plant should be clearly marked. The escape route is the shortest route to reach out of the plant area to open area, which leads to assembly point. This route should be indicated on the layout plan attached to the On-site Emergency Plan.

Evacuation: All non-essential staff should be evacuated from the emergency site. As soon as the emergency siren rings the workers have to shut down the plant and move to the assembly point. The plant shut down procedure in case of emergency should be prepared and kept ready and responsible person should be nominated for the purpose.

Counting of Personnel: All personnel working in the plant should be counted. Time office person should collect the details of personnel arriving at the assembly point. These should be checked with the attendances of regular workers, contract workers present in the site on the day of emergency. The accident control should be informed and arrangement should be made for searching missing person in the emergency affected area. The employees' address, contact number of next to kin should be maintained in the time office so that during emergency relatives of those affected due to emergency may be informed accordingly. Information in respect of emergency should be given to the media and other agency.

All Clear Signal: After control of emergency the Work Incident Controller will communicate to the works main controller about the cessation of emergency. The main controller can declare all clear by instructing the time office to sound "All Clear Sirens".

Mutual Aid System: Mutual aid scheme should be introduced among industries so that in case of emergency necessary help from mutual aid partner may be extended.
Essential elements of this scheme are –

Mutual aid must be a written document signed by the Chief Executive of the industries concerned.
Specify key personnel who are authorized to give requisition of materials from other industries.
Specify the available quantity of material/equipment that can be spared.
Mode of requisition during emergency.
Mode of payment/ replacement of material given during an emergency.
May be updated from time to time based on experience gained.
Mock drills on emergency planning should be conducted once in 6 months and sequence of events should be recorded for improvement of the exercise. Exercises on On-site Emergency

Planning should be monitored by Factory Inspectorate and the high officials of the organization and the plan is reviewed every year.

Emergency facilities: The following facilities should be provided in any factory to tackle any emergency at any time.

Fire protection and fire fighting facilities.
Emergency lighting and standby power.

Emergency equipment and rescue equipment –

Breathing apparatus with compressed air cylinder.
Fire proximity suit.
Resuscitator.
Water gel Blanket.
Low temperature suit.
First aid kit.
Stretchers.
Torches.
Ladders.

Safety Equipment –
Respirators.
Gum boots.
Safety helmets.
Asbestos Rubber hand gloves.
Goggles and face shield.
Toxic gas measuring instruments.
Explosive meter.
Oxygen measuring instruments.
Toxic gas measuring instrument.
Wind direction indicator.

On-site Emergency Plan should contain -

Site plan and topographic plan.
Plan showing the fire fighting facilities.
Plan showing hazardous material storage area.
Material safety data sheets for hazardous chemicals.
Facilities available in main control center.
List of emergency equipment.
List of Safety Equipment.
List of important telephone numbers and addresses.
Nearest hospitals and ambulance service center.
Nearest fire station.
Govt. Officials.
Transport provider.
Names and address & contact telephone number of Key Personnel.

The on site emergency plan so prepared shall be documented in a printed form in sufficient copies to give all concerned for knowledge, study and easy follow up. The emergency plan shall be rehearsed and practised at regular intervals to test efficiency of personnel, equipments co-ordinated efforts and to increase confidence and experience to operate such plan.

***Off-site Emergency Plan*:**

The main objective of the plan are –

To save lives and injuries.
To prevent or reduce property losses and
To provide for quick resumption of normal situation or operation.

Risk Assessment: Risk assessment is most essential before preparing any off site emergency plan. Hazardous factories and their hazard identification, other hazard prone areas, specific risks, transportation risk, storage risks, pollution risks by air and water pollution, catastrophic risks such as disasters, natural calamities, acts of god, earthquake, landslide, storm, high wind, cyclone, flood, scarcity, heavy rain, lightening, massive infection, heavy fire, heavy explosion, volcano, heavy spill, toxic exposure, environmental deterioration etc., risks from social disturbances, risks from the past accidents must be considered while carrying out risk assessment for a particular area(district) from which the offsite emergency plan is to be prepared.

Central Control Committee: As the offsite plan is to be prepared by the Government, a Central Control Committee shall be formed under the Chairmanship of the District Collector. Other officers from Police, Fire Service, Factory Inspectorate, Medical Department shall be incorporated as members of the Central Control Committee. Under the Central Control Committee the following committees shall be constituted under the control of the District Collector.

Incident and Environment Control Committee.
Fire Control Committee.
Traffic control, Law and order, Evacuation and Rehabilititation Committee.
Medical help, Ambulance and Hospital Committee.
Welfare, Restoration and Resumption Committee.
Utility and Engineering Services Committee.
Press, Publicity and Public Relations Committee.

The Off-site Emergency Plan shall be prepared by the District Collector in consultation with the factory management and Govt. agencies. The plan contains up to date details of outside emergency services and resources such as Fire Services, Hospitals, Police etc. with telephone number. The district authorities are to be included in the plan area.

Police Department.
Revenue Department.
Fire Brigade.
Medical Department.
Municipality.

Gram panchayat.
Railway Department.
Telephone Department.
Factory Department.
Electricity Department.
Pollution Control Department.
Explosive Department.
Press and Media.

Mock exercises on Off-site plan should be carried out at least once in a year to train the employees, up to date the plan, observe and rectify deficiencies.

Hazop Study:

Before making the on site and off site plan hazop study has to be carried out to identify the potential hazardous situations and to find out possible control measures. Hazop study is to be carried out by a team of experts. The team should consist of –

Mechanical Engineer.
Chemical Engineer.
R & D Chemist.
Works Manager.
Project Manager.
Outside experts.
Safety Officer/ Manager.

***Conclusion*:**

To carry out mock exercises and rehearsal of the off site plan to ensure its efficiency, test and response, interaction and co-ordination of operators various service organizations evaluate the effectiveness and adequacy of the equipments and to gain experience and confidence to implement the plan. The finalized disaster plan shall be given to all concerned for implementation and rehearsal for preparedness.

Emergency Procedures

Evacuations

The requirements outlined below should be in place to ensure the notification of all personnel and the safe and orderly evacuation of the work area in the event of an emergency. Documentation of site-specific evacuation elements shall be made on Site maps showing key emergency locations should be posted in all offices and assembly areas. These elements include:

An alarm or other notification system to alert personnel that there is an emergency;
Clear means of egress to allow personnel to safely leave the work area;
Appropriate travel distances for a quick and efficient evacuation;
Designated assembly areas and headcount procedures.

Assembly locations should be selected that are: 1) upwind from facility buildings (as applicable) to avoid toxic gas or smoke exposure in the event of a chemical spill or fire; 2) close to the main egress points of the work area; 3) away from the main site access roads to avoid congestion and confusion when emergency vehicles arrive; and 4) large enough to accommodate the number of people assigned to the location. If the project is located at an existing facility the location of assembly areas shall be coordinated with the customer/host facility.

Once the construction area has been evacuated, it is essential to quickly and accurately account for all individuals. Each contractor and subcontractor should have an individual who will be responsible for conducting the roll call for his or her employees. Once the roll call has been completed the results shall be provided to the NHPC Site Manager or in his absence the NHPC Site EHS Representative. If personnel are missing and are believed to be trapped in the construction area, this information should be provided to the emergency responders. The emergency responders should search for the missing individuals; untrained and unprotected employees must not be allowed to reenter the work area to participate in the search.

Medical Emergencies

All facilities should have basic first aid supplies available at the site and a person trained to provide first aid and cardiopulmonary resuscitation (CPR) in the absence of an infirmary, clinic or hospital in the near proximity. It is recommended that all locations, particularly those with unacceptable emergency response times, have at least two persons per shift who are trained to administer basic first aid and cardiopulmonary resuscitation.

The capabilities of medical services in the vicinity of the site must be evaluated. This may include availability of ambulance/emergency medical services, walk-in clinics, hospital proximity, emergency rooms staffed around the clock, specialty services such as critical care, burn units, etc. In addition, the street address, telephone number, directions to reach the medical facility (and/or map) shall be posted or readily available. The approximate response or travel time to each of the outside medical providers is important to determine if a service is readily available. Assistance with identifying and assessing medical services can be provided by the NHPC Power Systems Medical Group.

An important aspect in the preparation for any medical emergency is the concern for potential transmission of blood borne pathogens. An exposure control program shall be implemented to provide education and training in the use of engineering and work practice controls, personal protective equipment, housekeeping methods and medical waste disposal in order to reduce occupational exposures to blood borne pathogens. Employees who may have an exposure risk must receive annual blood borne pathogen training.

After a medical emergency has been identified, the Site Manager, EHS Programs Managers, and Contractor Supervisor should be notified immediately. The Site Supervisor has the responsibility to assure that the EHS Programs Manager has been notified.

The severity of the medical emergency and level of action required will be determined by the on-site First Aid Responder.

All Medical Emergency Care Providers will use the proper PPEs and will follow the proper standards of care.

All injured or ill Employees requiring emergency medical care for life/death medical emergencies will be transported by local Emergency Medical Services (EMS) to the nearest local Hospital.

All non-life/death medical emergencies will be managed by the First Aid Responder and Company Physician following proper standards of care.

Chemical and Oil Spills

Responses for a chemical spill or other release may involve many different actions and may be affected by a variety of regulatory requirements. Response actions and procedures will also be contingent upon the nature and quantity of the materials that are released. Annexure OCP-11

In order to determine the level of spill response capabilities required the site must first determine what chemical are present at the site and in what quantities. Material safety data sheets and chemical labeling can be used to determine the hazards associated with each chemical. The facility should use the chemical hazard information to define which chemicals have the potential to cause an emergency, in order to target its chemical response planning. In general, it should focus on those chemicals that it stores in bulk, chemicals which are flammable (e.g., solvents, fuels), toxic, corrosive, explosive, or radioactive.

Once the chemical hazards and potential impacts have been identified, provisions should be developed to properly control these occurrences. The site must evaluate the ability to provide response services for chemical hazard emergencies and/or use of outside response services. External response services are desirable where the facility is not capable of responding to an incident or may require additional support services. These services may include local fire departments, hazardous materials teams or chemical response units where available, and they must be able to respond in appropriate time frames, which depend upon the chemical, which is spilled or released.

Due to the extensive training and equipment requirements of developing an on-site emergency response team, only incidental spills will be responded to by site personnel. An incidental spill is defined as either an incident, which can be absorbed or controlled by personnel working in the immediate area, or releases, which do not present any health or safety hazards. A determination of when spills and releases must be responded to by an external emergency response service shall be based upon the size of the spill and the nature of the materials that have been released.

In the event of a spill of oil or chemicals the following spill response measures shall be taken as appropriate.

Site management must control, which includes isolating the area and preventing entry by any individuals except response personnel wearing the appropriate personal protective equipment.

Identification of the materials involved, including the type of material, the volume released, and what the material is being released to (for instance, spilled onto the floor, onto soil, or into drains).

Hazard and risk assessment which can be determined by consulting material safety data sheets.

Selection of personal protective equipment and clothing Based on the identification of the materials involved and the risks, the personal protective equipment needed for further response activities should be determined. The MSDS for the material should be consulted for the proper level of personal protective equipment to be used.

Control of materials released, which can be accomplished by a variety of means depending on the materials involved in the spill. This can include steps to control the source of the leak, such as closing valves, depressurizing the container, transferring the product, and patching or plugging the source of the leak, or using absorbent materials to collect and pick up spilled material.

Decontamination involves the process of cleaning the released material from the equipment and supplies, as well as from the personal protective equipment worn by the responders.

Termination procedures include legal documentation of the incident as necessary, and critiques and follow-up investigation of the incident.

Releases of some materials must be *reported* to regulatory agencies and HQ EHS, detailed spill reporting requirements are addressed in Section 8.a of this plan.

Weather Related Emergencies

The primary weather related emergencies which may affect project sites are flash floods, flooding, earthquakes or severe storms. In order to asses the likelihood of one of these events occurring the local weather station/ bureau should be contacted. The Weather Emergency Preparedness Plan, shall be used to document the measures taken by a site to prepare for weather emergencies.

Floods

Floods are among the most common and widespread natural disasters, and many areas can experience some degree of flooding after winter snow melts, spring rains or heavy thunderstorms. Most floods develop slowly over a period of days, but flash floods, which can be caused by intense storms, can develop in minutes. To determine if a site is subject to flooding, consider (1) the history of flooding in the area, the elevation of the site in relation to streams, rivers and dams, or contact local emergency management organizations and (2) if the site is subject to flooding, it should consider implementing flood-proofing measures, and should develop flood response procedures. Site flood response procedures should address several concerns. These include:

The manner by which the site will monitor for flood watches and warnings.

How its actions might coordinate with its community’s emergency plan.

Personnel should know community evacuation routes and where to find higher ground.

Warning and evacuation procedures should be established and should include assistance for employees who need transportation.

Procedures for implementing any contingent or emergency flood-proofing measures.

Procedures for removing mobile equipment from the site to higher ground.

When the floodwaters recede, damages should be assessed and repaired.

Excavations that have been subject to flooding are extremely unstable. Prior to resuming work in an excavation the soil should be retested and sloping and shoring systems repaired and inspected.

Earthquakes

Earthquakes occur suddenly and without warning. They can seriously damage buildings, disrupt utility services and communications, and cause landslides, flash floods and fires. In an earthquake, falling objects including lighting fixtures, ceilings and partitions can present a great danger to people. If the site is likely to be impacted by earthquakes, it should implement several measures to minimize its related risks. It should:

Follow local or regional safety codes during any new construction or major renovations, and consult with a structural engineer to inspect the site for recommendations as appropriate.

Assess the potential for damage to critical processes (power supply, pressurized pipes and vessels, fire and coolant water systems, electrical circuit hydraulic lines) and communication systems, which can lead to secondary emergencies. Damage prevention measures should be evaluated and prioritized.

Hazards from falling, spilling or breakage of materials should be reduced by keeping large or heavy objects on low shelves or the floor, securing shelving, cabinets, tall furniture, desktop equipment, light fixtures, large equipment, and heavy machinery to the floor or walls.

Drills and training are particularly important for safeguarding the lives of employees because earthquakes occur with little or no advance warning, and because a coordinated response may not be possible until after the earthquake ends.

Training should teach employees to take cover under a sturdy piece of furniture such as a desk or counter, or to brace themselves against an inside wall. If they are indoors, they should stay there until the earthquake subsides. If they are outdoors, they should move into the open, away from buildings, streetlights and power lines.

Following the earthquake, response procedures should be initiated. These should include a procedure to determine whether an evacuation is necessary. If evacuation is necessary, alarms should be activated and personnel should evacuate to their designated assembly points.

If headcounts indicate personnel are missing, emergency responders should be notified to search for the missing.

Damage to the site should be assessed and repaired. Prior to starting work, all structures, including scaffolding and platforms, and equipment such as cranes should be inspected.

Lightning

Preparedness can reduce the risk of the lightning hazard and raise safety levels. Lightning is a frequent weather hazard impacting construction site activities. Advance planning is the single most important means to achieve lightning safety. The following steps are suggested:

The site safety representative shall monitor weather conditions. An inexpensive portable weather radio will provide regular weather condition updates, as well as by clicking on these two web sites:

In the event of a forecast for thunderstorms and especially severe storms, the weather forecast should be monitored throughout the day. Learn the thunderstorm danger signs. Dark, towering, or threatening clouds. Distant lightning and thunder.

If severe weather is imminent, outdoor operations should be ceased or at least conducted in close proximity to safe assembly areas such as fully enclosed metal vehicles with windows up or substantial and permanent buildings. If lightning or thunderstorms are observed and are less than three miles away (15 seconds between flash and thunder), fieldwork should temporarily cease and field personnel should be in the safe areas.

Unsafe areas include:

Small structures including huts & rain shelters.
Nearby metallic objects like fences, gates, instrumentation and electrical equipment, wires, and power poles.
Also-AVOID trees, AVOID water, AVOID open fields,

When lightning is seen or by inference heard through thunder, all drilling, man lift, elevated and crane operations should be shut down, and if there is enough advance warning, the drill rig mast and booms should be lowered. It is the responsibility of the entire site to listen for thunder, as the equipment operators may not hear because of the engine noise. Operations should not resume until all threat from lightening is over.

Safety Rules
Go quickly inside a completely enclosed building.
If no enclosed building is convenient, get inside a hard-topped all-metal vehicle.
Do not take shelter under a tree.
If there is no shelter, avoid being the tallest object in the area. If only isolated trees are nearby, crouch on the balls of your feet in the open, keeping twice as far away from a tree as it is tall.
Avoid leaning against vehicles.
Avoid open spaces, wire fences, metal clothes lines, exposed sheds and electrically conductive elevated objects
Do not use metal objects like golf clubs, fishing rods, tennis rackets or tools

Do not work on fences, telephone or power lines, pipelines, or steel fabrications
Stop tractor work and heavy construction equipment, especially when pulling metal equipment, and dismount. Do not seek shelter under the equipment.
Avoid congregating in groups

Confined Space Rescue

Sites where personnel may perform confined space entry must have procedures in place to rescue entrants in an emergency. Confined space rescue may only be performed by personnel that have been trained in confined space rescue and have equipped with appropriate personal protective equipment.

Arrangements for confined space rescue may be made with the customer/host facility or by outside services, such as the local fire department. Outside services must be able to arrive in sufficient time (15 minutes) for effective rescue, and be properly equipped for rescue. In either case arrangements with the Confined Space Rescue Team must be made in advance of conducting any confined space entries. In addition, medical support should be available as needed. . Site EHS personnel shall complete annually the online Confined Space Awareness training (EHS 190) available at

Excavation Collapse Rescue

In the event of personnel becoming trapped by a collapsed excavation emergency medical and rescue services, such as the local fire department, must be contacted immediately. Site personnel shall not be allowed to enter the excavation to attempt rescue as they may become trapped if the excavation is continues to collapse. Mechanized equipment shall not be used to attempt rescues as additional injury to victims may occur.

Rescue from Heights

Rescue from heights may become necessary in the event that personnel become trapped on aerial lifts, personnel platforms, elevated work areas, scaffolding or following an arrested fall. In the event a rescue from heights is necessary the local fire department shall be contacted to conduct the rescue. Information about the specific location and height at which personnel are trapped should be provided at the time of the call to ensure that rescue services arrive on site with the appropriate response equipment.

If the employee can be reached safely using a secured ladder on site rescue may be conducted. Attempts to rescue personnel from equipment which is unstable or where ladder access is not possible shall not be conducted. Employees who are injured or in shock shall be rescued by outside rescue services only, to prevent additional injuries to victim and rescuers.

Civil Disturbances

Civil disturbances, such as phone threats, which include bomb threats acts of sabotage, and strikes, suspicious packages/letters may occur with little advance warning, and may greatly jeopardize employee safety. Actions taken to respond to these emergencies, such as evacuation, may be similar to responses to a fire or natural disaster. Civil disturbances may also involve unique conditions that may affect response capabilities. For example,

destruction of communication or alarm systems may require alternative procedures to alert employees. Appropriate response to these conditions requires prior planning and communication of procedures to employees, and coordination with local police and emergency services.

In the event of an act of civil disturbance or other security threat such as assaults, the local police department shall be notified immediately. Attempts to handle potentially violent employees shall not be made by on-site personnel including security with out the support of the police.

In the event that a threatening phone call is received at the site the following steps should be taken:

The individual receiving the phone call must remain calm and attempt to gather as much information as possible.

Information gathered on the call should be document. The form provided in may be used to collect this information.

After a threatening or harassing telephone call has been received, the recipient must notify the Site Manager and police department immediately. The call should not be discussed with anyone else unless directed by the Site Manager.

Employees who are likely to receive outside phone calls at the site such as Site Manager, Office Administrators, shall receive training on these procedures.

CHAPTER 9: LOCATION OF SAFETY EQUIPMENT AND EMERGENCY FACILITIES IN THE PLANT

What special equipment should you provide for emergencies?

Employees may need personal protective equipment to evacuate during an emergency. Personal protective equipment must be based on the potential hazards in the workplace. Assess your workplace to determine potential hazards and the appropriate controls and protective equipment for those hazards. Personal protective equipment may include items such as the following:

Safety glasses, goggles, or face shields for eye protection;
Hard hats and safety shoes for head and foot protection;
Proper respirators;
Chemical suits, gloves, hoods, and boots for body protection from chemicals;
Special body protection for abnormal environmental conditions such as extreme temperatures; and
Any other special equipment or warning devices necessary for hazards unique to your worksite.

CHAPTER 10: SAFETY INSPECTIONS AND AUDITS

The Site Manager shall have primary responsibility for ensuring that site safety inspections are conducted on a weekly basis.

Safety inspections shall be conducted as follows:

Inspections – On a weekly basis a documented site safety inspection shall be conducted and the results documented using the Weekly Inspection Checklist.

Construction Activities - The construction activities of each Contractor/Subcontractor and overall project shall be monitored on a daily basis. Annexure I

Audits

Audits are conducted by Safety officer on a quarterly basis. Audit results will be provided to the Site Manager. Audits and related abatement actions will be documented and maintained in the site EHS file. Each EHS audit shall be reviewed with the contractors. Safety officers conducting audits will use the IS 14489.

Audit findings are documented in the Audit Tracking System and assigned to the Site Manager as the Responsible Person. Findings will be closed rapidly and no later than when prescribed by the Safety officer.

Corrective Action Reports (CAR)

Upon observance of an EHS hazard, the NHPC Site Manager may, at his/her discretion, issue a CAR to the responsible party requiring prompt correction.

In cases of imminent danger, the NHPC Site Manager shall immediately prohibit site personnel from working in the affected area until the hazard has been corrected.

CHAPTER 11: SAFETY ORIENTATION, TRAINING AND STAFFING

Prior to starting work, all NHPC/Contractor/Subcontractor and visitors shall receive the training and orientation necessary to enable them to perform assigned tasks in a safe manner. Documentation of all training and orientation shall be maintained in the NHPC or contractor's site safety files and made available for review upon request. The following shall be included in the orientation program:

Project safety rules.
general safety awareness;
first aid;
emergency procedures including shock treatment;
use of personal protective equipment;
safety precautions while handling electro-mechanical equipment;
use of different types of fire fighting equipment;
response in the event of emergencies including fire, flood, landslide, earthquake etc;
site specific hazards and the precautions as well as response in respect of the same;
ten hours training per year to each employee;
Hazardous activities and restricted areas.
Review emergency reporting procedures.
Review rescue and first aid services used at the site.
Information for employees on their emergency evacuation assembly point and evacuation procedures.
Environmental rules and procedures.

The Site Safety Representative will be responsible for ensuring site training and staffing activities are correctly implemented and administered.

The owner shall ensure that adequate safety training is provided by the contractor to his employees. Safety promotional activities shall be organized periodically to create awareness and enthusiasm among the employees which shall include organizing safety day, safety week, fire safety day, fire safety week, safety competitions, Posters, slogans, safety calendars and displays depicting possible consequences of unsafe acts and conditions in conspicuous locations in the plant.

As required, each Contractor and Subcontractor shall provide a competent safety representative designated to NHPC in writing. A competent person must be identified to supervise - activities identified in Safety Manual Examples include:

Excavation and/or trenching
Scaffolding
Use of explosives and/or blasting
Underground construction, caissons, cofferdams, and use of compressed air
Safety monitoring system for roofing
Work at heights
Demolition

CHAPTER 12: HAZARD ANALYSIS AND RISK MANAGEMENT

For each phase of the work a Job Safety Analysis (JSA)/Risk Assessment and Method Statement (RA & MS) shall be developed.

Original JSAs/RA& MS s shall be maintained by the job supervisor and be available for review by employees involved with task. Copies of completed JSA/RA & MS shall be kept in the site EHS file.

You can use the risk awarness sheet to write the JSA. The analysis shall be job specific and address at a minimum the following areas:

Activity being performed including all of the major tasks
Sequence of work
Health and safety hazards include chemical, physical, and ergonomic stressors in the hazard analysis
For jobs involving the use of chemicals, the hazards associated with the chemical along with protective measures such as PPE must be included on the JSA and reviewed with personnel prior to starting work.
Control measure or precaution actions include PPE, fall protection measures, fire protection measures, barricades, work practices etc.

The responsible NHPC/Contractor's/Subcontractor's Supervisor shall review all work activities/tasks.

The completed JSA/RA & MS package shall be submitted to the Site Safety Representative for review. Once the JSA/RA has been reviewed by the Site EHS Representative, it will be returned to the originating Contractor/Subcontractor Supervisor. The Supervisor will sign the JSA/RA & MS, making it a formal document.

All risk elimination and or management required by the JSA/RA & MS, must be in place and complete, before the planned task is permitted to begin.

The Supervisor shall review the JSA/RA & MS, including any revisions, with all employees involved in the work activity/task and ensure they understand the requirements identified, and what is expected of them. This understanding shall be confirmed by each employee's signature. This can be done as a toolbox talk or job preparation meeting or Tailboard meeting.

The JSA/RA & MS shall be updated whenever there are significant changes in the work plan, materials used, work environment, or a new crew or subcontractor is assigned to conduct the work. Any changes/revisions to the JSA/RA & MS shall undergo the review process as the original JSA and assigned a revision number.

Site Hazard Communications (HazCom) Program

A HazCom program shall be prepared for the site and include an inventory and Material Safety Data Sheet (MSDS) for each hazardous material used on the project site. MSDS must meet any requirements regarding availability in local languages or languages spoken by employees present at the site.

NHPC and Contractor Personnel shall be provided with locally applicable HazCom training. Contractors shall be responsible to implement their site HazCom Program and conduct associated training.

Copies of Contractor MSDS are to be maintained in Site HazCom file.

A review of each MSDS received at the site will be conducted to verify that the copy of the MSDS maintained in the Site MSDS manual is the most recent version.

Safety Meetings

NHPC personnel including the NHPC Site Manager and the NHPC Site Safety Representative shall participate in a weekly safety meeting to coordinate related activities among each technical discipline and to facilitate site safety training and awareness. The Contractor's Site Manager and Site Safety Representative shall also attend these meetings. Documentation showing the following specifics of safety meetings shall be distributed to each attendee and maintained on file at the site.

Time and Date of meeting
Attendees
Topics/Comments
Assignments - Party responsible/Date corrected (if applicable)
Person conducting the meeting

Toolbox Talk

A Weekly Safety toolbox talk must be organized on site.
Subcontractors companies have to performe a weekly meeting on site.
This weekly meeting has to be documented and the attendants must be clearly identify

NHPC has to perform the same things, and all contractors working for NHPC has to participate in the toolbox talk. The management of the subcontractors companies has to assist at the weekly NHPC toolbox talk.

CHAPTER 13: PERSONAL PROTECTIVE EQUIPMENT

Introduction

In every construction industry Personal Protective Equipment (PPE) plays vital role in reducing the accidental injuries and avoiding major mishaps. Hazard exists in every workplace in many different forms: sharp edges, falling objects, flying sparks, chemicals, noise and a myriad of other potentially dangerous situations. Many hazards cannot be removed at source hence, use of PPE plays an important role to work as a shield against hazards and protects the precious life of workers on the site.

Everyone on site will be required to wear shirts with sleeves; long pants/trousers and sturdy lugged soled footwear capable of supporting the ankle while working in any construction area. Wear other PPE, such as respirators, where requirement is identified by the JSA/RA for the task. Wear high visible safety vest in all construction areas.

A Competent Person shall select PPE to be used.

Head Protection

Falling objects, overhead loads and sharp projections are to be found everywhere on construction sites. A small tool or bolt falling from 10 or 20 m high can cause serious injuries or even death if it strikes an unprotected head. Head injuries often occur when moving and working in a bent position, or when arising from such a position.

Safety helmets protect the head effectively against most of these hazards, and you should wear a helmet whenever you are on site and particularly when you are in an area where overhead work is going on. These areas, known as “hard-hat areas”, should be clearly marked with safety signs at entrances and other suitable places (figure 52). The same rule applies to managers, supervisors and visitors. Only safety helmets which have been tested to national or international standards should be used. A chin-strap on the helmet prevents it from falling off and should be used when appropriate.

Foot protection

Foot injuries fall into two broad types: those due to penetration of the sole by nails which have not been knocked down or removed, and those due to crushing by falling materials, which can be minimized by wearing protective footwear. The type of safety shoes or boots to be used will depend on the nature of the work (e.g. the presence of ground water on construction sites), but all safety footwear should have an impenetrable sole and uppers with a steel toe-cap. There are many types of safety footwear now available such as :

light, low-cut leather safety shoes for climbing jobs;
normal safety shoes or boots for heavy-duty work ;
rubber or plastic safety Wellingtons or gumboots which provide protection against corrosive substances, chemicals and water.

Hand and skin protection

Hands are extremely vulnerable to accidental injury, and in construction more injuries are caused to hands and wrists than to any other part of the body. Open wounds, abrasions, fractures, dislocations, strains, amputations and burns occur. They are largely preventable by

better manual handling techniques and equipment, and by wearing suitable hand protection such as protective gloves and gauntlets.

Among the common hazardous tasks where hand protection should be provided are:

operations involving contact with rough, sharp or jagged surfaces ;
contact with or splashes from hot, corrosive or toxic substances such as bitumen and resins;
working with vibratory machines such as pneumatic drills where some cushioning of the vibrations is desirable;
electrical work in humid and cold weather.

Skin trouble is common in the construction industry. Contact dermatitis is the commonest type of skin diseases. It feels itchy and looks red, scaly and cracked, and can become so bad that it affects your ability to continue working. Wet cement is one of the main skin hazards, but other substances include tar and putch, which can cause skin cancer after prolonged exposure, paint thinners, acids for masonry cleaning and epoxy resins. In addition to gloves, use barrier creams and wear long-sleeved shirts, full-length trousers and rubber boots.

Eye Protection
In industry many eye injuries occur as a result of flying material, dust or radiation when the following jobs are being carried out:
breaking, cutting, drilling, dressing or laying of stone, concrete and brickwork with hand or power tools;
chipping and dressing painted or corroded surfaces;
cutting off or cutting out cold rivets and bolts;
dry grinding of surfaces with power grinders;
welding and cutting of metals.

In some industrial processes there may also be a risk from the spillage, leakage or splashing of hot or corrosive liquids.

Some of these hazards can be removed permanently by proper machine guarding, exhaust ventilation or work design. For many hazards, for example, stone cutting or dressing, personal eye protection (goggles, safety glasses or shields) is the only practical solution. Sometimes workers are aware of the danger they run and the consequences if their eyes are damaged, but do not wear eye protection. This is because the type chosen interferes with vision or is uncomfortable to wear, or is not immediately at hand when needed.

Respiratory protection
On construction sites there are often tasks where harmful dust, mist or gas may be present, such as:

rock crushing and handling;
sandblasting;
dismantling buildings containing asbestos insulation;
welding or cutting materials with coatings containing zinc, lead, nickel or cadmium ;
paint spraying;
blasting

Correct choice of respirator
Whenever there is doubt about the presence of toxic substances in the atmosphere, a respirator must be worn. The correct type of respirator will depend upon the hazard and the work conditions, and you need to be trained in its use, cleaning and maintenance. Advice on suitable types of respirator and filter should be sought from appropriate safety and health authorities.

The simplest masks are disposable paper types. Remember that these are only effective against nuisance dusts.
There are three types of half-face mask with filters (figure 54):
for protection against airborne particles, e.g. stone dust, with a coarse filter fitted in the cartridge (note, these filters have a specific lifetime and should be changed as necessary)
for protection against gases and fumes, e.g. when using paints containing solvents, with a filter containing activated carbon;
a combination filter containing both a dust and a gas filter. Cartridges must be replaced regularly.

A full-face mask can be fitted with the same types of filter, and it also protects the eyes and face. Self-contained breathing apparatus with a full-face mask fed with air at positive pressure always gives the best protection, and must be used in confined spaces and whenever a sufficient supply of air or oxygen at the working place is in doubt. The air may be supplied from a compressor with a filter, or air / oxygen bottles (figure 55). In a hot climate, the full-face type is the most comfortable mask because it is looser fitting around the face and the air itself has a cooling effect. Users must be trained in the use of self-contained breathing apparatus and must keep to the manufacturers' specifications.

FALL PROTECTION

Safety harness

The majority of fatal accidents in construction are due to falls from heights. Where work cannot be done from a scaffold or ladder, or from a mobile access platform, the wearing of a safety harness may be the only way to prevent serious injury or death.

Circumstances in which a safety harness may be worn were discussed in Chapter 7. Another common situation in which a safety harness may be used – sometimes supplemented by the use of a safety net – is maintenance work on steel structures such as bridges and pylons.

There are many types of safety belt and safety harness available in preference to a safety belt.

The manufacturer or supplier asked for advice on suitable types for the intended purpose and for instructions on use and maintenance. A full safety harness should always be used.

A safety harness and its lanyard must:
- limit your fall to a drop of not more than 2 m by means of an inertia device;
- be strong enough to support your weight;
- be attached to a strong structure through a firm anchorage point above the place at which you are working

Lifeline

20mm diameter polypropylene rope or 8 mm wide rope should be used as a lifeline and properly anchored to an anchorage point.
Horizontal lifelines should be positioned so as to provide points of attachment at shoulder level or higher for personnel utilizing them.
Lifelines should not be used for any purpose other than fall protection.
The sag of the life line should not be more than 15 degree.

Use of Safety Belts and harnesses – different ways of providing safe anchorage points for safety lines.

Swing Falls

Swing fall occur when the anchorage point is not directly above the point where a fall occurs. The force of striking an object in a swing fall may cause serious injury or death. Minimize swing falls by working as close to the anchorage point as possible.

Rope Grab Fall Arrestor

Rope grab type fall arrestors should be used to protect fall of workers during vertical movement such as ascending or descending Scaffold towers, vertical ladders etc.

Retractable Type Fall Arrestor

Retractable fall arrestors should be used in places where high risk of fall of workmen persists. This fall arrestor can be directly anchored to the anchorage or can be used in conjunction with a lifeline.

Energy Absorber

It is an optional attachment, which may be used in conjunction with the lanyard to connect the harness to the anchorage point. In case of fall it reduces the impact energy passed on to the worker considerably by absorbing part of the energy. Energy absorber should be used only while working above 6 m.

Safety Net

Providing adequate platforms and edge protection may not always be possible or reasonably practicable. If so, safety nets will be required. They do not stop people falling, but minimize the potential injuries if they do. If nets are used make sure that they are properly installed by competent riggers as close as possible below the roof involved to minimize the distance fallen. Installing a net does not mean proper working platforms and edge protection can be ignored, because the first priority is to stop people falling in the first place. Refer IS 11057- Specification for Industrial Safety Nets for more details.

CHAPTER 14: COMMUNICATION SYSTEM

Communication is a key component to control an emergency. The following communication system may be provided in the plant-

Walky Talky.
Telephone (internal & external).
Cell phone.
Intercom/paging.
Runners (verbal or written messages).

CHAPTER 15: FIRE PREVENTION AND PROTECTION

Overview of Statutory Provisions r*elating to Fire Protection (As per BOCW Act & Rules) – Chapter IV- General Provisions*

Fire Protection – Fire extinguishing equipment, water supply, training, inspection & maintenance. (Rule 35)

Emergency action plan (Rule 36)

Fire Extinguishing Equipment / Facilities

While the fire prevention measures covered in the Rules are mostly applicable to underground excavation and tunneling work and explosives, the fire extinguishing equipment is required to be provided throughout the construction site where fire is probable. Annexure OCP-20

Types of fire extinguishing equipment

Fire extinguishing equipment could be in the form of water and sand buckets, portable fire extinguishers, small bore hose-reels and hydrant system. The last two types are generally part of the property / facility to be constructed and the contractor is not required to put up these systems for use during construction. Water & sand buckets and portable fire extinguishers are to be provided by the Contractor at appropriate places in the Construction Site for use during fire emergencies during construction.

Class of Fire		**Suitable type of Extinguisher**
Class `A' Fire	- Fires due to combustible materials such as wood, paper, rubbish, etc.	Water Buckets; Water-type / ABC Powder type Extinguishers
Class `B' Fire	- Fires in flammable liquids like oil, petroleum products, solvents, grease, paints, etc.	Sand Buckets; Mechanical Foam/ Carbon dioxide, Dry Powder / ABC Powder type Extinguishers.
Class `C' Fire	- Fires arising out of gaseous substances	Carbon dioxide/ Dry Powder / ABC Powder type Extinguishers.
Class `D' Fire	- Fires arising from reactive chemicals active metals, etc. (These chemicals / materials are not generally used at construction stage of any plant or building)	Sand Buckets; Special type of Dry Powder Extinguishers.

Fires in electrical equipment are to treat as either class `A' or class `B' fires depending on the ingredients of the electrical equipment, but the water type and mechanical foam should not be used unless the electrical supply to the equipment is isolated. Other types suitable for

class `A' or `B' fires can be used on the elec. equipment on fire even if supply is not switched off.

Scale of deployment

There are no national standards on the scale of deployment of fire extinguishing equipment at construction sites (for use during construction stage only). In the absence of such standards, the following guidelines which are based on the requirements applicable to construction projects in the premises of the factories, may be followed.

One 9 litres of water bucket should be provided for every 100 sq.m. of work area.

One Water type extinguisher can be provided to replace 6 water buckets or part thereof.

However, a minimum of 1 water type fire extinguisher and 2 water buckets should be available at each work place.

Water buckets may be dispensed with if the number of extinguishers is double that indicated above.

Acceptable replacements for water buckets and water type extinguishers in places where class `B' fires are anticipated are as given below:

Acceptable Replacements	Buckets of Water		Water-type Extinguishers (For each 9 Litres Extinguishers)
	For One bucket	For 3 bucket	
Dry Sand	1 bucket	3 buckets	-
Carbon Dioxide Extinguishers	3 kg.	9 kg. (In not less than 2 Extinguishers)	9 kg.
Dry Powder Extinguishers	2 kg.	5 kg. (In one or more extinguishers)	5 kg.
Foam Extinguishers	9 Litres	9 Litres	9 Litres

One 2kg. Dry powder or CO_2 extinguisher within 15 m of electrical equipment (Transformer, motor, other equipment)

The fire extinguishers should be located in such a way that a person in a workplace has to travel not more than 15 m to reach the nearest extinguisher.

The extinguishers should be in conspicuous places and readily accessible for immediate use. Generally, these are to be placed near exits, stair case landings, routes of escape. Access should not be blocked by materials or otherwise.

This aspect can be verified by Inspector during inspection.

The extinguishers or buckets should be placed at convenient height, such that their bottom is 75 cm above floor level.

This aspect can be verified by the Inspector during inspection.

Water Supply

At least 4.5 lakh litres of water should be stored in static tanks distributed around the construction site with due regard to potential fire risk.

If there is piped supply, the supply should be at the rate of 4,500 litres/min. at a pressure of 7 kg./sq.cm.

A power driven trailer pump of min. 550 litres/min. capacity and with a towing attachment for towing by a vehicle will be useful at the construction site.

Training for operating the equipment

In every shift, there should be persons trained in the operation and effective use of the equipment. There are no particular norms on the number of trained persons to be available. The Shift Supervisor, Sub-Contractor's Supervisor, and some building workers should be trained in the operation. The Contractor may maintain a register of training with names & designations of the persons trained, date of training, name of the trainer, duration of training and the aspects covered in the training (such as demonstration / operation, hands-on trials by participants, films shown, topics covered, etc.). Great value is attached to refresher training.

Inspection & Maintenance of Extinguishing Equipment
The Rules requires –

proper maintenance
regular inspection at intervals of not less than once a year by responsible person and maintaining the record of inspection.
The record of inspection should be maintained in a Register as per the format given in the Indian Standard IS 2190 : 1992 – Selection, installation and maintenance of first-aid fire extinguishers – Code of Practice.

Sl. No.	Type	Capa-city	Year of manuf-acture	Make	Loca-tion	Monthly Inspe-ction Dates	Annual Inspe-ction Dates	Pre-ssure Tested on	Date of Disc-harge	Refil-led on	Due for Refil-ling	Rem
1												
2												
3												
4												
5												
6												

Document for verification: Register of Fire Extinguishers

In addition, the following details should be painted on the body of each equipment and imprinted on a metal tag attached to the extinguisher.

Sl. No. / distinguishing number of extinguisher
Date of last refilling
Date of last inspection

The Inspector may verify at random, whether the above details are available on the extinguishers.

Specific Locations where fire extinguishers should be installed

Launch or boat or other craft used for transport of building workers (Water & DCP type)
Cabin of each lifting appliance (mobile crane included) {CO_2 / Dry Powder Type)
Places where mobile asphalt layers & finishers are used (Dry Powder & Mechanical foam type)
Air locks and other places in excavation & Tunneling (Water, DCP Type) Places of welding and cutting (Water / DCP)

Fire Emergency Plan

A written fire emergency plan should be developed and should at least include the following:

Response to fire alarms and fire systems supervisory alarms.
Notification and evacuation of personnel identified in the plan.
Evacuation of personnel not directly involved in the fire fighting activities from the fire area.
Co-ordination with the security forces or other designated personnel to admit public fire department and control traffic and personnel.
Fire preplanning that defines fire extinguishment activities.
Periodic drills to verify viability of the plan.
Control room operators' and auxiliary operators' activities during fire emergencies. Approved breathing apparatus should be readily available in the control room.

General Guidelines for Fires and Related Emergencies:

If you discover a fire or see/smell smoke, immediately follow these procedures:

Notify the local Fire Department.

Notify Organization's Security Force.

Activate the building alarm (fire pull station). If not available for operation, verbally notify people in the building.

Isolate the area by closing windows and doors and evacuate the building, if you can do so safely.

Shut down equipment in the immediate area, if possible.

If possible and if you have received appropriate training uses a portable fire extinguisher.

Assist one to evacuate.
Assist another to evacuate.
Control a small fire.

Do not collect personal or official items; leave the area of the fire immediately and designated gathering area.

You should provide the fire/police team with the details of the problem upon their arrival. Special hazard information you might know is essential for the safety of the emergency responders. You should not re-enter the building until directed to do so. Follow any special procedures established for your unit.

If the fire alarms are ringing in your building, you must evacuate the building and stay out until notified to return. Move to your designated meeting location or upwind from the building staying clear of streets, driveways, sidewalks, and other access ways to the building. If you are a supervisor, try to account for your employees, keep them together and report any missing persons to the emergency personnel at the scene.
If an individual is overexposed to smoke or chemical vapors, remove the person to an uncontaminated area and treat for shock. Do not enter the area if you suspect that a life threatening condition still exists (such as heavy smoke or toxic gases). Get medical attention promptly.

If your or another person's clothing catches fire, extinguish the burning clothing by using the drop-and-roll technique, wrap victim in a fire blanket or douse victim with cold water (use an emergency shower if it is immediately available). Carefully remove contaminated clothing; however, avoid damage to the burned area. Cover injured person to prevent shock. Get medical attention promptly.

CHAPTER 16: EMERGENCY ESCAPE ROUTES

Emergencies can develop very rapidly. Make sure that you are equipped to move the employees to a total or relative place of safety without delay. The following will be helpful:

Make exit route design permanent.

Ensure that the number of exit routes is adequate based on the number of employees, the size of the building, its occupancy, and the arrangement of the workplace.

Separate an exit route from other workplace areas with materials that have the proper fire resistance-rating for the number of stories the route connects.

Ensure that exit routes meet width and height requirements. The width of exit routes must be sufficient to accommodate the maximum permitted occupant load of each floor served by the exit route.

Ensure that doors used to access exit routes have side hinges and swing in the direction of travel (depending on occupancy and hazard areas).

Design exit routes that lead to an outside area with enough space for all occupants.

An outdoor exit route is permitted but may have additional site-specific requirements.

Maintain the fire-retardant properties of paints and solutions that are used in exit routes.

Ensure that required exit routes and fire protections are available and maintained, especially during repairs and alterations.

Ensure that employee alarm systems are installed, and in operable condition.

Direct employees through exit routes using clearly visible signs. These signs must meet the required letter height and illumination specifications.

Arrange exit routes so that employees are not exposed to the dangers of high hazard areas.

Exit routes must be free and unobstructed. Prevent obstructions, such as decorations, furnishings, locked doorways, and dead-ends within exit routes.

Plan escape routes and make sure they remain available and unobstructed.

Consider signs for people unfamiliar with escape routes.

Light all escape routes sufficiently for people to use them safely in an emergency.

Make sure emergency lighting complies with the requirements. Use an independent power source, eg a generator, in case the mains electricity supply fails.

If using floodlighting, lighting towers etc as temporary lighting make sure it does not shine in people's faces along the escape route, making it more difficult for them. As an alternative, 'festoon lighting' along an escape route prevents glare.

Plan how, where necessary, you will evacuate people to a place of relative safety from where they can proceed to a place of total safety.

Plan to provide additional assistance to people with a disability, those with limited mobility and children.

All doors and gates leading to final exits, as well as site exits themselves, should be available for immediate use at all times.

Check they are:
unlocked – if security is an issue they should be staffed not locked
free from obstructions
open outwards in the direction of escape

CHAPTER 17: WORK ENVIRONMENT (ILLUMINATION, NOISE, VENTILATION, DUST NUISANCE, FUMES/GASES, ETC.)

Illumination

Adequate levels of illumination and emergency lighting should be maintained in the premises as per NEC Code. All glazed windows and skylights used for the lighting of the workplace should be kept clean on both the inner and outer surfaces.

Minimum illumination intensities should be maintained as per the following table.

Illumination level in lux	Area of operation
54	General construction areas, concrete placement, excavation and waste dumping areas, access ways, active storage areas, loading platforms, refueling and field maintenance areas
54	Indoors, warehouses, corridors, hallways and exit ways
54	Tunnels, shaft and general underground work areas (except that minimum of 108 lux is required at tunnel and shaft heading during drilling, mucking and scaling)
108	General construction plant and shops
325	First-Aid stations, Infirmaries and offices

Noise Protection

Noise levels should be restricted to safe values in accordance with Rule 34 and Schedule VI of BOCW Rules, 1998 as per the following table. Annexur OCP-14

Total time of exposure per day (in hours)	Sound pressure level (in dBA)
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.75	107
0.5	110
0.25	115

Notes:-

No exposure in excess of 115 dBA is to be permitted.

For any period of exposure falling in between any figure and the next higher or lower figure as indicated in column (1), the permissible sound pressure level is to be determined by extrapolation of a proportionate basis.

As a good practice effective ear muff / ear plugs should be used in areas above 90 dB even if the time of exposure is within permissible limit.

Ambient Air Quality Standards in Respect of Noise

Area Code	Category of Area / Zone	Limits in dBA	
		Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

Note: 1. Day Time shall mean from 6.00 am to 10.00 pm
2. Night time shall mean from 10.00 pm to 6.00 am.

The following control measures should be taken against noise and vibration:

Sl. No.	Control Measures	Examples
1	Engineering Control : Replacing machines and process which create noise and vibration	The following developments and improvements in machines and processes: Pneumatic drills and jackhammers can be replaced by electro-pneumatic hammers. Remote operation for vibrators jackhammers and drills. Acoustic Enclosure and improved design for compressed air discharges and the cutters, blades and exhausts of engines. Better means of supporting or holding manually operated tools to reduce the effects of vibrations. Better vibration damping measure on handles controls and seats of the vibration creating machines.
2	Administrative control: Reducing duration of exposure	Priority should be given to the reduction of the duration of workmen exposure to noise and vibration while operating : Jackhammers, drills and compressors High impact noise tools.
3	Use of PPEs : Using suitable Personal Protective Equipment	The following Personal Protective Equipment should be used against noise and vibration: Ear Plug / Ear Muff against noise Suitable Protective Hand gloves against vibration.

Ear Plug / Ear Muff should be used when the noise levels exceeds 85 db. For further details regarding hearing protection refer chapter Personal Protective Equipment.

Ventilation

Whenever hazardous substances such as dusts, fumes, mists, vapours or gases exist or are produced in the course of construction work, their concentrations should not be allowed to

exceed TLV. Ventilation should be used as Engineering control measure to reduce the concentration to the acceptable level. Annexur OCP-09

Local Exhaust Ventilation

Local exhaust ventilation should be designed to prevent dispersion into the air of dusts, fumes, mists, vapours and gases in concentrations causing harmful exposure.

Such exhaust system should be so designed that it draws the contaminants from the source and expel them out of the work areas.

It is very important to note that the exhaust system does not draw the contaminated air through the work area of employees.

Forced Ventilation and Extraction

Forced Ventilation systems, like Exhaust fans, jets, ducts, hoods, etc. should be so designed, constructed, maintained and operated as to ensure the required protection by maintaining a volume and velocity of exhaust air sufficient to gather dusts, fumes, vapours or gases from said equipment or process, and to convey them to suitable points of safe disposal, thereby preventing their dispersion in harmful quantities into the atmosphere where employees work.

Ventilation system should be provided with a back up power supply source so that it continues to operate in the event of failure of regular power supply system.

Harmful Gases and Dust Pollution:

Equipment should be provided with degree of protection in accordance with relevant Indian Standards. Building interiors should be provided with protection against harmful gas and dust as per NEC Code. Personal protective equipment as prescribed in this Manual should be used for individual dust protection and protection against harmful gases.

CHAPTER 18: PROTECTIONS AGAINST HAZARDOUS CHEMICALS/GASES

Gas masks should be provided in accordance with the requirements of IE Rules, 1956 in buildings housing generators.

For each chemical used, manufacturer's instructions for use, storage, labeling, disposal and for dealing with emergencies arising from it use should be duly followed.

Solvents, cleaners and degreases should be used only in well-ventilated areas.

Smoking and other ignition services should be kept away from inflammable materials.

Each MSDS shall be reviewed prior to brining the material on site. All chemical containers that are stored and used at the site must be labeled. Labels must not be removed or defaced.Containers containing hazardous chemicals must be labeled, tagged, or marked with the following information: Annexure OCP-07

Identity of the Hazardous Chemical
Appropriate Hazard Warnings
Name and Address of the Manufacturer

An up to date site chemical inventory shall be maintained by the designated person.

Chemicals transferred into secondary containers for use must be labeled or marked with the following information:

Identity of the Hazardous Chemical, per MSDS
Hazard symbol or descriptive text in local language(s)

Chemical Storage

Use, store, handle and dispose of hazardous materials in accordance with applicable law/requirements and in a manner that will not cause harm to personnel and the environment. The following storage and handling practices shall be followed:

Hazardous Chemicals and oils received at the Site must be immediately moved to their designated storage area.

All storage areas shall be provided with containment and protected from the elements using a roof, tarp, or approved hazardous material storage cabinet. Storage areas shall be surrounded by a berm or dike to contain any possible spill. The ground area inside the dike shall be protected by three layers of 6 ml plastic or equivalent containment. All seams of the plastic layers shall be sealed so not to allow leakage of fluids.

Storage of liquids in bulk tanks and/or barrels shall be away from the proximity of natural watercourses, or wetlands, in level storage areas and surrounded by a berm or dike. Above ground fuel and oil storage tanks shall be checked for leakage and spillage on a daily basis. All spills no matter how minor shall be reported *to* the NHPC Site Safety Representative.

Combustible Materials are not permitted to be stored inside Flammable Storage Cabinets.

Where practical, chemicals should be stored at or below eye level.

Chemicals must be segregated by their hazard characteristics, classification, and compatibility. The area will be well defined and labeled.
When chemicals are transported by hand they will be transported in covered containers.

Storage of chemicals at the point of use will be limited to those amounts necessary for one operation or shift. Containers in-use will be properly labeled and of minimum size.

Additional storage requirements apply for certain classes of chemicals and for chemicals that are incompatible with other chemicals. All chemical storage must be reviewed by a competent person for compliance with applicable standards and precautions.

Provisions shall be made to prevent the release of hazardous materials and petroleum products to the environment including but not limited to the following:

Drip pans, oil absorbents and pigs shall be used as appropriate during material transfer operations.

Oil transfers will be monitored to insure that all hose connections are in good repair and not leaking.

Equipment, which uses hydraulic or lube oils shall be maintained in a manner, which prevents leaks. Any equipment, which is leaking, shall be repaired or removed from service.

Note: These provisions should be further emphasized in the sites Emergency Preparedness and Environmental Plans, and communicated to all at their site orientation training.

Lead paint

All suspected lead paint shall be identified by competent and/or qualified person and verified prior to start of work.

CHAPTER 19: SAFETY IN HANDLING OF OILS

These products are flammable but evaporate only slowly at ambient temperature and, in normal use; they do not constitute a significant fire or health hazard. Never heat a container that has stored oil without first ensuring that it is free of residual oil and oil vapour. In the unlikely event of a fire involving oil products, call the emergency Services immediately. To extinguish a small fire, foam, dry powder or CO2 extinguisher or earth/sand can be used. Annexure OCP-02 & OCP-34

DO NOT USE WATER ON AN OIL FIRE AS IT WILL CAUSE THE FIRE TO SPREAD

Avoid prolonged or repeated exposure of skin to contact with oil and avoid splashing it into the eyes, swallowing it, or inhaling the vapour in a confined space.
In the event of contact with skin, wash with large volumes of water; for contact with the eyes, bathe them with clean water for ten minutes and seek medical attention if irritation persists.
Materials contaminated with oil should not be carried, or left in pockets, and any clothing that is heavily contaminated should be changed as soon as practicable.
Do not deliberately drink or inhale petroleum products but if this should happen accidentally, seek urgent medical attention.

The removal and disposal of an oil tank that is no longer required is a specialist operation and must not be undertaken without the use of safe and environmentally friendly procedures; advice on tank removal and disposal will be available from your oil supplier.

OIL STORAGE

Oil products should be stored in a soundly constructed tank, designed specifically for the purpose, and should be sited away from any source of heat or potential ignition. A means, such as a drip-tray or bund, should ideally be provided, capable of containing any oil that may leak or spill from the tank.
There should be suitable and unobstructed access at ground level to the tank and/or its fill point.
The tank should be clearly marked with the grade of oil required and the tank's total capacity.
An accurate gauge or dipstick should be fitted to the tank to avoid overfilling (a principal cause of spillages). Water from rain or condensation should be removed from the tank regularly.
The tank and its associated equipment should be examined carefully before and after a delivery and if there is a problem, such as a spillage or leakage, this must be notified to the oil supplier as soon as possible.
In the event of a spillage or leakage, do not smoke in the vicinity and do not try to disperse the oil with water; under no circumstances should a petroleum product be allowed to enter a drain or watercourse.

CHAPTER 20: HEALTH AND SAFETY GUIDELINES FOR PAINTING WORKS

In industry, the most popular method of applying paint is to spray it on, using compressed air, a high velocity airless spray or an electrostatic applicator. Paint can also be applied with brushes. The material itself is the primary hazard when painting. Painting may expose you potentially dangerous chemicals which may damage your health. This guide outlines some of the hazards associated with painting and provides information on how to work safely while painting. Annexure OCP-30

Choose paint materials with safety in mind. Never use materials which are unlabeled their contents cannot be determined. Always follow the safety recommendations for the material being used.

Health hazards

Overexposure to a substance means too much has been breathed in, swallowed or absorbed through the skin. The possible effects of overexposure to paint and the chemicals it contains vary according to the type of paint. Some health problems caused by overexposure to paint material are:

- drowsiness;
- dizziness/light headedness;
- disorientation;
- nausea/vomiting;
- eye and throat irritation;
- dermatitis;
- general allergic response such as hives;
- asthma-like wheezing with tightness in the chest;
- heavy metal poisoning (lead, chromium, nickel and cadmium); or
- nerve, kidney or liver damage.

A wide variety of ingredients are used in paints and thinners. These chemicals are not found in all paints, but you have probably come into contact with some of them at one time or other. The following is a list of common ingredients of paints and thinners:

Pigments

- white lead
- red/brown iron oxide
- chromium oxide
- iron blue
- cadmium yellow
- lead powder

Solvents – thinners

- toluene
- xylene
- carbon tetrachloride
- perchloroethylene
- iopropyl alcohol
- cyclohexanol
- n-amyl acetate

- methyl ethyl ketone
- cyclohexanone
- methylene chloride

Resins
- isocyanates (contained in urethane resins)
- epichlorohydrin (contained in epoxy resins)

You may already be familiar with the paints you use regularly, but do you know their possible harmful effects? Ask for the Materials Safety Data Sheet (MSDS) (see below) for each paint. These are available from the manufacturer or paint supplier. The MSDS will describe the possible hazards and what precautions are needed. All of the above listed ingredients have standards for worker exposure.

Spray Painting Safety

Spray painting is a common and effective way to protect and beautify parts, products, vehicles, and buildings. Spray painting allows coverage of large areas with even coats of primer, paint, sealers, and other coatings. However, workers in spray painting operations need to recognize and guard against the hazard associated with spray painting processes.
Hazardous chemicals in coatings and solvents can enter the body several ways. Workers can inhale chemical vapors from spraying, absorb the chemical by skin contact or inject the chemical with high pressure spray painting equipment.

As proper ventilation is important when working with paint coatings, a spray booth is an excellent way to remove spray paint vapors and debris from a worker's breathing zone. Many coatings contain flammable substances that are aerosolized when sprayed through powered equipment and without proper ventilation, such as in a spray booth, these vapors can build up and create an explosion and fire danger. But to provide maximum protection, the spray booth must be properly maintained, including regular cleaning of filters and overspray. And to prevent sparking a flammable substance, smoking and other sources of flame near spray painting operations should be prohibited and tools should be properly rated and grounded for work in a spray painting area.

Because much of the equipment used for spray painting and surface preparation uses compressed air, workers should be aware that noise can be a risk, so should wear hearing protection when working with air powered tools.

How to Control Health Hazards

Following a few sensible rules can help to reduce exposure to chemical hazards.

Environmental Control
Whenever possible, painting or priming operations should be done in a spray booth or room. These areas have been designed to reduce exposure to paint vapors and additives – use them correctly. You should make sure that the ventilation in the spray booth or room is adequately maintained and working properly.
Before using the spay booth or room:
- turn on the ventilation system,
- check the spray booth filters and change if necessary, and

- turn on the make-up air unit.
- When painting in an enclosed space (a room):
- provide outside ventilation air with fans or open windows,
- turn off ignition sources like wall heaters
- When painting:
- follow the equipment manufacturer's instructions,
- avoid using plastic drop cloths on the floor (slip hazard)
- never point a spray gun at yourself or anyone else,
- position yourself so the piece you are spraying is between you and the exhaust fan,
- do not over spray, and
- use appropriate personal protection.

Personal protection

One positive step you can take to ensure continuing good health is to use personal protective equipment. Here is a brief description of some of the protective equipment available.

Respirators

Two types of respirators, the air-purifying and the atmosphere supplying, are commonly used in spray painting. IMPORTANT – you MUST use the correct type of respirator for the job being done and the chemicals being used.
The air-purifying type of respirator should be used only during exposure to those specific chemicals, or groups of chemicals, described on the respirator cartridge. These cartridges are good only for a limited time and must be replaced with new ones when:

- you can smell vapors in the mask,
- they become difficult to breathe through, or
- they have been used for their specific lifetime.

The atmosphere-supplying type of respirator must be used in some paint spraying operations, particularly with urethane paints or when painting in a confined space e.g. inside a tank.

REMEMBER — whichever respirator is used, it must FIT properly to ensure adequate protection (check the manufacturer's instructions). Respirator maintenance and cleaning is important. No one wants to use a dirty, leaky respirator which has been worn previously by someone else. Keep your respirator in good condition by cleaning and sanitizing it regularly. Store it in a clean place. Check it for pliability and signs of deterioration before you wear it. If the respirator needs repair, use only the manufacturer's recommended replacement parts. With a little thought, and a small amount of effort, your respirator will protect you for a long time.

Eye and Hearing Protection

Without good eyesight you cannot do your job properly — so why risk eye damage, or loss of eyesight from solvent spray or splashing. Wear your SAFETY GOGGLES to protect your eyes from paint materials as well as the particulates created during sanding and grinding.

Some painting equipment such as grinders and compressors create loud noise. Hearing protection is required when noise levels exceed 85 db.

Protective clothing

Some of the chemicals you work with can injure skin or cause dermatitis. Coveralls and gloves prevent these chemicals from coming into contact with your skin, reducing the risk of damage. Wear your coveralls and gloves whenever working with chemicals. Clean your gloves and wash your coveralls regularly to prevent chemicals from accumulating, especially around the cuffs where they can easily come into contact with your skin. As an additional protective measure, use BARRIER CREAMS on your hands, face and neck. Check to make use you have the correct barrier cream for the chemicals being used.

Fire and explosion hazards

Because of the danger of fire and explosion where paints which contain flammable solvents are being used, care should be taken to remove all potential sources of ignition before starting work. This means naked flames, cutting and welding torches, gas fired heaters and materials which may give off sparks, whether electrical, mechanical, friction or static, and there must be no smoking. Make sure the correct types of fire extinguishers are available at the work site.
REMEMBER different types of fires require different types of extinguishers.
IMPORTANT: Flammable materials are required to be stored is flammable materials storage cabinets. Many Paint and solvents are flammable materials.

Dust and Preparation

Many painting projects require preparation of the materials to be painted. Preparation often involves sanding of the surface which creates a health hazard if dust masks are not worn. Ideally dust collection systems should be used to prevent large amounts of small particulates from entering the air.
Sanding and scraping of old paint may hold additional hazards if the old paint contains lead.

Things to do and not to do before painting
DO Post “No Smoking” and “No Welding” signs
DO Remove portable lamps and heaters from the area
DO Make sure painting is done away from naked flames, sparks, non-explosion proof motors or any other source of ignition.
DO Check the ventilation system to make sure it is on and working correctly.
DO Electrically ground all spraying equipment
DO Make sure approved respirator, eye goggles and any other protective equipment required for the job are worn
DON’T Smoke
DON’T Take more paint out of the store room than you can use in one day.

Housekeeping

Housekeeping should be systematic, comprehensive and consistent with the requirement of applicable Safety Rules. The requirements of IS 4082 (latest version) should be followed regarding stacking and storage of construction materials at site.

Workmen are frequently injured by tripping, stumbling, stepping on or bumping into tools, material and other objects left lying around or by carelessly placed objects falling from above. To ensure good housekeeping, the following safety precautions should be observed in construction / O & M activity as applicable:

Loose materials which are not required for use should not be placed or left so as dangerously obstruct workplaces and passageways.

All projecting nails should be removed or bent over to prevent injury.

Equipment, tools and should objects should not be left lying unattended where they could cause an accident either by falling or causing a person to trip.

Scrap, waste and rubbish should not be allowed to accumulate at the site.

Workspaces and passageways that are slippery owing to oil or other causes should be cleaned up or strewn with sand, ash or suitable means.

Portable equipment should be returned after use to its designated storage place.

Walks, aisles, stairways, fire escapes and all other passage ways should be kept clear of all obstructions.

Tools and materials should not be placed where they may cause tripping or stumbling hazards or where they may fall and strike any one below.

Puddles of oil and water create a slipping hazard and should be cleaned up promptly.

Nails in boards, such as those removed from scaffolds, forms and packing boxes, constitute a hazard and should be removed. The boards should be carefully stacked or stored.

Dirty and oily waste rags should be disposed off as soon as practicable to avoid fire hazard.

All pathways should be conspicuously marked.

All floor areas, pathways should be even & free from pot holes, pits & humps.

Broken light bulbs, glass, metal scrap and other sharp objects should be dumped in places, provided specially for them.

Discarded fluorescent and other gas filled tubes should be disposed of safely.

Cleanliness

Workplace should be kept clean and free from effluvia arising from any drain, privy or other, nuisance and in particular-

Accumulations of dirt and refuse should be removed daily by sweeping or by any other effective method from the floors and benches of workrooms and from staircases and passages, and disposed of in a suitable manner.

The floor of every workroom should be cleaned at least once in every week by washing, using disinfectant, where necessary, or by some other effective method;

Where a floor is liable to become wet in the course of any manufacturing process to such extent as is capable of being drained, effective means of drainage should be provided and maintained.

All inside walls and partitions, all ceilings or tops of rooms and all walls, sides and tops of passages and staircases should –

- where they are painted otherwise than with washable water-paint or varnished, be repainted or re-varnished least once in every period of five years;
- where they are painted with washable water paint, be repainted with at least one coat of such paint at least once in every period of three years and washed at least once in every period of six months;
- where they are painted or varnished or where they have smooth impervious surfaces, be cleaned at least once in every period of fourteen months by such method as may be prescribed;

In any other case, inside walls and partitions be kept whitewashed or colour washed, and the whitewashing or colour washing should be carried out at least once in every period of fourteen months;

All doors and window frames and other wooden or metallic frame work and shutters should be kept painted or varnished and the painting or varnishing should be carried out at least once in every period of five years;

All floors, steps, stairs, passages and gangways should be of sound construction and properly maintained and should be kept free from obstructions and substances likely to cause persons to slip, and where it is necessary to ensure safety, steps, stairs, passages and gangways should be provided with substantial handrails. Refer Housekeeping Checklist at Appendices.

CHAPTER 21: SAFETY IN TRANSPORTATION, EARTHMOVING EQUIPMENT AND OTHER CONSSTRUCTION EQUIPMENT OR MACHINERY (INCLUDING MATERIAL HANDLING

Manual Handling of Materials

Material is handled between operations in every department, division, or plant of a company. It is a job that almost every worker in industry to handle - either as his sole duty or as part of his regular work, either by hand or with mechanical help

Preventing common injuries

Handling of material accounts for 20 to 25 percent of all occupational injuries - These occur in every part of an operation, not just the stock room or warehouse. On an average industry moves about 50 tons of material for each ton of product produced. Some industries move 180 tons for each ton of product. Strains, sprains, fractures, and contusions are the common injuries. They are caused, primarily by unsafe work practices, such as improper lifting, carrying too heavy a load, incorrect gripping, failing to observer proper foot or hand clearances and failing to wear personal protective equipment.

To gain insight into the material handling injury problem, the safety professional should consider the following operating practices and management policies.

Can the job be engineered to eliminate manual handling so far as possible?
Can the material be conveyed or moved mechanically?
In what way do the materials being handled (such as chemicals, dusts, rough and sharp objects) cause injury?
Can employee be given handling aids, such as properly sized boxes, adequate trucks, or hooks that will make their jobs safer?
Will protective clothing or other personal equipment help prevent injuries?

These are by no means the only questions that might be asked, but they serve as a start toward overall appraisal and detailed inquiry. The largest number of injuries occurs to fingers and hands. People need instruction if they are to learn the proper way to lift objects and to set them down. Training in safe work habits, breakdown and study of even the simplest job operations, and adequate supervision can help minimize these accidents.

General points that can be given to those who handle materials include:
Inspect materials for jagged or sharp edges, burrs, rough or slippery surfaces.
Grasp the object with a firm grip.
Keep fingers away from pinch and shear points, especially when setting down materials.
When handling lumber, pipe or other long objects, keep hands away from the end to prevent them from being pinched.
Wipe off greasy, wet, slippery or dirty objects before trying to handle them.
Keep hands free of oil and grease.

In most cases, gloves, or other hand protectors should be used to prevent hand injuries. In other cases, handles or holders can be attached to objects, such as handles for moving auto batteries, tongs for feeding materials to metal-forming machinery or baskets for carrying laboratory samples. Feet and legs sustain a major portion of material handling injuries - the

greater percentage occurring to the feet. Workers should be instructed to wear foot protection such as safety shoes. The eyes, head and trunk of a body can also be injured. When opening a wire-bound or metal bound bale of box, a person should wear eye protection equipped with side shields as well as stout gloves, and take special care to prevent the ends of the bindings from flying loose and striking the face or body. The same precaution applies to handling coils or wire, strapping, or cable. In many cases, special tools are available to safely cut bands, strapping, and the like. Workers should always read the labels on packages for special instructions. If material is dusty or is toxic, the person handling it should wear a respirator or other suitable personal protective equipment. Manual handling of materials increases the possibility of injury and adds to the cost of a product. To reduce the number of material handling injuries and to increase efficiency, manual material movement should be minimized by combining or eliminating operations. Mechanical movement of materials should be used so far as possible. For those jobs that cannot be mechanized, here are some suggestions.

Lifting by hand

Physical difference makes it impractical to establish safe lifting limits applicable to all workers. A person's height and weight, although important, do not necessarily indicate lifting capability, because some small thin individuals can handle heavier loads than some tall, heavy persons, and medical recommendations should also be used when establishing lifting standards. When a worker lifts a heavy or bulky object and carries it to another location, the route over which the object is moved should be inspected before hand to make sure that there are no obstructions or spills that could cause slipping or tripping injuries. If clearance is not adequate for handling the load, then an alternate route should be taken. The object should be inspected next to decide how it should be grasped and how to avoid sharp edges, or other things that might cause injury. The object may have to be turned over before attempting to lift it. Also, if the object is wet or greasy, it should be wiped dry so that it will not slip. If this is not practical, the worker should use a rope sling or other device that will give a positive grip. Most strains and back injuries occur when lifting and setting down objects by hand. It is important that those who do this work be trained in the proper lifting techniques, if these injuries are to be reduced.

The correct applications of six basic factors are essential.
Correct position of fact
Straight back and bent knees.
Load held close to the body 9for lifting and carrying)
Correct grip
Chin in
Use body weight

Correct position of feet

One of the causes of muscle injury, particularly to the back is the loss of balance due to working with the feet too close together. Lifting off the ground, pushing and pulling or reaching (and in many instances over reaching) may cause an off balance body condition. A common reaction to this condition is a stiffening of muscles in the lower limbs and back. In the kinetic method, however, the feet are correctly positioned with one placed in the proposed direction of movement and the other in a position where it can give thrust to the body. The worker can decide whether he prefers the forward foot to be his left or right.

Straight back and bent knees
A straight back is not necessarily a vertical back. In the kinetic method, the back is often inclined, particularly when lifting weights from the ground but the inclination should be from the hips so that the normal curvatures are maintained. This is termed a 'straight back'.

With 'straight back lifting' the spine is fairly rigid and the pressure on the lumbar intervertibral disks is evenly distributed. When lifting with the back bent, the spine forms an arc, with the result that the lower back muscles are subject to strain causing an uneven pressure on the disks. In addition to the risk of intervertibral disc lesions, lifting an object with the back bent and the legs straight imposes excessive stress on the muscles of the back for two reasons. First, the back must be inclined at a greater angle to the vertical for the hands to reach the objects. Since the 'effective weight' (the object plays on the upper part of the worker's body) increases rapidly as this angle is increased, a much greater position. Second muscular effort is required to straighten the spine. When a weight is properly lifted from the ground, with maximum effective use of the legs, the back is straight but inclined forward. As the lift proceeds by the extension of the knees, the back returns to the vertical position. The position of the feet and the flexion of the knees are the key factors for maintaining a straight back.

Load close to the body
While lifting and carrying weights, the worker should keep the load close to the body. To do this, the arms should be close to the body and remain straight whenever possible. Flexing the elbows and raising the shoulders imposes unnecessary strain on the upper arm and chest muscles. Carrying involves a static posture of the arms, and, in the case of long distance carrying, any assistance given by the body in supporting the weight will lessen the tension in the muscles. Carrying with arms straight down enables the weight to rest again the body

Correct grip
An insecure grip may be caused by taking the load on the finger tip thus creating undue pressure at the ends of the finger and strain to certain muscles and tendons of the arm. Because greasy surfaces often prevents a secure hold, surfaces, should be wiped clean. The use of suitable gloves should also be considered. The worker should make certain that the gloves fit properly. A full palm grip will reduce local muscle stress in the arms and decrease the possibility that the load will slip.

Chin in
Raising the top of the head and tucking the chin in straightens the whole spine, not merely the neck. This position automatically raises the chest and shoulders for more efficient arm action. This chin-in action should be introduced immediately before lifting and maintained throughout the procedure. The worker will be looking down at the early stages of the lift, which may conflict with his desire to raise this head to see where he is going. However, as he returns to the upright position, his head will automatically be raised at the same time.

Use of body weight
Employing the correct positioning of the feet and the flexion and extension of the knees, the weight of the body can be effectively used to push and pull objects and to initiate a forward movement, such as placing an object on a shelf or walking.

Before lifting the load to be carried, the worker should consider the distance to be travelled and the length of time that the grip will have to be maintained. The worker should select a

place to set the load down and rest in order to make allowance for the loss of gripping power during a long distance carry this is especially important when negotiating stairs and ramps.

To place an object on a bench of table, the worker should first set it on edge and push it far enough onto the support to be sure it will not fall. The object should be released gradually as it is set down. It should be moved in place by pushing with the hands and body from in front of the object. This method prevents fingers from being pinched.

To raise an object above shoulder height, the worker should lift it first to waist eight. He should rest the edge of the object on a leg, stand. He should then shift hand position, so the object can be boosted after the knees are bent. The knees should be straightened as the object is lifted or shifted to the shoulder.

To change direction, the worker should lift the object to the carrying position and turn the entire body, including the feet. He should avoid twisting the body. To deposit manually in a height space, it is safest to slide it into place with the hands in the clear

Team lifting and carrying

When two or more people carrying one object, they should adjust the load so that it rides level and that each person carries an equal part of the load. When two people carry long sections of pipe or lumber, they should carry them on the same shoulder and walk in step. Shoulder pads will prevent cutting o the shoulders and reduce fatigue.

When a gang of worker carries a heavy object such as a rail, the supervisor should make sure that proper tools are used.

Handling Specific Shapes

Boxes, Cartons, and Sacks: The best way to handle boxes and cartoons is to grasp the alternate top and bottom corners and to draw a corner between the legs. Sack materials are also grasped at opposite corners. Upon reaching an erect position, the worker should let the sack rest against his hip and belly and then swing the sack to one shoulder. As the sack reaches his shoulder, he should stoop slightly and put his hand on his hip, so that the sack rests partly on the shoulder and partly on the arm and back. The other hand should be holding the sack at the front corner. When the sack is put down, it should be swung slowly from the shoulder until it rests against the hip and belly. While the sack is being lowered the legs should be flexed and the back kept straight.

Barrels and drums: Those who handle heavy barrels and drums require special training. A barrel is generally less hazardous to handle than a drum because the shape of the barrel aids in unbending it. Since the weight and contents of a barrel or drum may vary greatly, special attention should be given to these factors. Frequently, only one person is available to handle a drum, in which case it is better to wait for help or use mechanical assistance. A commercially available drum tilter equipped with wheels is commonly used. An extension handle provides control and leverage during the tilting operation. The wheels allow the tilted drum to be transported short distances more readily. Another commercial device is a two-wheeled trolley equipped with large rubber tyres that is gaining popularity due to the ease of tilting and transporting. If it is necessary to roll a barrel or drum, the worker should push against the sides with the hands. To change direction of the roll, he should grip the chime rather than kick the drum. A clamp device for carrying a drum is available. To lower a drum or

barrel down a skid, the drum should be turned and slid endwise. Rolling a drum or barrel up a skid takes two persons, who should stand outside the skid, neither inside the rails nor below the drum or barrel being raised or lowered. If drums or barrels are to be handled on an incline or skid, ropes or other tackle should be used to control their motion. The drum or barrel should be snubbed with a rope, one end of which is securely fastened to the platform from which the drum or barrel is to be lowered. The rope should then be passed around the barrel or drum, and the operator, keeping a firm grip on the free end, can gradually lower the load.

Sheet metal usually has sharp edges and corners and should be handled with leather gloves, or gloves with metal inserts. Gauntlet-type gloves or wristlets will give added protection to wrist and forearm. Bundles of sheet metal should be handled with power equipment.

Flat glass should be handled by persons equipped with gloves or hand laps, wrists and arms should be protected with leather cuffs and safety sleeves. The worker should wear a leather apron, leggings, and safety shoes. Unless the glass plates are small, the worker should carry only one at a time and walk with care. The plate should be lifted carefully and carried with its bottom edge resting in the palm (turned outward) and the other hand holding the top edge to steady it. Glass plate should never be carried under the arm because a fall might break the glass and severe an artery. To transport larger glass plates over any distance, handling equipment should be used. Larger flat glass should be handled by equipment specifically designed for that purpose. Equipment such as cranes equipped with vacuum frames. C-frames or spreader bars, and special wagons etc. are normally used to transport heavy glass. If large plates must be transported by hand, two workers wearing safety hats, safety sleeves, cuffs, gloves, and safety shoes should be assigned to the job.

Long objects: Long pieces of pipe, bar stock, or lumber should be carried on shoulder, with the front end held as high as possible to prevent striking other employees, especially when going around corner. Workers should wear shoulder pads for this operation.

Irregular objects: Presents special problems. Often the object must be turned over or up on end, so that the best possible grip can be secured. If the worker questions his ability to handle the object, because of either its weight or shape, he should get help.

Scrap Metals: In a scrap storage area, the best possible housekeeping practices should be observed irregularly shaped jagged pieces may be tangled in such a way that strips or pieces may not fly when a piece is removed from a pile. Workers, therefore, should be provided with goggles, leather gloves or mittens, safety hoe, safety hats and protection for the legs and body. Workers should be cautioned against stepping on objects that may roll or slide.

Heavy, round flats, objects: Can be rolled by hand only with considerable skilled personnel. The operation required careful training and exacting precautions. It is preferable to use hand truck or power equipment designed for the purpose.

Safety in Material Handling

Crane and Motorized Equipment Operation
Permit only qualified and authorized operators to operate cranes and motorized equipment. The Contractor shall make available upon request, documentation supporting operator's qualifications. Annexure OCP-28

Operate cranes and motorized equipment within the manufacturer's specifications and limitations.

Permit only Competent Person(s) to rig loads.
Lift plans shall be developed for lifts, which meet any of the following criteria. Lift plans shall be completed by a Competent Person and submitted to the Site Safety Representative for review.
Lifts using more than one crane
Lifts greater than 70% of the cranes capacity
Lifts that are large or awkward in shape or that would have a tendency to act as a "sail".

Crane and Motorized Equipment Inspections

All cranes and motorized equipment must be inspected by a competent person at the beginning of each shift to ensure all parts, equipment and accessories that affect the safe operation are operating as designed.

Monthly crane inspections must be conducted by a Competent Person and documented Certification and other test/inspection documentation must be available for review upon request.

Annual crane inspections must be conducted by a qualified and approved organization and documented. Certification and other test/inspection documentation must be available for review upon request.

Any deficiencies affecting safe operation must be corrected before the equipment is placed in service.

Crane Suspended Personnel Platforms

The use of a crane or derrick to hoist employees on a personnel platform is prohibited, except when the erection, use and dismantling by conventional means of reaching the work site, such as a personnel hoist, ladder, stairway, aerial lift elevated work platform, or scaffold, would be more hazardous or is not possible because of structural design or work site conditions. For instances requiring the use of a personnel platform, a permit system will be used and the task supervised by a Competent Person to safeguard personnel while working in a crane suspended work platform.

Where a crane suspended personnel basket is used, a safe work procedure including a JSA /RA must be produced by a competent person. This must comply with applicable regulatory requirements.

Reference to regulations

The Site Safety Representative, where authorized, will review any use of crane suspended personnel platforms.

Equipment Inspections

Inspect tools, electrical cords, welding leads, and rigging equipment for safety defects prior to use.

Prohibit the use of unsafe tools, electrical cords and rigging equipment.

Unsafe tools, electrical cords and rigging equipment shall be tagged “Defective - Do Not Use” and shall be repaired prior to reuse or discarded.

Tools, electrical cords, welding leads, and rigging equipment shall be thoroughly inspected and tested as appropriate on a quarterly basis. Inspection shall be documented using tags, color codes, logs, or other means to indicate that equipment has been inspected.

Storage and Handling

The stacking, storage and handling of materials generally used in for construction works should conform to the following guidelines:

i. **Timber**

Timber should be stacked on unyielding and level tonnage. Cross strips or cross piling should be used where the pile is more than 1m high.
The top of each pile should be kept as level as possible when timber is being removed.
No nails should be allowed to protrude so as to cause any injury.
At least two men should carry long boards, and care should be exercised at corners and crosswalks.

ii. **Cement**

Workmen, handling bulk cement,

Should wear protective clothing, respirators and goggles,
Should be instructed the need of cleanliness to prevent dermatitis.
Should be provided with Barrier Cream

Stacks should not be higher than 15 bags. If the stack has to be more than 8 bags high, the bags should be arranged in header and stretcher fashion, that is, alternate layers lengthwise and crosswise, so as to tie the piles together to lessen the danger of toppling over. Bags should be removed uniformly from the top of the piles to avoid tipping of the stack.

Bulk cement stored in silos or bins may fail to feed to the ejections system. When necessary to enter a silo or bin for any purpose, the ejection system employed should be shut down and locked out. When necessary for a workman to enter such storage area, he should wear a lifeline, with another workman outside the silo or hopper attending the rope. Work permit system should be implemented for carrying out this work.

iii. **Sheet Glass and Fibre Glass**

Glass panes used in building construction should be stacked on edge with suitable supports.
Glass edges should be covered or otherwise protected to prevent injuries to workmen passing by.
Waste glass pieces should be stored or disposed of in such a manner as to avoid injuries to workmen.
Workmen handling glass panes, waste glass pieces and fiberglass should be provided with suitable hand protection.
Holding the glass sheet under arm pit should be prohibited.

iv. **Pipe, Poles and Piles**

Pipe should be stacked on solid, level sills and contained in a manner to prevent spreading or rolling of the pile. Where high quantity storage is necessary, suitable packing should be placed between succeeding layers to reduce the pressure and resulting spreading of the pile.
Heavy-duty cantilever racks can be used to allow good visibility and easy access to materials.
Orderly storage as to sizes and lengths enhances access and removal operations.
Removal of pipe from a pile should be accomplished by working from the ends of the pipe.
In loading pipe or transit, it should be so secured as to insure against displacement.
While handling piles or poles taglines should be used to control movement of them.
In stacking and handling of pipes and other conducting materials the following minimum safety distances should be ensured from the overhead power lines :-

11kV and below	1.40m
Above 11 and below 33kV	3.60m
Above 33 and below 132 kV	4.70m
Above 132 and below 275 kV	5.70m
Above 275 and below 400 kV	6.50m

v. **Reinforcement Steel and Structural Steel**

Reinforcement steel should be labeled and stored on firm ground according to length, size and shape, and should be piled in such a manner as to prevent tipping or falling.
Steel should be stored on a solid foundation with adequate number of wooden packing below.
Adequate spacing should be maintained between piles to ensure safe access.
Structural steel should be carefully piled to prevent sliding or tipping.
Precautions laid down in 2.4 should be followed.
Tag lines should be used to control the movement of the load during handling Reinforcement or structural steel when a crane is employed.
As far as possible, lifting and carrying of heavy materials manually should be avoided.

vi. **Handling Heavy & Long Items**

Loading and unloading of heavy items should, as far as possible, be done with

cranes or gantries. The workman should stand clear of material being moved by crane. The slings and the ropes used should be of adequate load carrying capacity, so as not to give way and result in accidents. Adequate safety clearance should be maintained from overhead electrical lines.

vii. **Loading and Unloading from Motor Vehicles**

The motor vehicles should be properly blocked while being loaded or unloaded; brakes alone should not be dependent upon to hold them.
Ladder should be used to climb up / down the vehicle.
Load on the vehicle should be secured adequately so that the load does not slide down. If the width of the load exceeds that of the vehicle, red lights / flag should be provided on all the corners of the vehicle to caution other vehicles on the road.
Unloading should be started from top.
When motor vehicles are being loaded or unloaded near passageways or walkways, adequate warning signs should be placed on each end of the Vehicle to warn pedestrians and the drivers of the other vehicles.

viii **Sand, Gravel and Crushed Stone**

Stockpiles of these materials should be so located as to provide easy access for withdrawing. In stacking these materials minimum safety distances mentioned under 3.4 should be between the material and the over-head power lines.
When withdrawals are made from stockpiles, no overhand should be permitted.
Materials should not be piled against walls that will be endangered by thrust, nor along the sides of any excavation or on the top of an embankment so as to cause slips.
Employees required to enter hoppers should be equipped with safety belts and lifelines, attended by another person. Machine-driven hoppers, feeders, and loaders should be locked in the off position prior to entry. Work permit system should be implemented.

ix. **Paints, Varnishes and Thinners**

Paints, varnishes, thinners and other flammable materials should be kept in properly sealed or closed containers. The containers should be stored in a well ventilated, free from excessive heat, smoke, sparks or flame. A separate shelter should be provided for storing these materials.
Paint materials in higher quantities other than required for daily use should be kept stocked under regular storage place.
Paint scrapings and paint-saturated rags and debris should be removed daily from the premises and preferably, destroyed by burning at a safe place.
Ventilation adequate to prevent the accumulation of flammable vapours to hazardous levels of concentration should be provided in all areas where painting is done. When electric lights, switches or electrical equipment are necessary, they should be of explosion-proof design.
Fire Buckets and foam type should be kept ready for use in case of fire.
No smoke or open fire, exposed heating elements, or other sources of ignition of any kind should be permitted in areas or rooms where spray painting is being done.

x. **Bitumen, Bituminous Emulsion and Road Tar**

No stack should exceed 100 drums (180/200 litres). Safe distance of 6m minimum should be kept between stacks.
Drums should be kept stacked on their sides so that water does not collect on them.
Pyramid stacking should always be used and the height of the stack should not exceed 3 tiers.
Stack building or de-stacking should be done only by using crane.

xi. **Flammable Materials**

A separate shelter should be provided for storing flammable materials.
Flammable materials should be stored in accordance with the relevant regulations and rules so as to ensure the desired safety during storage. Explosives like detonators should be stored in accordance with the existing regulations of Indian Explosives Act.
Operations in connection with handling, storage and issuance of inflammable liquids should be under the supervision of qualified and experienced persons.
Workmen should be required to guard carefully against any part of their clothing becoming contaminated with flammable fluids. They should not be allowed to continue work when their clothing becomes so contaminated.
Petroleum products delivered to the job site and stored there in drums should be protected during handling to prevent loss of identification through damage to drum markings, tags, etc. Unidentifiable petroleum products may result in improper use, with possible fire hazard, damage to equipment, or operating failure.
Bulk delivery and storage of petroleum products requires the same care in identification, and particular attending to fire hazards during handling.
Outdoor storage of drums requires some care to avoid contaminations. Moisture and dirt in hydraulic brake and transmission fluid, gasoline, or lubricants may easily cause malfunction or failure of equipment, with possible danger to personnel. The storage area should be free of accumulations of spilled products, debris and other hazards.
Compressed gases and petroleum products should not be stored in same building or close to each other.
For bulk storage of petroleum (petrol, diesel etc.) and the like, the storage should comply strictly with the specifications given in the Petroleum Rules (and with the relevant act).

Construction and maintenance of lifting appliances

Ensure at a construction site of a building or other construction work that –

all lifting appliances, including their parts and working gear, whether fixed or movable and any plant or gear used in anchoring or fixing of such appliances, are
of sound construction, sound material and of adequate strength to serve the purpose for which these are to be used and all such appliances should be free from patent defects; and maintained in good repair and working condition;
every drum or pulley around which the rope of any lifting appliance is carried, is of adequate diameter and sound construction in relation to such rope;

any rope which terminates at the winding drum of a lifting appliance is securely attached to such drum and at least three dead turns of such rope remain on such drum in every operating position of such lifting appliances;
the flange of a drum projects twice the rope diameter beyond the last layer of such rope and if such projection is not available, other measures like anti-slackness guards should be provided to prevent such rope from coming off such drum;

every lifting appliance is provided with adequate and efficient brakes which
are capable of preventing fall of a suspended load (including any test load) and of effectively controlling such load while it is being lowered;
act without shock ;
have shoes that can be easily removed for running; and
are provided with simple and easily accessible means of adjustment:

Controls of every lifting appliance -
are so situated that the driver of such appliance at his stand or seat has ample room for operating and has an unrestricted view of building or other construction work, as far as practicable, and that he remains clear of the load and ropes, and that he remains clear of the load and ropes, and that no load passes over him;
are positioned with due regard to ergonometric considerations for proper operation of such appliance;
are so located that the driver of such appliance remains above the height of the heel block during the whole operation of such appliance;
have upon them or adjacent to them clear markings to indicate their purposes and model of operations;
are provided, where necessary, with a suitable locking device to prevent accidental movement or displacement;
move, as far as practicable, in the direction of the resultant load movement; and
wherever automatic brakes are provided, automatically come to the neutral position in case of power failure.

Ensure at construction site of a building or other construction work that –
all lifting appliances including all parts and gears thereof, whether fixed or movable are tested and examined by a competent person before being taken into use for the first time or after it has undergone any alterations or repairs liable to affect its strength or stability or after erection on a construction site and also once at least in every five years, in the manner specified in Schedule I annexed to these rules;

all lifting appliances are thoroughly examined by a competent person once at least in every twelve months and where the competent person making such examination forms the opinion that the lifting appliance cannot continue to function safely, he should forthwith give notice in writing of his opinion to the owner of the lifting appliance;

Transport and Earth Moving Equipment

Earth moving equipment and vehicles – Ensure at construction site of building or other construction work that-

All vehicles and earth moving equipment are made of good material, proper design and sound construction and are sufficiently strong for the purpose for which such equipment are

used and are maintained in good state of repair and are properly used in accordance with standard safe operating practices :
Provided that the truck or trailer employed for transporting freight containers are of the size sufficient to carry the containers without overhanging and are provided with twist locks conforming to national standards, at all the four corners of each of such truck or trailers and such truck or trailers are certified for such use by an authority under the relevant law for the time being in force and is inspected by a responsible person, at least once in a month and record of such inspection is mentioned;
All transport of earth moving equipment and vehicles are inspected at least once a week by a responsible person and in case any defect is noticed in such equipment or vehicle, it is immediately taken out of use;
power trucks and tractors are equipped with effective brakes, head-lights and tail lamps and are maintained in good repair and working order;

Side stanchions on power trucks and trailers for carrying heavy and long objects are:

- Of sound construction and free from defects;
- Provided with tie chains attached to the top across the loads for preventing such stanchions from spreading out; and
- Kept in position while loading and unloading;

Safe gangways are provided for to and fro movement of building workers engaged in loading and unloading of lorries, trucks, trailers and wagons;
Trucks and other equipments are not loaded beyond their safe carrying capacity which should be clearly marked on such trucks and other equipments;
Handles of hand trucks are so designed as to protect the hands of the building workers working on such trucks, or such handles are provided with knuckle guards;
No unauthorized person rides the transport equipment employed in such work;
A driver of transport equipment maneuvers such equipment under the direction of a signaler;
Adequate precaution such as isolating the electric supply or erecting overhead barriers of a safe height is taken when earth moving equipment or vehicles are required to operate in dangerous proximity to any live electric conductor;
Vehicles and earth moving equipments are not left on a slope with the engine of such vehicles or equipment running;
All earth moving equipment, vehicles or other transport equipment are operated only by such persons who are adequately trained and possess such skill as are required for safe operation of such equipment, vehicle or other transport equipment.

Power shovels and excavators

a. A shovel or an excavator whether operated, by steam or electric or by internal combustion used for such work is constructed, installed, operated, tested and examined as required under any law for the time being in force and the relevant national standards;

b. Excavator equipped for use as a mobile crane is-
   i. Examined and tested in accordance with the requirements for such mobile crane under these rules; and
   ii. Fitted with an automatic safe working load indicator;

c. Buckets or grabs of power shovels are propped to restrict the movement of such buckets or grabs while being repaired or while the teeth of such buckets or grabs are being changed.

Bulldozers

a. An operator of a bulldozer before leaving such bulldozer-
   i. Applies the brakes;
   ii. Lowers the blade and sipper; and
   iii. Puts the shift lever into neutral
b. A bulldozer is left on level ground at the close of the work for which such bulldozer is used;
c. The blade of a bulldozer is kept low when such bulldozer is moving uphill;

d. The bulldozer blades are not used as brakes except in an emergency.

Scrapers

a. A tractor and scraper is joined by safety line at the time of its operation;
b. The scraper bowls are propped while blades of such scraper are being replaced;
c. A scraper moving downhill is left in gear

Mobile asphalt layers and finishers

a. A mixture elevator is within a wooden or sheet metal enclosure with a window for observation, lubrication and maintenance;
b. bitumen scoops have adequate covers;
c. When asphalt plants are working on a public road; adequate traffic control is established on such road and the building workers working with such plant are provided with reflecting jackets;
d. A sufficient number of fire extinguishers are kept in readiness on such workplace where fire hazards may exist;
e. the materials are loaded on the elevator after the drying drain has warmed up of such elevator;
f. No open light is used for ascertaining the level of asphalt;
g. Inspection opening is not opened till there is a pressure in the boiler which may cause injury to a building worker.

Pavers

The employer should ensure at a construction site of a building or other construction work that pavers are equipped with guards suitable to prevent building workers from walking under the skip of such pavers.

Road rollers

The employer should ensure at a construction site of a building or other construction work that-

a. Before a road roller is used on the ground, such ground is examined for its bearing capacity and general safety, especially at the edges of slopes such as embankments

on such grounds;

b. A roller is not moved downhill with the engine out of gear.

General safety

a. Every vehicle or earth moving equipment is equipped with-
   i. Silencers;
   ii. Tail lights;
   iii. Power and hand brakes;
   iv. Reversing alarm; and
   v. Search light for forward and backward movement, which are required for safe operation of such vehicle or earth moving equipment;

b. The cab of vehicle or earth moving equipment is kept at least one metre from the adjacent face of a ground being excavated;

c. When a crane or shovel are traveling, the boom of such crane or shovel is in the direction of such travel and the bucket or scoop attached to such crane or shovel is raised and without load, except when such traveling is downhill.

Transporting Machinery

i. General Safety

Every vehicle or earth moving equipment should have the following fully functional :
Silencers;
Tall lights;
Power and hand brakes;
Reversing alarm; and
Search light for forward and backward movement

ii. Driver's Cabin

Motor trucks, tractors and dumpers should be equipped with a cabin or a canopy of sufficient strength and so installed as to provide adequate protection to the driver.

If the cabin is enclosed, it should be provided with windows giving maximum possible view and should be well ventilated. The driver should be able to make a easy exit in case of any emergency.

Driver's seat should have backrest and the seat should be of such design, construction and dimensions as will absorb vibration sufficiently and provide reasonable comfort.

Motor trucks and tractor's should be equipped with a footboard steps and hand-holds such that it is possible to get into and out of the driver's cabin safely and the cabin should be so arranged that the driver can easily get off in case of emergency.

iii. Brakes and Controls

Motor trucks, tractors and dumpers should be equipped with brakes that will hold them

under the heaviest load that may be hauled in any operating conditions and should enable the vehicle to be locked when stationary.

iv. Draw Gears

Motor trucks, hauling trailers and tractors should be equipped with draw gear such that during coupling no workmen can come between the vehicles being coupled or the vehicles being coupled cannot run into each other.

Vehicles should not move down the hill with the engine off or with the engine out of gear.

v. Drivers

Only competent and licensed persons should drive motor trucks and tractors.

Drivers should be required to leave the cabins and stand in the clear while the motor trucks are being loaded.

Drivers of tripper trucks used for hot mix plants and batch mix concrete plants and similar operations should wear the industrial safety helmets.

vi. Other operating Conditions

Motor trucks should be stationed at such a distance from the power shovel (excavator) that there is a clearance of at least 0.6m between the trucks and the superstructure of the power shovel (excavator) even when it pivots.

Where the driver does not have a clear field of vision the movement of motor trucks and tractors should be controlled by a code of standard hand signals.

When uncoupling vehicles, both vehicles should be blocked by brakes or chocks.

Vehicles being loaded or unloaded should be effectively braked or blocked.

Motor trucks should not be loaded beyond their capacity.

Before a loaded motor truck starts, the load should be inspected to ensure that it is secure, evenly distributed and of safe height, length and width.

Sufficient stop blocks should be provided at every tipping point and these should be used on every occasion when material is dumped from the truck damper.

Machine Guarding

All motors, cogwheels, chains and friction gearing, flywheels, shafting, dangerous and moving parts of machinery (whether or not driven by mechanical power) and steam pipes are securely fenced or lagged;
the fencing of dangerous parts of machinery is not removed while such machinery is in motion or in use;

No part of any machinery which is in motion and which is not securely fenced is examined, lubricated, adjusted or repaired except by a person skilled for such examination, lubrication, adjustment or repairs;
Machine parts are cleaned when such machine is stopped;
When a machine is stopped for servicing or repairs, adequate measures are taken to ensure that such machine does not re-start inadvertently.

Work Permit System

What is a Work Permit System

Work Permit is a written statement containing information and instructions pertaining to hazards that are to be avoided in a particular operation.
It indicates that all hazards have been considered in advance and that foreseeable appropriate precautionary measures have been taken.
People responsible to execute a job defined in the permit are to review them from the point of compliance.
A permit is a written consent of the proprietor that guarantees proper and safe conditions where personnel can work safely by complying with the instructions on the permit.
It also indicates that the people executing the job have reviewed the permit and accept responsibility of adhering to the instructions and limitations stipulated.
Thus a permit finally becomes a document of consent by both parties, i.e. the proprietor and job executor. Annexure OCP-35

Types of Work Permit

Different types of Work Permit are:

Work Permit for entry into tanks / confined space.
Hot Work Permit or Work on pipeline carrying flammable materials.
Work Permit for Electrical Shutdown (plant maintenance work).
Work Permit for working at height / Fragile roof.
Work Permit for Excavation / Digging / Breaking Floors.

Who Issues Permits and to Whom

Permits are issued by engineers/ supervisors having proprietary responsibility of areas and equipment. It is issued in the name of a Supervisor or Technician who is to carry out the required job under the known hazardous conditions.

General Work Permit System

This is a permit issued to works of routine nature such as lifting, shifting, transporting, in-house cleaning, replacement of fused lamps, garden maintenance, housekeeping activities etc.

The officer having the proprietary control of that area issues the permit to person executing the job.

The permit will be issued by the officer in-charge only after identifying the possible hazards during the course of work & ensuring proper control measures are taken.

Entry into Tanks / Confined Space

A written certificate is to be given by the competent person based on test carried out by him and stating that the space is reasonably made free of all hazards and is fit for persons entering it. The person who enters into the tanks/ confined space shall wear suitable breathing apparatus and a belt securely attached to a rope, free end of which is held by a person outside the confined space.

Usually the Engineer having the proprietary control over the equipment / vessel issues a Safe Entry Permit and authorizes entry and work in, on and around a confined space. Before issuing such a permit, it will be his responsibility:-

to isolate the equipment / vessel from all sources, through which any energy, stock or harmful substances can get introduced, by disconnecting, blinding, blanking etc.

to drain, clean, wash and purge the equipment / vessel to make it free from toxic gases and other harmful substances.

to test the air inside the vessel to determine presence of explosive mixture, toxic gas, oxygen sufficiency etc. In case of presence of explosive mixture / toxic gas or deficiency of oxygen, it should be further ventilated, till such time the explosive mixture / toxic gas is removed or the oxygen content is adequate.

to ensure all electrical / pneumatic/ hydraulic equipment/ drives been disconnected.

to ensure the persons required to enter confined space been trained in dealing with specific hazards.

to ascertain only 24V hand lamps are used for the purpose of illumination. However, care should be taken to ensure that the 24V transformer is kept outside the confined space.

to engage a rescue team equipped with emergency rescue devises put on stand by.

Caution

Sweetening the air in confined space with oxygen from a cylinder should never be attempted.

In case of deficiency in oxygen that cannot be improved upon, entry into the vessel / equipment should be strictly restricted to the use of adequate breathing apparatus, and the usage of breathing apparatus should also be restricted to Self Contained Breathing Apparatus (SCBA) or a Supplied Air Line Respirator. The person using SCBA should be trained about the use and its limitations. As far as practicable two man ways or other openings on the equipment / vessel should be kept open for cross ventilation.

After ensuring all the above points, the operating engineer should prepare adequate number of safe entry permits and display conspicuously at each point of entry. Any other precautions to be taken for entry should be clearly specified on the permit. Persons entering into a vessel

/ equipment, that has been declared as safe to enter by exhibiting safe entry permit, must read the safe entry permit carefully and strictly obey and comply with all the instructions detailed on the safe entry permit. Where reading by all concerned becomes a problem suitable signs may be used.

Hot Work Permit

Hot Work in General Open Area

The arc should be free from any combustible material.
Area of welding/ gas cutting should be condoned out.
Adequate fire extinguishing material and water availability should be ensured.
Proper PPE such as apron, welding goggles, welding shield should be used.
The job should be supervised.

Hot Work at Height

Care should be taken to see that the sparks arising out of welding/ gas cutting are contained & do not make a free fall by providing a coverage of fire resistant cloth/ sheet below the welding / cutting activity.
However area just below the welding/ cutting activity & ground floor should be condoned out and entry in this should be prevented to avoid accidental fall of welding/ cutting splinters.
The adequate fire quenching facility should be provided.

Hot Work in Confined Space

The area within should be purged with copious amount of fresh air if it contained any flammable, toxic & any other material that is not conformable to human life & health.
No part or portion or surface of the confined space should be made / comprise of combustible material such as rubber, plastic, poly propylene, etc. that can generate fire by virtue of hot work.
Permit will only be issued to authorised persons.
Proper exhaust systems/ fume extraction system should be provided to take out welding fumes & other gases arising out of hot work.
Oxygen sufficiency should be ensured within confined space.
The hot work should be conducted on a continuous basis. Regular rest breaks should be at every 15/20 minutes after welding/ cutting.
The person performing hot work should be provided with necessary PPE including online breathing apparatus.
Adequate fire quenching devices should be made available.
The job should be done under strict supervision.

Hot Work near Combustible Material, Tanks, Containers, Pipelines Carrying Flammable Substance

Explosivity of general ambient should be checked for absence of flammable mixtures.
Job should be strictly supervised.
Fire-quenching media should be made available at site.
Permit will be issued only to authorised persons.

Electrical Work Permit System

Work on electrical installations, equipment and apparatus is considered to be very hazardous. Therefore, it is of utmost importance that sufficient safety precautions are taken before carrying out any work on electrical circuits, lines and equipment. Hence, to exercise greater control over such work and to ensure that adequate precautionary measures are taken before commencement of work on electrical equipment, an Electrical Work Permit known as “Permit-to-work” has been developed.

This permit is issued to carry out work on electrical equipment, installation after completely deenergising the equipment from electrical energy & providing effective grounding. The electrical permit should clearly indicate –

The equipment / installation under work.
The person who is handling the work.
Duration of work.
Type of work that is carried out.
Points/ Means of isolation indicating each point of isolation (as per SOP to ensure that the equipment is completely isolated from all sources of electric supply).
Grounds provided to the equipment.
Additional precautions if any to be indicated on the permit
The permit should be signed by the issuing persons & also by the working party/ person.

Carry over of work over to next shift

As far as possible the work should be completed in the same shift. If it is not possible the earlier work permit should be cancelled by the working party & a fresh permit for the same job should be issued to the person taking over the equipment for work in next shift.

Care should be taken to clearly indicate the existence of ground connection to the equipment and other conditions related to equipment by the person in the previous shift to the person in the next shift.

Notations to be made

The issue of permit to work, nature of repair carried out, transfers, if any, cancellation of permit are to be noted in the Log Book maintained by the permit issuing department.

Safe Work Permit for Working at Height/Fragile Roof

Many accidents are caused due to falls while working at heights and roof tops. Most of the accidents result in fatalities or very severe injuries. This phenomenon is more acute in construction activities. Therefore, to put a curb on the rising trend of fall accidents it was felt necessary to bring about certain controls over such works and provide adequate safe guards for the people working at higher elevations.

In the event of any person required to stand, pass over or work on or bear any roof of ceiling covered with fragile material or required to work at an elevation of more than 3 meters height, adequate safety measures should be provided to prevent falls. For this purpose it is suggested to use ladders, duck ladders, crawling board and safety belt etc. Each time a

person is required to work on the fragile roofs or at higher elevations, the job shall be carried out under the authority of a work permit issued by Head of the Department (or authorized person from Prod. Dept., Maint. Dept. or Dev. Dept.).

Work Permit for Excavation/Digging/Breaking Floors

In NHPC like other industries pipelines, electrical cables, telephone cable etc, are run underground. In some cases where grounds are not stable or contaminated, digging and excavation work may cause accidents and / or property damage. Hence, to prevent such accidents, injuries or property damages the digging and excavation works are controlled by permit system. Industries having permit systems to control excavation work, forbid as a rule, any excavation work whatsoever, within the factory premises without a valid excavation permit.

Here again, the originator of the permit will be the supervisor having proprietary responsibility of the area where excavation work is intended to be carried out. The originator after preparing the Excavation Permit in duplicate, indicating the exact location where the excavation work will be carried out, sends both copies of the permit to the Engineering Department. The Plant Engineer studies the relevant drawing of the area to be excavated and determines whether any pipelines or cables are located in the area. If any such obstacles are seen, he prescribes the special precautions to be taken while excavating, and puts his signature on the permit. One copy of the permit is retained by the originator and the duplicate handed over to the agency executing the job. The duplicate copy, in fact, is held in the possession of the person who actually carries out the job at the work site. The permit is required to be produced for inspection and checking when demanded by the concerned authorities.

Safety in Workshop and Garage

Safety is the constant concern of this organization. Every precaution has been taken to provide a safe workplace. Safety officer makes regular inspections and holds regular safety meetings. The Safety officer also meets with management to plan and implement further improvements in our safety program. Common sense and personal interest in safety are still the greatest guarantees of your safety at work, on the road, and at home. We take your safety seriously and any willful or habitual violation of safety rules will be considered cause for dismissal. NHPC is sincerely concerned for the health and well being of each employee.
The cooperation of every staff member is necessary to make this entity a safe place in which to work. Help yourself and others by immediately reporting unsafe conditions or hazards to your supervisor or to a member of the safety committee. Give earnest consideration to the rules of safety presented to you by posters, signs, discussions with your supervisor, posted department rules, and regulations published in the handbook. Begin right by always thinking of safety as you perform your job, or as you learn a new one.

Any injury at work—no matter how small—must be reported immediately to your supervisor and receive first-aid attention. Serious conditions often arise from small injuries if they are not cared for at once.

Safety rules and guidelines

To ensure your safety, and that of your co-workers, please observe and obey the rules and guidelines appropriate to the general populace or specific jobs: Annexure OCP-33
Observe and practice the safety procedures established for the job.
In case of sickness or injury, no matter how slight, report at once to your supervisor. In no case should an employee treat his or her own or someone else's injuries or attempt to remove foreign particles from someone else's eye.
In case of injury resulting in possible fracture to legs, back, or neck, or any accident resulting in an unconscious condition, or a severe head injury, the employee is not to be moved until medical attention has been given by authorized personnel.
Do not wear loose clothing or jewelry around machinery. It may catch on moving equipment and cause a serious injury.
Never distract the attention of another person, as you might cause him or her to be injured. If necessary to get the attention of another person, wait until it can be done safely.
Where required, you must wear protective equipment, such as goggles, safety glasses, masks, gloves, hair nets, etc. appropriate to the task.
Safety equipment such as restraints, pull backs, and two-hand devices are designed for your protection. Be sure such equipment is adjusted for you.
Pile materials, skids, bins, boxes, or other equipment so as not to block aisles, exits, fire fighting equipment, electric lighting or power panel, valves, etc. Fire Doors and Aisles must be kept clear!
Keep your work area clean.
Use compressed air only for the job for which it is intended. Do not clean your clothes with it, and do not fool around with it.
Observe "No Smoking" regulations.
Shut down your machine before cleaning, repairing, or leaving it.
Tow motors and lift trucks will be operated only by authorized personnel. Walk-type lift trucks will not be ridden and no one but the operator is permitted to ride the tow motors.
Do not exceed a speed that is safe for existing conditions.
Running and horseplay are strictly forbidden.
Do not block access to fire extinguishers.
Do not tamper with electric controls or switches.
Do not operate machines or equipment until you have been properly instructed and authorized to do so by your supervisor.
Do not engage in such other practices as may be inconsistent with ordinary and reasonable common sense safety rules.
Report any unsafe condition or acts to your supervisor.
Help to prevent accidents.
Use designated passages when moving from one place to another; never take hazardous shortcuts (i.e., between moving equipment or across roadways).
Lift properly—use your leg muscles, not your back muscles. For heavier loads, ask for assistance.
Do not adjust, clean, or oil moving machinery.
Keep machine guards in their intended places.
Do not throw objects.
Clean up spilled liquid, oil, or grease immediately.
Wear hard-sole shoes and appropriate clothing (i.e., shorts or mini dresses are not permitted).
Place trash and paper in proper containers and not in cans provided for cigarette butts.

Safety checklist

It is every employee's responsibility to be on the lookout for possible hazards. If you spot one of the conditions on the following list—or any other possible hazardous situation—report it to your supervisor immediately.
Slippery floors and walkways
Tripping hazards, such as hose links, piping, etc.
Missing (or inoperative) entrance and exit signs and lighting
Poorly lighted stairs
Loose handrails or guard rails
Open, loose or broken windows
Dangerously piled supplies or equipment
Unlocked doors and gates
Electrical equipment left operating
Open doors on electrical panels
Leaks of steam, water, oil, other liquids
Blocked aisles
Blocked fire extinguishers, hose sprinkler heads
Blocked fire doors
Evidence of any equipment running hot or overheating
Oily rags
Evidence of smoking in non-smoking areas
Roof leaks
Directional or warning signs not in place
Safety devices not operating properly
Machine, power transmission, or drive guards missing, damaged, loose, or improperly placed

Safety equipment

Your supervisor will see that you receive the protective clothing and equipment required for your job. Use them as instructed and take care of them. You will be charged for loss or destruction of these articles only when it occurs through negligence.

Safety shoes

The organization will designate which jobs and work areas require safety shoes. Under no circumstances will an employee be permitted to work in sandals or open-toe shoes. A reliable safety shoe vendor will visit the entity periodically. Notices will be posted prior to the visits.

Safety glasses

The wearing of safety glasses by all shop employees and volunteers is mandatory. Strict adherence to this policy can significantly reduce the risk of eye injuries.

Seat belts
All paid and volunteer staff must use seat belts and shoulder restraints (if available) whenever they operate a vehicle on organization business. The driver is responsible for seeing that all passengers in front and rear seats are buckled up.

Good housekeeping

Your work location should be kept clean and orderly. Keep machines and other objects (merchandise, boxes, shopping carts, etc.) out of the center of aisles. Clean up spills, drips, and leaks immediately to avoid slips and falls. Place trash in the proper receptacles. Stock shelves carefully so merchandise will not fall over upon contact. Annexure OCP-25

General layout of a garage

Keep wiring, heating and ventilation systems in good condition.
Provide adequate lighting with no glare; supply additional local lighting for hazardous procedures to ensure increased vision and reduced eye strain and fatigue.
Replace any flickering fluorescent tubes - the "strobe" effect may make some moving parts appear as not moving.
Designate separate areas for operations such as welding, cleaning, painting, lubricating and battery maintenance.
Allow adequate floor space for the volume of work expected.
Provide a clean lunchroom and washroom that are separate from the work area.
Do not block or hinder access to fire extinguishers, doorways, and emergency exits.
Ensure that emergency lighting works.
Ensure good ventilation. All running engines (vehicles, lawn mowers, snow blowers, etc.) produce carbon monoxide. Exposure to carbon monoxide can cause headaches, sleepiness, loss of consciousness and death. It is also a flammable gas.

General operational safety

Use tools and service equipment only for the tasks for which they are designed.
Keep power tool guards and safety devices in place and functional.
Inspect and service fire extinguishers regularly.
Keep first aid kits fully stocked. Have emergency eyewash stations or showers where appropriate.
Post emergency phone numbers.
Keep floors and benches clean to reduce slipping and tripping hazards.
Empty trash containers regularly.
Discard rags, paper and other items soaked with flammable materials (such as oil, gas or solvents) in approved metal containers.

Safety in storing materials

Pile materials securely:
Cross-tie piles.
Do not use damaged cartons.
Allow nothing to overhang.
Do not overload.
Place wedges beside stock the will roll
Keep aisles clear.
Place heavy items on shelves at waist height. Identify the weight of unfamiliar loads and load limits on shelving.

Clearly label all chemicals and materials. Check the material safety data sheet (MSDS) or safety data sheet (SDS) for storage and handling instructions. Contact the manufacturer if you require more information.
Label flammable and combustible materials clearly and store in a separate place, away from heat and ignition sources. Laws may require separate rooms or cabinets. Check with your local authorities.
Use only approved safety containers for flammable and combustible liquids.
Ground and bond containers when transferring flammable liquids from one container to another.
Store compressed gas cylinders upright, and secure with chain or brackets.
Store and dispose of waste oils and fluids according to local by-laws or environmental regulations.
Close valves on empty cylinders. Make sure valve protection caps are in place.
Keep fuel gas cylinders and petroleum products separate from oxygen cylinders.
Do not smoke or use matches near flammable materials.
Do not store combustible material, such as paper or work clothes, near heating units.
Do not eat in shop areas. Always wash hands before eating (or smoking) to prevent transfer of contaminants from your hands to your mouth.

Safe Handling And Disposal of Hazrdous Waste

The Ministry of Environment & Forests, Government of India, notified the Hazardous Waste (Management & Handling) Rules on July 28, 1989 under the provisions of the Environment (Protection) Act, 1986, which was further amended in the year 2000 and 2003 for effective management of hazardous waste (HW), mainly solids, semi-solids and other industrial wastes, which do not come under the purview of the Water (Prevention and Control of Pollution) Act and the Air (Prevention and Control of Pollution) Act and also to enable the Authorities to control storage, transportation, treatment and disposal of waste in an environmentally sound manner. Annexure OCP-6

PURPOSE
Hazardous waste means any waste which causes danger to health or environment, whether alone or when in contact with other waste.
The key objectives of these rules are to minimize the hazardous waste in terms of quantity, to dispose off as close to the source and reduce the trans boundary movement.

PROVISIONS
Every hazardous waste handling / generating unit has been made responsible for collection, reception,
Mandatory authorization from the SPCB is to be sought for collection, treatment, storage and disposal of hazardous Waste.
Import and export of hazardous waste is not permitted for dumping and disposal.
Import and export of HW is permitted as raw materials for recycling and reuse subject to the compliance of procedure prescribed involving the grant permission from MoEF for such import and export HW.
Under these rules the HWGUs may also dispose their hazardous at a common disposal site(s) identified and finalized after a proper environmental impact assessment.
Recyclers /re-refiners of non-ferrous metal, waste/used oil are required to register themselves with CPCB. Owner or occupier generating specified non-ferrous metal waste or generating

used oil or waste oil of 10 tons or more per annum are required to sell to auction such waste only to a registered re-refiner or recyclers.
The implementation of the said rules is of utmost importance now a days in view of ongoing case before Honorable Supreme Court in which issues of national and international importance are being addressed. The high power committee constituted in pursuance of the court orders has suggested that all the industries involved in hazardous chemicals and generating hazardous wastes display online data outside the factory gate, on quantity and nature of hazardous chemicals being used in the plant as well as water and air emissions and solid wastes generating in the factory premises. In case of failure to do so the units may even be asked to close down.

Common pre-requisites for obtaining authorization for storage under HW Rules

Display of updated data outside the main factory gate in two boards of size 6 feet x 4 feet both in English and in Hindi (the local language).
Storage facility should have appropriate containment system.
The container/enclosure holding hazardous waste should be marked (Hazardous Waste) in red colour in English/in Hindi and should bear the prescribed label.
The occupier must take precautions to prevent any accidental ignition or reaction of ignitable or reactive waste.
The containment system should be leak proof and able to drain / remove liquids.
Units that store hazardous waste should do so in such a manner that it does not in any way contaminate the environment or the ground water due to air/ rain / seepage/leakage etc.

1.1.1.1.1.1	***NHPC LIMITED*** 1.1.1.2 **TEESTA-V POWER STATION** 1.1.1.2.1 INTEGRATED MANAGEMENT SYSTEM **OPERATIONAL CONTOL PROCEDURE**	Doc. No. OCP-01 Revision No.: 00 Eff. Date: 01.08.2009 Page 1 of 1

HANDLING OF COMPRESSED GAS CYLINDERS

- Ensure that there is no other inflammable material stored near the Compressed Gas Cylinders.
- Ensure that nobody smokes and carries the matchbox in compressed gas storage area.
- Switch off the knob of the cylinder when the gas is not in use for a long time.
- Ensure that hosepipe is periodically checked and changed. Inspect hoses before use; replace old, damaged or worn hose.
- Ensure that all the cylinders should be stocked properly to avoid sudden fall and any impact. Acetylene cylinders should be kept in vertical position.
- Ensure that there is no loose wiring in that area.
- Always check the gas-cutting torch before starting job.
- Lines shall be bled, regulators removed, and valve caps replaced before unsecured cylinders are moved.
- Compressed gas cylinders shall not be exposed to temperatures exceeding 125^{o} F (50 ^{o} C).
- Empty cylinders shall be stored separately from full cylinders and shall be segregated by cylinder content. The valves on empty cylinders shall be closed. Compressed gas cylinders shall not be stored near an electrical source or where the cylinders may come in contact with electrical wiring.
- Hoses, apparatus, and cylinder valves shall be free of grease, oil, dust, and dirt.
- Cylinders, apparatus, and hose or piping connections shall be gas tight.

Stand to one side and away from the front of pressure regulator gauge when opening cylinder valve.

CHECKLIST FOR ON-SITE INSPECTION

ACTIVITY: SAFETY AND HOUSEKEEPING

Project:		**Date:**	
Location:			

NOTE:- Please ☑ appropriate box or enter readings as per requirements

Sl. No.	**ITEM**	**YES**	**NA**	**Remarks**
1	Is the general status of safety and orderliness in the area maintained?	[ ]	[ ]	
2	Are the workers wearing their helmets and safety belts when required?	[ ]	[ ]	
3	Are all openings (shafts, doors, balconies) and cut outs safely barricaded or covered?	[ ]	[ ]	
4	Is the staircase area barricaded?	[ ]	[ ]	
5	Is the toilet area inspected daily for cleanliness?	[ ]	[ ]	
6	Is the ladder access area on the floor safely accessible and the ladders checked for damage?	[ ]	[ ]	
7	Are all the floor tiles/ granite/ marble properly covered to avoid damages?	[ ]	[ ]	
8	Is the cleaning taking place on a daily and orderly manner?	[ ]	[ ]	
9	Are the debris being cleared on a daily basis and moved out of the site?	[ ]	[ ]	
10	Are the trenches and excavations properly barricaded?	[ ]	[ ]	
11	Is the construction material properly stacked or removed to a collection point?	[ ]	[ ]	
12	Is barricading provided especially in the staircase opening areas?	[ ]	[ ]	
13	Is there sufficient lighting provided on site (staircase, hoist)?	[ ]	[ ]	
14	Are warning and direction signboards readable and recognizable (clean and orderly fixed)?	[ ]	[ ]	
15	Is the scaffolding safely erected, anchored to the building and properly supported at bottom?	[ ]	[ ]	
16	Is it been ensured that an orderly and safe access route to the site and all floors exits?	[ ]	[ ]	
17	Have problems/ recommendations with regard to safety, cleanliness and orderliness on site been addressed?	[ ]	[ ]	

Checked by:

Sign

Name

Date

Approved by:

Sign

Name

Date

1.1.1.2.1.1	***NHPC LIMITED*** 1.1.1.3 **TEESTA-V POWER STATION** 1.1.1.3.1 INTEGRATED MANAGEMENT SYSTEM **OPERATIONAL CONTOL PROCEDURE**	Doc. No. OCP-02 Revision No.: 00 Eff. Date: 01.08.2009 Page 1 of 1

HANDLING OF OIL AND GREASE

- Ensure the availability of separate measuring cans (of different capacities – 1 liter, 2-liter. 5-liter) and funnels for the issue of the various grades of oils.
- Placement of oil drums, cans in tray should be so ensured to facilitate collocation of spilled over oils is easy.
- Availability & use of appropriate pumps / transfer equipment for the transfer of spilled oil should be ensured.
- Separate jerry cans for intermediate storage of oil, if replaced, should be used. These cans should be kept in trays with proper identification and pumps should be used to draw out required quantity of oil into handy container. Ensure the containers are having lid to avoid spillage during handling.
- Top up oil using correct sized funnels.
- Rejected oil from equipment should be collected to avoid spillage using proper device (funnel, tray, and containers). Collected oil should be transferred to site at identified locations. The filled drums should be returned to store for further disposal action. Ensure that the waste oil collected is sold to authorized recycles (By Central Pollution Control Board) and records to be maintained as per Hazardous Waste (Management, Handling and Trans-boundary Movement) Rules.
- The fresh left over oil should be kept/poured back into the respective containers kept in the maintenance section / sub store-using funnel to avoid spillage.
- In case of any spillage of oil, wipe with waste cotton / jute & throw it in the designated bin.
- Keep the records of the oil issued / returned.

WELDING AND CUTTING

- Applicable to all welding machines & cutting set in maintenance department and contractual labours carrying out welding / cutting inside the factory.
- Carry out Welding and Gas Cutting in well-ventilated and well-illuminated places only.
- Always supervise work carried out by external agencies.
- Use Personal Protective Equipments like Goggles / Glass shield, Gloves, Shoes, and Masks etc. as required.
- Check the welding machine for electrical fittings; ensure that proper earthing is provided
- Ensure that the area is free from flammable substances.
- Carry out the work as per the job specification.
- Ensure that welding sparks/cutting hot iron pieces do not fall through floor opening / floor grating on chemicals / equipment / cable etc.
- Store the waste flux, cutting material, waste cloth and other wastes in designated areas / bins.
- Keep the hot job out of reach of other personnel.
- Keep the cylinders separately in their designated location away from normal working area.
- Clean the workplace after finishing work and put the generated wastes in designated bins.
- Remember, no oil or similar lubricant shall be used on any valves or other fittings of any cylinder.
- Do not roll any cylinder in the ground, do not subject the cylinder any heat treatment or expose to high temperature or to the sun or stored with any other flammable or explosive material.
- If a leak in the valve cannot be rectified by tightening the gland nut or the spindle, remove the cylinder to an open space where it is least dangerous to life and property and inform the Dealer / Supplier Agency / Filler.

Cylinders used in horizontal position shall be so secured that they cannot roll.

BATTERIES HANDLING AND DISPOSAL

Lead Acid Batteries (from Fork Lifts, DG Sets)

- Keep Lead acid batteries in tray only.
- Check for acid leakage & prevent spillage.
- Maintain level in battery between the desired minimum & maximum levels.
- Inspect all the Connections.
- When Battery needs replacement, take out the old one & keep it in identified place.
- Ensure that all old batteries are sold to Authorized dealers only for further recycling purposes.
- Give back one old battery against every new battery purchased.
- Keep records of the incoming & outgoing batteries in the Maintenance Department.

Alkaline Batteries

- Identify old battery due for replacement and keep in identified place.

Dispose off batteries to Pollution Control Board approved vendors only for recycle purpose; else, contact the Manufacturer/ Supplier for suitable replacement and disposal. Maintain records for the same.

1.1.1.5.1.1	***NHPC LIMITED*** 1.1.1.6 **TEESTA-V POWER STATION** 1.1.1.6.1 INTEGRATED MANAGEMENT SYSTEM **OPERATIONAL CONTOL PROCEDURE**	Doc. No. OCP-05 Revision No.: 00 Eff. Date: 01.08.2009 Page 1 of 1

COMPRESSOR AND COMPRESSED AIR LINES

- Ensure that there is no oil leakage from the compressors.
- In case of oil leakage, arrest it immediately & keeps the oil in a tray for reuse.
- Check and maintain oil level as per the marking provided at the machine.
- Put old/ used spares, waste cloths in the designated bin.
- Use ear plugs/ muffs in the compressor area, when it is in operation.
- Check and arrest any air leakage from valves, flanges, pressure gauges etc., check for any pinholes and drop in desired air pressure. In case any deviation is found, get it corrected immediately.
- Maintain pressure as per process requirement.
- Display the safe working pressure (range) in the compressor and also mark the same suitably in the pressure gauge.
- Drain moisture from the Air reservoir once in a day.
- Do preventive / scheduled maintenance as per Manufacturer's recommendation and statutory testing (as applicable).

Refer to the Manufacturer's Operations and Maintenance Manual for the Compressors.

DISPOSAL OF HAZARDOUS WASTES

- Segregate the Hazardous waste from general waste such as Oily cloth/ oily soaked cotton waste, empty chemical containers, empty paint containers, e-waste from electronic data processing, oil filters, oil bearing strainer, oil bearing contaminated residue from centrifuge, oil bearing cartridge filter, contaminate collector from electronic liquid cleaner,
- Ensure that there is no spillage of waste during handling; use Personal Protective Equipments as may be required.
- Collect hazardous waste in drums during maintenance activities or as required.
- Collect used or spent such as oil, Lubricants, Waste coolant, strainer cleaning waste water from centrifuge, metallic cartridge cleaning waste water in drums during maintenance activities or as required.
- Ensure that there is no spillage of oil during handling.
- Collect the oil in designated Leak Proof MS / Fibre Drums only.
- Ensure that the drums are not damaged / leaking. Label the containers as per the Hazardous Wastes (Management, Handling & Transboundary Movement) Rules.
- Send hazardous waste to the Scrap yard for proper storage and maintain record in Form 3 of the Hazardous Wastes (Management, Handling & Transboundary Movement) Rules.
- Load them in and keep in designated area only.
- Ensure to keep the waste oil drums in concreted storage areas only.
- Follow the Hazardous Wastes Authorization conditions as received from Sikkim Pollution Control Board.
- Check for the Authorization of the Dealer to whom the waste oil drums are sold for recycling and ensure that he is registered with the Sikkim / Any other State Pollution Control Board as Authorized Recycler. Get the List from the Central Pollution Control Board Website http://cpcb.nic.in; also ensure the validity of the Certificate of the Agency as well as the Capacity allotted.
- Dispose off the waste oil as per the method prescribed in the aforesaid “Authorization”.

While disposing off waste oil, give Transport Emergency (TREM) Card to the transporter.

1.1.1.7.1.1	***NHPC LIMITED*** 1.1.1.8 **TEESTA-V POWER STATION** 1.1.1.8.1 INTEGRATED MANAGEMENT SYSTEM **OPERATIONAL CONTOL PROCEDURE**	Doc. No. OCP-07 Revision No.: 00 Eff. Date: 01.08.2009 Page 1 of 1

HANDLING OF CHEMICALS

- Ensure that there is no other inflammable material stored near the Compressed Gas Cylinders.
- Ensure that nobody smokes and carries match box in compressed gas storage area.
- Switch off the knob of the cylinder when the gas is not in use for a long time.
- Ensure that hosepipe is periodically checked and changed. Inspect hoses before use; replace old, damaged or worn hose.
- Ensure that all the cylinders should be stocked properly to avoid sudden fall and any impact. Acetylene cylinders should be kept in vertical position.
- Ensure that there is no loose wiring in that area.
- Always check the gas-cutting torch before starting job.
- Lines shall be bled, regulators removed, and valve caps replaced before unsecured cylinders are moved.
- Compressed gas cylinders shall not be exposed to temperatures exceeding 125^{o} F (50^{o} C).
- Empty cylinders shall be stored separately from full cylinders and shall be segregated by cylinder content. The valves on empty cylinders shall be closed. Compressed gas cylinders shall not be stored near an electrical source or where the cylinders may come in contact with electrical wiring.
- Hoses, apparatus, and cylinder valves shall be free of grease, oil, dust, and dirt.
- Cylinders, apparatus, and hose or piping connections shall be gas tight.
- Stand to one side and away from the front of pressure regulator gauge when opening cylinder valve.
- While purchasing chemicals, mention in the purchase order that the Supplier / Transporter shall ensure proper displays regarding any hazard(s) and handling instruction(s).
- While receiving chemical containers, check for damages -if found, transfer the contents immediately in a fresh container.
- Study the Material Safety Sheet (MSDS) and store in conditions mentioned. Train the personnel handling the same on the MSDS; also ensure displays as may be required.
- Do not store incompatible chemicals near each other.
- Use appropriate Personal Protective Equipments e.g., gloves, boots, masks etc. - as mentioned in the MSDS.
- There should not be any sources of heat or electricity near the storage location.
- While transferring chemicals, check that there is no spillage - if spillage occurs, wipe clean with cloth and out in designated bin.
- If chemicals are stored for a long period, check for leakage from time to time.

In case of fire, remove all flammable materials nearby to the extent possible; use foam type fire extinguisher.

DISPOSAL OF NON-HAZARDOUS WASTES

- Segregate the general waste into
  1) Bio degradable, such as food waste, paper.
  2) Non-biodegradable, such as rubber parts like shaft sleeves, rubber seals from dam, electrical waste, metallic waste like rusted flanges, nuts, bolts etc.
  3) Waste Cloth, Jute, Cotton, Gloves.
  4) Electrical and Electronic e.g. Batteries, Cartridges, Toners, Bulbs, Tubes etc.
- Ensure that there is no spillage of waste during handling; use Personal Protective Equipments as may be required.
- Do not throw any non-degradable waste on land or water to prevent pollution.
- Dispose off waste only through company approved Agencies.
- Verify periodically how the vendor disposes off the waste & keep records.
- Ensure that disposal of waste do not lead to land contamination, air or water pollution.
- Where possible, look for opportunities to recycle/reuse wastes.
- Ensure reduction of generation of waste where possible.
- Collect waste cloth etc. and put them in designated Bins; Sell off cloth waste to vendors for recycling and reuse purposes.
- Clean empty containers / cans / drums and sell for recycling; wherever possible, use it in house for making waste bins.
- Dispose biodegradable waste into pits for natural decomposition.
- Dispose reusable spares, metallic / non-metallic wastes

Dispose electrical and electronic wastes to company authorised dealers /suppliers for further recycling or reuse and maintain record of wastes disposed.

AIR CONDITIONING AND VENTILATION SYSTEM

- Check compressor for any leakage of oil & Refrigerant (R122/R134A)
- Check discharge and suction line pressure to observe any abnormality.
- Check all pumps of AC & Ventilation systems for any abnormality.
- Check all pipelines of AC & Ventilation system for any abnormal behaviors.
- Logging of all temperatures of AC & V system to monitor healthiness of system.
- Check the heat exchangers for any choking.
- Ensure that thermal insulation provided on pipes is in good conditions.
- Change of duty cycle of compressors.
- Check functioning of all temperature controllers.

Note down the readings of all pressure gauges provided in the systems for any abnormal behaviour

ENERGY CONSERVATION

- Put off the lighting during daytime – use daylight to the extent possible
- Ensure that all temperature controllers are working satisfactorily
- Use Air Conditioners only when required and ensure to carry out periodic maintenance
- Switch on and off all building lights timely
- Ensure that all power factor correcting panels are working satisfactorily
- Switch off all fans / AC's / Coolers / Heaters when not required or moving out of the cabin / work area.
- Ensure to switch off the control panels of the machines when it is not use.
- Keep your Computer Monitors in energy saving mode; do not keep the printers / accessories in "ON" condition
- Regularly clean the reflectors in the lighting fittings
- Use the water pumps judiciously.
- Switch 'OFF' all lights of non essential areas.
- Do's and Don'ts for Energy Conservation as follows:

Domestic and Commercial Consumers	**Industrial Consumers**
SWITCH OFF light when it is bright • Use wire of proper size in house wiring to reduce loss of energy. • Use ISI standard electrical fittings and fixtures. Keep lamps and fixtures free from dust and dirt. • SWITCH OFF the stabilizer when appliance is not in use. • Clean Air-conditioner, Desert Cooler pads and Refrigerator radiator periodically. • Use stairs more. • SWITCH OFF lights and fans while leaving the room. • SWITCH ON the tube light with 4-microfarad capacitor instead of bulbs. • Do not disturb the Thermostat & Keep at normal setting.	• Lubricate motor and motor drives regularly to reduce friction. • Motors should be kept clean to help them cool properly. • A motor should be placed as close to the load as possible. • Match motors to your requirement. Oversized motors waste energy. Use motors of high efficiency. • Use shunt capacitors across motor terminals to reduce KVA charges and also avoid damage to motors. • Tighten belt and pulley at regular intervals to reduce loss of energy due to 'Slip'. • Replace worn out bearings immediately and ensure timely repairs. • Make greater use of daylight.

PREVENTION OF OIL LEAKAGE, SPILLAGE

- Centrifuging of all the oils.
- Annual checks of the oil by reputed firm.
- Check OPU manifold blocks for oil leakage through couplings.
- Check all the bearing housings of abnormal oil level & leakage of oil.
- Check oil leakage from turbine & MIV Servomotors; change the seals to avoid leakage.
- Check oil leakage from bearing housing oil cooler.
- Check oil level of LGB housing from oil level gauge.
- Check oil leakage from transformers.
- Check leakage of oil from chiller compressor.
- Control oil spills during manual handling, topping up, manual transfer / pumping.
- Check oil drums / containers for leaks
- In case of any leaks/spills, transfer re-usable oil in another container, soak the rest spill / leak with saw dust / jute / cloth and throw in designated bin.

PREVENTION OF ELECTRICAL HAZARDS

- Do not touch loose or fallen wires unless you are a trained electrician.
- Place insulating mats or other electrically non-conductive material on the floor at Switchboards, power control panels, or other electrical devices where there is a potential for Shock hazard.
- Electrical equipment and illumination devices used in wet or potentially wet areas shall have Circuit breaking arrangements.
- Adequate clearance around electrical panels and circuit breaker boxes must be maintained. Electrical panels and circuit breaker boxes shall be labeled with the equipment controlled by the panel or box.
- Check that the equipment is properly grounded. If applicable, check that surrounding metal objects, fencing, metal enclosures, etc. is grounded.
- Check that inspection and cover plates are in place. These plates are required to be in place except when inspection or maintenance is being performed.
- Powered equipment must be stopped and locked out before maintenance or repairs are performed unless the equipment is designed or fitted with safeguards to protect personnel during maintenance/repair. Lockout/tag-out procedures will include locking out electrical, mechanical and stored energy as appropriate.
- Use fuse tongs or hot-line tools to remove/replace fuses in high potential circuits. Do not remove or replace fuses by hand if the circuit is still energized unless the circuit is designed or had a special device to prevent shock when fuses are changed.
- Shut off the power source or check that wires are properly energized before using metal tools to repair bare wires, trolley wires, or electric rails.
- Check that transformers are enclosed and that the housing in good condition. Check for leaks or staining on the transformer or surrounding surface.
- Transformers near vehicle or equipment travel ways shall be protected from impact hazards.

PREVENTION OF ELECTRICAL HAZARDS

- Electrical terminals or junction boxes shall be guarded.
- Do not use damaged electrical cords/cables until repaired by a certified electrician. Do not remove a plug that has broken off in a receptacle unless you are a trained and certified electrician.
- Check that plugs are free of dirt, grease, oil, etc. before using.
- Cords/cables used in the workplace shall be 3-pronged and grounded. Do not remove the grounding prong or attach a 2-prong adapter to a 3-prong plug and grounded.
- Do not use extension cords unless there are no other options. Check that the extension cord is adequate for the power output required. Use an extension cord of the same type and size as the cord of the electrical equipment to be connected.
- Extension cords shall not be substituted for hard wiring and shall not be passed through Wall openings or under doors or windowsills. It shall never be secured in place with staples, nails, or other sharp objects.
- Do not overload extension cords or electrical outlets.
- Does not use an extension cord near oil or water unless the cord cover is resistant to oil and/or water.
- Place cords and cables so that they do not create a trip hazard. Do not use cords/cables on stairways, in doorways, in passageways, or in areas where they may be exposed to excessive heat.
- Do not step on cords/cables or drive over unshielded cords/cables with mobile equipment.
- Do not drape cords/cables over lighting fixtures or metal structures without softeners or other insulators or adequate protection.
- Do not pull on the cord when removing a plug from a receptacle.
- Do not estimate or “guess” the voltage of a power line; when in doubt, contact the person or organization that operates or controls the electrical power source.

CONTROL OF NOISE

- Ensure the availability of PPE like ear muffs/ ear plugs and insist to use the same
- Ensure the display of awareness Boards to insist on usage of PPE at work locations that are noise prone zones
- Check the condition of doors of all the enclosures, gaskets, sealing under normal conditions ensure the doors to be closed. Under abnormal conditions of noise check the equipment for leaks of oil, vacuum conditions etc.
- Inform maintenance staff for attending abnormalities
- Ensure the periodic checking of PPE for their effectiveness/healthiness
- If a PPE is found defective, replace the same
- Never open the acoustic doors of the Diesel Generator Sets while it is running.

WATER TREATMENT PLANT

Untreated water supply to domestic lads to Diarrhoea, Dysentery, Gastritis, Worm Infestation, Amoebic Colitis and Other Gastroenterological diseases.

Water treatment Plants in Teesta Power Station will arrest the above mentioned diseases by the process of alum tank, Pressure Filter and Chlorinator.

Alum Tank: Alum tank is required to doze alum into water prior to the treatment in sedimentation tank. This will help in arresting all colloidal particles in sedimentation tank or clarifier.

Frequency: Daily

Pressure Filter: The water coming out of sedimentation tank or clarifier contains a small amount of colloidal and bacteria. For supplying, pure clean water it is customary to arrest all this colloidal particles and bacteria and hence pressure filter is required.

Two numbers of pressure filters are required to be installed for proper purification of water. The two filters may used at half of the capacity or one can be used at full capacity rendering the other as standby. As back washing of pressure filter is required very often i.e. at an interval of 1 to 3 days, the standby filter may be operated during backwashing and maintenance.

Frequency: 1 to 3 days

Chlorinator: Pressure filter removes most of the impurities of the water but it cannot remove the pathogenic bacteria, which causes the water borne diseases. Thus to make the water free from bacteria, chlorine or chlorinators compound is required to be mixed with water. On line chlorinator mixes the chemical automatically into the water as per the outflow of water. The water out flowing the chlorinator will be collected in the main distribution tank.

Frequency: Daily

Dosage: 1 mg per litre.

Testing of water by state Government Pollution Control Board by Every One Year/ as per requirement.

BIO MEDICAL WASTE HANDLING IN HOSPITAL

- Place colour coded bins at various identified sites in Hospital such as – casualty section, laboratory, labour room, male and female wards and major and minor OT.
- Used disposable syringes are rinsed with 1% Hypochloride Solution, and then cut with needle cutter. Other plastic wastes such as I.V. catheter, rubber tubes, and plastic bottles are cut into two pieces and stored into specified container for safe disposal.
- All soiled dressing materials such as cotton, gauge, leucoplast tape, catgut, placenta etc. are stored in specified bins for safe disposal within 48 hours by deep burial method.
- X-ray is done following the required protective measures such as using radio opaque aprons, lead shield. Monitoring of radiation exposure of X-ray technician is done on quarterly basis from BARC approved agencies.
- Disposal of developer and fixer used for X-ray are done by discarding into the concealed drain leading into the concealed drain leading into the septic tank.
- Waste material from laboratory such as used chemical, urine, stool & blood samples are flushed out into the concealed drain leading into the septic tank after disinfections by chemical treatment.
- All medical and paramedical staff should wear aprons and use hand gloves, face masks while attending the patients in indoor and outdoor wherever required.
- To ensure the deployment of trolley for loading & unloading of waste from container and transport it to suitable places such as secured disposal yard.

PAPER CONSERVATION

- Ensure segregation of waste papers from the office
- Do not burn papers, if required may be shredded
- Do not fold waste paper
- Reuse one sided used papers for rough work, taking rough prints, photocopy, fax etc.
- Check the final draft of documents in the computer – avoid rough prints to the extent possible
- Use email for external communication to the extent possible.
- Check the printer and page settings before taking any printout
- Make use of both sides of writing pads
- Once unusable, put the waste papers, magazine etc. in waste bins so that they can be collected at a time.

Sell unusable paper to interested parties for recycling

FIRE PREVENTION AND FIGHTING

INSTRUCTIONS FOR FIRE PREVENTION & FIRE FIGHTING

Identify all the activities / location where there is a potential for fire and explosion.

1. Do not keep any flammable material near the potential hazardous area and electrical points.
2. Ensure that nobody smokes inside the identified fire prone areas.
3. Ensure that the electrical earthing is in place.
4. Follow safe electrical practices while handling electrical equipments, machinery and lines. Use Rubber mats, Electrical Grade Gloves, Shoes wherever required.
5. Do not allow any spillage or leakage in working Area; in case any spillage is noticed, immediately wipe off with cloth. Throw the cloth in the designated bin
6. Make sure that non-compatible materials are not kept together, especially chemicals. Also, good electrical practices to be in place e.g. no naked wires etc.
7. Ensure availability of adequate number(s) of appropriate type Fire Extinguishers in the fire prone places
8. Keep yourself informed about the type of fire and extinguisher to be used
9. Participate actively in the periodic Mock Drills to ensure emergency preparedness.
10. Know your CLASS of Fire and use appropriate Fire Extinguishers; remember compatible Fire Extinguishers are marked with the corresponding Class.
    Class A fire - Fire due to combustible materials such as wood, textiles, paper, rubbish and the like.
    Class B fire - Fire in flammable liquids like oil, petroleum products, elements, paint etc.
    Class C fire - Fire arising out of gaseous substances.
    Class D fire - Fire from reactive chemicals, active metals and the like.
    Class E fire - Fire involving electrical equipment and delicate machinery and the like.

DIESEL GENERATOR SETS

- Before starting the DG Set, follow the points given in the checklist
- Correct any abnormal condition
- Ensure that there is no oil leakage. In case of oil leakage, arrest it immediately & keep the oil in a tray for reuse.
- Check the cooling water temperature & ensure that it is maintained below 90°C.
- Ensure that the coolant is added as per required ratio in the system. Used coolant to be collected in a container and left for natural evaporation; the leftover to be mixed with used oil for onward disposal.
- Ensure that lube oil temperature is maintained below 105°C.
- Avoid spillage of oil & diesel on the floor. In case of spillage wipe the floor with cloth and put the cloth in the waste bin for onward disposal.
- Put used filters in the designated bins.
- Check all electrical connections for tightness to prevent any sparking.
- Maintain optimum loading (80 %) on DG Set for efficient output, whenever the DG Set is in continuous operation. Do not overload.
- Whenever the DG Set is not in regular use, carry out checks by operating for a few minutes daily.
- Ensure earthing is in place and isolation is working properly.
- Ensure that no emission is taking place at ground level and no gas leakage is there from the silencer.
- Ensure that you are using ear plug / muff while working near operating DG Set(s).
- Arrangement for First-Aid to be kept ready.
- Fire fighting arrangements to be regularly checked for their effectiveness.
- Ensure that lube oil is changed at desired intervals; collect the used oil and dispose as per the requirements of the Hazardous Wastes (Management, Handling and Trans-boundary) Rules.
- Do preventive maintenance as per Schedule and maintain records. Ensure that the external agency responsible for the same is carrying out all desired checks at quarterly frequency.
- Do not smoke inside DG Room and also never store inflammable materials near the DG Sets.

TRANSFORMERS

- Take adequate Precautions so that no live parts are exposed.
- Concerned Installation to be responsible for continuous observance of required provisions.
- During maintenance, take written work permit before start of work.
- Ensure use of Personal Protective Equipments and stand on rubber mat while working.
- Ensure that equipment is Off loaded.
- Ensure that equipment is earthed.
- Ensure that power terminals are discharged to ground before working on them.
- Ensure that no loose objects/ tools are left inside the terminals box and surrounding it after the completion of work.
- While Insulation resistance testing, ensure that after testing, winding is discharged to ground and also ensure that testing leads are not loosely connected to winding or touched with bare hands.
- Display the Danger Mark (Skull and Bone) and High Voltage Installation Symbol in the Transformer Area.
- While topping up of oil, ensure that there is no spillage – always put used and oily cloth in designated bins.
- Ensure fire fighting systems are healthy.
- Used oil to be collected in leak proof containers and the same to be discharged as per the provisions of the Hazardous Wastes (Management, Handling and Trans-boundary Movement) Rules.
- No body should smoke in this area.
- Carry out the Inspection and maintain records

OIL CATCHER

- The oil / lubricant which come out of the vehicle/Equipment at the time of washing has to be separated in order to avoid contamination of water and disposed off separately.
- To separate the oil/ lubricant from water, an arrangement has been made. The function of oil catcher is that oil remains as a floating in the catcher while the water will be allowed to flow through the sand bed and later it is to be disposed off in the existing open drain.
- Frequency of Vehicle washing: 2 Nos. Per Month.
- Collection of oil/ lubricants: Three Months
- Ensure that there is no spillage of oil during handling.
- Collect the oil in designated Leak Proof MS / Fiber Drums only.
- Ensure that the drums are not damaged / leaking.
- Send hazardous waste to the Scrap yard for proper storage and maintain record.
- Follow the Hazardous Wastes Authorization conditions.
- Check for the Authorization of the Dealer to whom the waste oil drums are sold for recycling and ensure that he is registered with the Sikkim / Any other State Pollution Control Board as Authorized Recycler. Get the List from the Central Pollution Control Board Website http://cpcb.nic.in; also ensure the validity of the Certificate of the Agency as well as the Capacity allotted.
- Dispose off the waste oil as per the method prescribed in the aforesaid “Authorization”.
- Annual Return for Sale / Auction of Used / Waste Oil and Non-Ferrous Metallic Waste to vendors registered under CPCB / SPCB .
- While disposing off waste oil, give Transport Emergency (TREM) Card to the transporter.

Operation of Radial Gates

I. Ensure Power Supply (Grid Supply, DG Set Supply). Switch on main supply, control panel isolator and switch on the control supply.
II. Blow the Siren before operation of Radial Gate(s)
III. For lifting radial gate(s) press push button “RAISE” and lift as per requirement.
IV. For stopping the radial gate(s) in any position during lifting cycle push the button “STOP”.
V. For lowering the radial gate(s) during operation push the button “LOWER”
VI. In the event of failure of Grid Supply as well as DG Set Supply the operation of radial gate(s) shall be done manually.
VII. During operation of Spillway Radial Gate(s) Hand Gloves and Helmets shall be provided to concerned personnel.
VIII. Arrangements for First Aid shall be kept at site.
IX. In case of fire Siren shall be blown and fire extinguishers be put in use.
X. During non-operating period checking and maintenance shall be carried out as per requirement to ensure the safe availability of the system for operation.
XI. For any other information regarding operation of radial gate(s) refer to ‘Operation and Maintenance Manual’.
XII. Carryout the periodic inspection as per the relevant check list.

Operation of DT Gate for Desilting

I. Ensure Power Supply (Grid Supply, DG Set Supply). Switch on main supply, control panel isolator and switch on the control supply.
II. Blow the Siren before operation of DT Gate.
III. For lifting DT gate press push button “RAISE” and lift as per requirement.
IV. For stopping the DT gate in any position during lifting cycle push the button “STOP”.
V. For lowering the DT gate during operation push the button “LOWER”
VI. During operation of DT Gate Hand Gloves and Helmets shall be provided to concerned personnel.
VII. Arrangements for First Aid shall be kept at site.
VIII. In case of fire Siren shall be blown and fire extinguishers be put in use.
IX. During non-operating period checking and maintenance shall be carried out as per requirement to ensure the safe availability of the system for operation.
X. For any other information regarding operation of DT gate refer to ‘Operation and Maintenance Manual’.
XI. Carryout the periodic inspection as per the relevant check list.

Operation of Spillway Gantry Crane

XII. Ensure Power Supply (Grid Supply, DG Set Supply). Switch on main supply, control panel isolator and switch on the control supply.
XIII. For lifting press push “LIFT” button and lift as per requirement.
XIV. For stopping the lifting operation in any position stop pushing “LIFT” button.
XV. For lowering push the “LOWER” button.
XVI. For lateral movement push the left or right button as required.
XVII. For forward or backward movement push the forward or backward button as required.
XVIII. During operation of Spillway Gantry Crane Hand Gloves and Helmets shall be provided to concerned personnel.
XIX. Arrangements for First Aid shall be kept at site and if required the Ambulance may be made available at short notice.
XX. In case of fire Siren shall be blown and fire extinguishers be put in use.
XXI. During non-operating period checking and maintenance shall be carried out as per requirement to ensure the safe availability of the system for operation.
XXII. For any other information regarding operation of Spillway Gantry Crane refer to ‘Operation and Maintenance Manual’.
XXIII. Carryout the periodic inspection as per the relevant check list.

Removal of Hill Slides from Roads

I. Equipment available at site shall be deployed for removal of slips as and when occurred.
II. Operator and other staff at site shall be provided with safety helmets.
III. The operator shall work under the instructions of Site Engineer /Jr. Engineer/ Sr. Foreman.
IV. Site Engineer /Jr. Engineer/ Sr. Foreman shall constantly observe the behaviour of hill slide and control the movement/working of equipment as well as the personnel crossing the road on foot in the interest of safe passage.
V. No crossing of blocked portion of road by any person shall be allowed while slide is active.
VI. Arrangements for First Aid shall be kept at site and if required the Ambulance may be made available at short notice.

Painting of Structures

I. Scaffolding, Propping, ladders and working platform shall be provided wherever required keeping in view the height of structure.
II. Proper inspection for adequacy of Scaffolding, Propping, ladders and working platform shall be ensured before start of work.
III. Hand Gloves, Safety helmets and safety belts shall be provided to the working crew as per requirement.
IV. Only experienced working crew shall work at site.
V. Small working containers with brushes etc. shall be provided to the working crew.
VI. Arrangements for First Aid shall be kept at site and if required the Ambulance may be made available at short notice.
VII. The contractor shall be capable and eligible to carry out the work as per work specifications and due safety.

Working on HT / LT lines

I. After receiving complaints, work permit shall be taken from sub station / complaint cell.
II. Work permit no. and code shall be given by shift in charge after de-energizing the lines.
III. HT/LT lines shall be earthed at both the end of working place.
IV. Authorized person to work on line shall ensure to have proper tools and tackles.
V. Before start of work safety items shall be checked by supervisor.
VI. Safety equipments like safety belts shall be hooked to structure which are safe to work.
VII. Ladders of sufficient length with respect to length of poles and helpers shall be ensured.
VIII. Using of protection system shall be checked by work supervisor during the work.
IX. After completion of work, work permit shall be cancelled by concerned person with permission from shift in charge.
X. Line shall be charged after cancellation of work permit.

OCCUPATIONAL HEALTH CHECKUP

1. POLICY / SIGNIFICANT RISK : Occupational illness of personnel.

2. OBJECTIVE : To carry out specific Occupational Health examination for personnel.

3. PROGRAMME : OCCUPATIONAL HEALTH CHECKUP.

4. PROCEDURE :

Sl. No.	**Activity**
1	Identification of personnel exposed to eye strain (e.g. welders etc.), high noise (e,g. in powerhouse operations).
2	Eye sight test of personnel.
3	Audiometry of personnel.
4	General medical examination for all other personnel.
5	Suggesting remedial measures, counseling.

Tyre repair

1)Proper care shall be taken while dismantling puncture tyre, tubes to avoid injury .
2) Verification of Air pressure gauge should be calibrated.
3) Air pressure shall be checked with pressure gauge for the air pressure as per requirement.

Tyre Size	**Air pressure (Pound)**	
	Max pressure (F)	**Max Pressure(R)**
(9.00x20.00)	80-85	90-95
(10.00x20.00)	90-95	100-105
(7.50x16.00)	60	60
F78X15	30	32
Radial Type	22	24

Handling and Storage of Lubricant Oil.

I. Ensure the seal & leakage of the drum before unloading from the vehicle/truck
II. Ensure the proper parking of the vehicle/Truck at the ram site of the Lubricant store.
III. Ensure the unloading of the drum through ram one by one.
IV. Ensure the seal & leakage of the drum after unloading from the vehicle/truck.
V. Ensure the Stacking of the drum in proper manner i.e older drum should be stacked earlier to the new drums.
VI. Ensure the issue of the lubricant filled drum on first comes first out process.

WORK PERMIT SYSTEM

Whenever carrying out maintenance activities ensure that permit to work is issued by competent person only.

i. Ensure the display of Permit Board like “Work Permit Issued” at work site as well as in control room at appropriate place.

ii. Ensure that a register is maintained at control room for issuing/cancellation of Work Permits.

iii. Ensure that Men and material have been removed from work site before energizing the system.

Ensure that permit to work has been cancelled by competent person before energizing the system.

Ensure that permit register is reviewed on periodic basis

GRINDING ACTIVITIES

I. Wear proper safety equipment such as goggles, hand gloves, grinding apron and safety shoes before starting Grinding
II. Ensure proper earthing of the grinding machine
III. Ensure to wear breathing mask to avoid inhaling fine metal dust
IV. Ensure the grinder-man is properly insulated
V. Ensure there is no loose connection in the system
VI. Position the job properly and firmly
VII. Ensure the grinding sparks are not directed towards any person, flammable materials or any sensitive system for heat
VIII. Do not leave the grinding machine ON when not required
IX. Since the grinding machine operates at a high speed, ensure safety guard over the grinding wheel
X. Do not touch the hot job

CHAPTER 22: SAFETY WHILE WORKING AT HEIGHT

Introduction:

Working at height is an unavoidable situation at any site. Many activities are associated which involve the workers to work at height and the fact of working at height above 2m height itself creates a potential situation for fall if no protection is used.

An analysis of **accidents** shows that disabling injuries are more either due to fall of persons or falling objects. Falls are the leading cause of deaths in the construction industry.

Most fatalities occur when employees fall from open-sided floors and through floor openings. Falls from as little as 4 to 6 feet can cause serious lost-time accidents and sometimes death.

Legal :

The Building And Other Construction Workers' (Regulation Of Employment And Conditions Of Service) Act, 1996 And Rules, 1998

Chapter XIV : CONSTRUCTION, REPAIR AND MANITENANCE OF STEEP ROOF
All the rules applicable **(169-171)**

Chapter XV : LADDERS AND STEP LADDERS
All the rules applicable to LADDERS AND STEP LADDERS **(172-174)**

Chapter XVI : CATCH PLATFORMS AND HOARDINGS, CHUTES, SAFETY BELTS AND NETS
All the rules applicable (**175-180)**

General measures to prevent fall of persons
After consideration of general site condition s as they affect safety, it is a logical step to examine now general measures which should "be taken on any site to prevent certain categories of accidents which occur with frequency on all sites.

The first category is "fall of persons".
A fall is really the result of an accident rather than an accident itself, but there is a convenience in regarding it as an accident. It identifies the nature of an occurrence against which certain general precautionary measures can be suggested.

There are two main categories of falls: fall from one level to another; and fall on the same level.

Together these constitute more than 25 per cent of the total number of accidents occurring on civil & engineering sites and include a high proportion of the more serious injuries. This is perhaps not surprising in view of the vast amount of movement which takes place on a site and the elevated positions in which men frequently have to work. It does however give emphasis to the need for taking active measures to prevent falls.

Falls are caused mainly by persons slipping, tripping, stepping out or otherwise moving into space or they may be a consequence of the failure of a means of support. Other influencing

factors can be wet, slippery or uneven surfaces, loose articles on a floor, the wearing of unsuitable footwear, lack of protection at sides and edges of elevated sites, plant or equipment, insufficient handhold or foothold, insecure supports and bad lighting. There are obviously many factors which have to be considered and possible hazards removed before there can be any substantial reduction in the number of falls of persons.

When falls from one level to another and falls on the level are compared, the total numbers of accidents do not vary widely.

Suggested general preventive measures.

The following suggestions are intended only to indicate the kinds of measures which should be taken to prevent the types of falls of persons which are known to occur.

(I) Fall of persons from one level to another General preventive measures

Falls from structures:
These include falls from structural work in course of erection, sides of structures, through openings in floors and walls, and falls through fragile materials.

Remedial measures should include the provision of proper staging or scaffolding, where any part of any structure from or on which any person has to work does not give proper security, either "by not providing proper handhold and foothold or "because its bearing capacity is doubtful. The staging or scaffolding provided should be properly constructed and maintained. The sides and edges of any existing structure, including wall openings, on which it is otherwise safe to work, should be protected to prevent falls.

Openings in floors should be carefully covered and the coverings suitably marked to indicate their purpose. Where possible, suitably protected gangways or runways should be provided over areas which are not capable of supporting additional loading, e.g. areas covered by fragile materials. Such areas should be clearly indicated by prominent notices. Suitable crawling boards should also be provided for use on such surfaces.

Fall from scaffolds, ganagways and runways :
All scaffolding should be constructed to prevent collapse of the whole or any part. Its erection therefore should be undertaken by a competent person and there should be sufficient equipment of the right kind available. Platforms of scaffolds should be of adequate width, kept free of unnecessary obstructions and tripping risks, guarded where necessary at the sides and edges and frequently inspected, especially in wet or frosty weather.

Falls from ladders :
Causes of falls with or from ladders include:

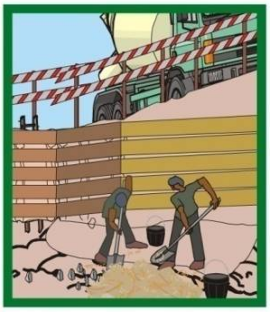
- failure, to lash securely where necessary or to have a person stationed at the foot;
- failure to place on proper footing;failure to rest ladder against a firm support;
- using a ladder at a dangerous angle of incline;
- not facing the ladder when climbing or descending;

- allowing rungs to become greasy;
- overloading (accidents have been caused "by having too manypeople on a ladder at once);

- carrying bulky materials when a hoist line should be used;
- use of a ladder which is in an unsafe condition;
- overreaching on a ladder when it ought to be moved to another position;
- ladder not extending beyond support or adequate handholds for climbing off or on ladder not provided;
- using ladder for purposes other than intended.

Falls into excavations;

- barriers should be placed alongside excavations whenever possible to prevent accidental falls into them;



3. Provision of adequate shoring.

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- suitable gangways should be provided for crossing an excavation since there is a tendency for people to try to jump over and across an excavation if no other way is conveniently near.

7. Precautions against vehicular traffic taken by barricading the area.

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Falls from mobile plant

Falls from all kinds of moving plant, including transport vehicles and operational equipment are frequent. They occur to drivers getting on to or off of their machines, and to employees servicing, loading or unloading machines. Others injured include persons riding in unsafe positions. Remedial measures include:

- provide and keep all steps or other means of access on to vehicles in good repair and free of mud or grease;
- workers should not be allowed to ride on such plant, unless there is safe accommodation. There should be a prohibition of riding on tow bars, steps, running boards and dumper skids.

Falls from cranes:

- safe access should be provided for drivers and for people engaged in lubrication, repair work, examinations or inspections;

- platforms for drivers or signallers should have suitable barriers to prevent falls or safety belt.

Falls at hoists:

- hoistways - falls down hoistways should be prevented by suitable enclosure of the hoistway. Gates at landing levels hould never be open unless the platform or cage is stationary
  there;
- no person should travel in a hoist, erected for the work on the site, unless it is of safe construction and has a cage with interlocked gates.

Falls at lifting machines

The falls referred to here are those in which people are raised or lowered by standing on crane hooks or other unsuitable gear operated by power. This kind of practice should be prohibited.

Falls into water

These are falls from positions alongside or above water which may result in drowning. Two things must be taken into account; the prevention of the fall and the prevention of drowning :

- prevent the fall in the first place by protecting the sides or edges of the place of work;

11. Adequate and safe platform and space is provided.

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- if a fall does occur prevent the falling person from falling into water, by using safety "belts and lines, safety nets and sheets as appropriate;
- provide immediately available means of rescue in case of a fall into water. In bridge work over water this shouldinclude provisions for a craft equipped with rescue equipmentand available for instant use;
- persons working over or near water should be provided with a suitable buoyant work vest or life preserver.

(2) Falls of persons on the same level General preventive measures

In considering means of preventing falls on the same level it might be helpful to look at optimum conditions first and then see what should be done, to make the site as safe as possible when optimum standards cannot be obtained. It can be said that where the underfoot conditions are not of the best, falls will occur. The best possible underfoot surface is one which is firm, dry, even, level and free of obstacles or loose materials over which persons can fall or trip. The surface of any workplace on which people have to stand or move while they are focusing their attention on the job should have the above qualities. The same high standards cannot be expected over the whole of a site and therefore enough roads, paths and gangways with suitable surfaces should be provided.

It should be recognised that workers at some time or other may be required to go to some part of a site where the underfoot conditions are not perfect. It would be most helpful if the whole site surface were kept as level and firm as possible and free of any litter.

The need for good lighting and tidiness has already been emphasised.

Many falls on the same level are associated with the moving or carrying of materials either by hand or in barrows or similar devices. If any load is carried it should be well within the carrying capacity of the individual concerned. Loads should not impede visibility.

The use of unsuitable footwear with soles which are smooth or badly worn is to be avoided. At all times, workpeople should exercise care and never take short cuts across terrain which may be dangerous.

CHAPTER 23: SCAFFOLDING SAFETY

Aim: Worker should not fall from height while working on scaffold.

Legal Requirements :

CHAPTER XIX - SCAFFOLD
Rule no. 188 to 204 From The Building other Construction Workers' Central Rules 1998
Rule No.188 – Scaffold construction
Ensure that-

a) Every scaffold and every component is of adequate construction, made of sound material, free from defect and is safe for the purpose for which it is used.
b) If bamboo scaffold is used, it should be of suitable quality, good condition free from protruding knots, stripped off to avoid injury during handling.
c) Metal scaffold should conform to National Standard.

Rule No. 189: Supervision by a responsible person

Ensure that every scaffold is erected, added, altered, dismantled under the supervision of a responsible person
Rule 190: Maintenance

Ensure that-

a) the scaffold is maintained in good repairs and measures are taken against its accidental displacement.
b) scaffold or partly dismantled scaffold should not be allowed to remain in such a condition that:-
    i) Stability of the remaining portion is not ensured
    ii) for unsafe scaffold if the notice in Hindi is not displayed.

Rule 191: Standards, ledgers, putlogs-

Standards:- It means a member used as a vertical support or column in the construction of scaffolds which transmits the load to the ground.

Ledger:-It means spanning horizontally and tying scaffolding longitudinally and which acts as a support for putlogs or transoms

Putlogs:-It means a horizontal member on which the board, plank or decking of a working platforms are laid.

Transoms:- It means a member placed horizontally and used to tie transversely one ledger to another, or one standard to another in an independent tie scaffold

Ensure that:

a) Standards of a scaffold are---
    i) plumb, where practicable

ii) fixed sufficiently close together to secure stability considering all possible working situations, conditions for intended use of scaffold
iii) spaced as close as possible to ensure stability

b) Displacement of scaffold is prevented by providing sole plate or base plate.

c) Ledgers of metal scaffolds are placed at vertical intervals with regard to safety and stability.
d) Bamboo ledgers are kept as nearly as possible. They are placed and fastened to standard with due regard to safety and stability.

Rule No. 192: Working Platform
Ensure that--

a) working platform is provided around the face/ edge of the building adjoining

- at every uppermost permanent floor of the building under construction
- at any level where construction work such building is carried out

b) A platform is designed to suit –
- the number of building workers working on each bay
- the material, articles, tools carried by them in such bay

c) The safe working load and the no. of workers to be employed in each bay must be displayed.

Rule 193: Board, plank and decking
Ensure that-
Board, plank, decking used for working platform is-

a) of uniform size, strength and capable of supporting the workers and load as per national standard.
b) Metal decking should be of non- skid surface
c) Board or plank used for making platform should not project beyond its end support. If it is projecting out, then it should be effectively prevented from tripping or lifting
d) Board, plank, decking is fastened and secured.
e) At any one time maximum two working platform per bay should be used to support workers, material etc.
f) Use safety net or similar method to prevent injury from falling material.
g) Concrete and other debris should not be accumulated on any platform
h) If work is to be done up to the end of wall, work platform should be faced or extended by 0.6 meter.

Rule no. 194:Repair of damaged scaffold
Ensure that-
a) Workers should not go on damaged or weak scaffold. Take adequate safety measures then only send workers on such scaffold.
b) When repair of scaffold is undertaken, necessary warning sign should be displayed.

Rule no. 195:Opening
Ensure that-

a) There should be no opening in any working platform (Exception- access to the platform)
b) If openings are unavoidable, necessary protection against falling of material/ workers such as nets, belts etc.
c) Suitable safe ladder should be provided for accessing from one platform to other platform.

Rule no. 196: Guardrail
Ensure that-

- Suitable guardrail and toe board is provided to prevent fall of building workers, material, tools, from any platform provided on scaffold.

Rule No. 197: scaffold used by building workers of different employers
Ensure that-

a) If a scaffold used by earlier employer required to be used by another employer, he should thoroughly inspected by a responsible person the same and then use it.
b) If any rectification, alteration, or modification is to be made; it should be made under the supervision of the responsible person mentioned above.

Rule No. 198: Protection against electric power line

Ensure that all practicable measures are taken to prevent workers working on scaffold coming in contact with electric wires and dangerous equipment.

Rule no.199: Screening nets and wire nets

Ensure that no pedestrian or vehicular traffic is suffered from the falling of objects hazard from a scaffold by enveloping such scaffold by a suitable wire nets or screening nets.

Rule no.200: Tower scaffold

Ensure that-

a) The height of every tower scaffold should be less than 8 times, the lesser of the base dimension.
b) It is lashed to a building or a fixed structure before using it.
c) Tower scaffold which can be moved or castered is
    - Stable and adequately weighted at base
    - used only on plain and even surface
    - has casters provided with locking devices to hold it in position
d) When it is shifted there should no worker, tools, material on it.

Rule no. 201: Gear for suspension of scaffold

Ensure that-

a) Chains, ropes or lifting gears used for suspension of a scaffold are of adequate strength, sound material, suitable for the purpose and is in good maintenance.
b) Chains, wire ropes metal tubes used for the suspension of scaffold are-

c) Properly and securely fastened to every anchorage point, ledgers of other main supporting members, and so positioned to ensure stability

Rule No. 202: Trestle scaffold and cantilever

Ensure that-

a) Trestle scaffold should not be more than 3 tiers if its working platform is more than 4.5m above the ground. It should be designed by a professional engineer.
b) Trestle scaffold should not be erected on suspended scaffold.
c) Jib scaffold should be used with adequate support, fixed or anchored on opposite side of its support.
   - It should have out-riggers of adequate length.
   - Wherever necessary it should be supported and braced to ensure stability.
d) Working platform resting on bearers which are inside a wall on one end and other end is free without support, in such case
   -bearers must be of adequate strength
   -braced through the wall
   -securely fastened on the other side

Rule No. 203: Scaffold supported by building

Ensure that-

a) If a part of building is used as a support for scaffold it should have sufficient strength and made of sound material.
b) Overhanging eaves gutters should not be used as support.
c) Suspended scaffold should be made as per the relevant standard.

Rule No. 204: Use of winches and climbers for suspended scaffold

Ensure that-

a) A suspended scaffold should be raised or lowered by winches or climbers only-

   - if it is made of sound material, adequate strength
   - if it is tested and certified safe for use by a competent person before the start of its use.
b) All suspended scaffolds should be properly balanced by a approved counterweight.
c) The working platform of the suspended scaffold should be fastened to the building or structure to prevent its swinging and to make it safe.
d) Safe carrying load capacity of a suspended scaffold should be displayed.

Rule No. 205: Safety devices for suspended scaffold

Every suspended scaffold-

- is provided at each suspension point with a safety rope with such a safety device which will support the platform in the event of -
- failure of primary suspension wires, winches or any part of the mechanism used for raising or lowering.

This rule shall not apply, If the suspended platform is supported by two independent wire ropes so that in case one fails, other rope will sustain the weight of such platform and prevent it from tilting too.

If an automatic system is present to support the platform in case failure primary suspension takes place.

Scaffold Materials

a) The components used to assemble scaffolds should be inspected before each use and should conform to requirements of this section regarding materials, strength, dimensions, etc.
b) Scaffold components manufactured by different manufacturers should not be intermixed unless the components are compatible (fit together without mechanical force) and the scaffold's structural integrity is maintained. Scaffold components manufactured by different manufacturers should not be modified in order to intermix them.
c) Scaffold components should be free from detrimental corrosion.
d) Any scaffold component that is obviously damaged, excessively corroded, defective, or does not meet the applicable codes and standards should be marked and be immediately destroyed and should not be re-used on the project site. However, if possible, defective sections of planks or tubing may be cut off. In this case, the plank or tubing may be reused.
e) Scaffold components made of dissimilar metals should not be used together because of the potential for galvanic corrosion.
f) Scaffold components should not be exposed to acids or other corrosive substances, unless adequate precautions have been taken to protect the scaffold from damage.
g) Where a built-in ladder is part of a scaffold system, it should conform to the requirements for ladders (IS: 3696, Pt-II).
h) Scaffold components should be properly stored to prevent damage.

5.2 Scaffold Foundation

a) Foundations should be sound, rigid, and capable of carrying the scaffold self-weight plus the maximum intended load without settling or displacement. Unstable objects such as barrels, boxes, loose brick or concrete blocks should not be used to support scaffolds, planks, or timber sills.

b) A sound base is essential. Therefore, the ground or floor on which a scaffold stands should be carefully examined for its load-bearing capacity. Sand or made-up ground (fill) may need compacting to ensure there are no cavities. Such bases as floors, roofs, etc., may need shoring from underneath.

c) Timber sills (sole boards) at least 225 mm (9 inches) wide by 38 millimeters (1-1/2 inches) thick should be used to spread the load on sand, made up ground, asphalt pavement, wooden floors, and other soft or slippery surfaces. The ground beneath sills should be level and compact. A sill should extend under at least two posts (standards), unless not feasible because of uneven or sloping ground. In this case, sills under individual posts (standards) should be at least 765 mm (30 inches) long. Scaffold planks should not be used as sills.

d) All scaffold posts (standards) should be pitched on steel base plates at least 150 millimeters (6 inches) by 150 millimeters (6 inches) and 6 millimeters (1/4-inch) thick. For Special Scaffolds, the base plate should be designed to support the maximum scaffold post (standard) load. Timber sills should be used where base plates may be exposed to corrosive materials.

e) Screw jacks should be used to compensate for variations in ground level. Screw jacks should not be adjusted to more than two-thirds of the total length of the threaded section. Screw jacks should be used and loaded in accordance with the manufacturer's specifications.

f) Front-end loaders, forklifts, or pieces of equipment should not be used to support scaffolds.

g) Scaffolds should not be hung from or supported by guardrails or handrails.

h) A crane or other lifting device should not lift any scaffold, unless it's a Special Scaffold specifically designed for lifting and the scaffold plan was reviewed in accordance with the requirements of the standard practices.

Stability

a) Scaffold posts and frames should be erected and maintained vertical and plumb and vertically braced in both directions to prevent swaying and displacement. Plumbness should be checked using a spirit level, plumb bob, or by using vertical lines on an adjacent building or structure.

b) Where uplift or tension loads may occur in posts (standards) or frames (such as the back side of cantilevered scaffolds), they should be locked together by pins (not joint pins), bolted or pinned spigots, end-to-end (sleeve) couplers, or equivalent means able to carry the tension loads.

c) Supported scaffolds with a height to the uppermost planked level that is over four times the minimum base dimension (over a 4:1 height-to-width ratio) should be restrained from tipping by ties, guys, outrigger frames, or equivalent means. Upper section(s) of a stepped scaffold should not have a height over four times the width of the scaffold at the base of that section, unless ties or guys are properly installed to ensure stability.

d) Ties and guys should be installed as follows:

- Ties should be connected to buildings or structures by connecting a tie tube to at least two posts (standards) or two horizontal members (i.e., runners) and coupling this to a two-way tie, column box tie, reveal tie, or an equivalent connection.
- Ties or guys should be installed according to the scaffold manufacturer's recommendations.
- All tie connections should be made with right-angle (double) couplers.
- Tie tubes or guys should be installed at locations where runners (ledgers) and bearers (transoms) support the post (standard) in both directions. Tie tubes or guys should be connected to posts as close as possible to the horizontal members, or connected to horizontal members as close as possible to the posts.
- Ties or guys should be installed adjacent to transverse vertical bracing.
- The lowest level of ties or guys should be installed at the lift located closest to the height of 4 times the minimum base dimension (4:1 ratio).
- The uppermost level of ties or guys should be installed as close as feasible to the top of the scaffold.
- Ties or guys should be spaced vertically every 8 meters (26 feet) (4 lifts) or less.

Design Requirements

a. Principles of Designing

The design of the scaffold should take into account the following:

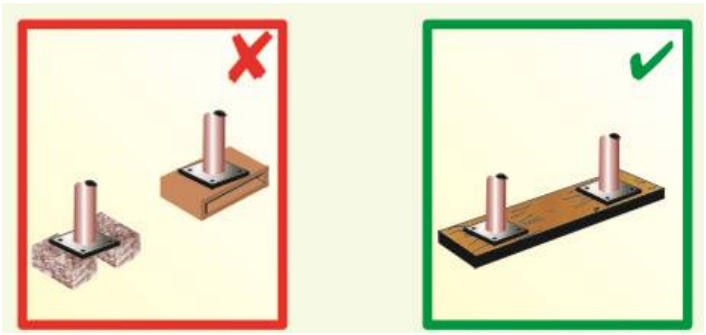
- The strength, stability and rigidity of the supporting structure;
- The handling normally associated with scaffolding;
- The safety of persons engaged in the erection, alteration and dismantling of the scaffold;
- The safety of persons using the scaffold;
- The safety of persons in the vicinity of the scaffold.

b. Foundations

- Scaffolding foundations must be adequate to carry the whole weight of the scaffold, including the imposed loads, and must be maintained in a stable condition during the life of the scaffold. Steel base plates must be used under all standards.

- When scaffolds are supported on the ground, suitable sole plates must be used to spread the load. The sole plates should preferably be long enough to support at least two standards. Timber sole plates must be not less than 200 x 38 x 500 mm long. Bricks, blocks and similar loose material are unsuitable as they are liable to fall over or split, and are easily driven into the ground.

- Where the foundation is leveled concrete of adequate thickness or of a similar hard surface, the sole plate may be omitted, but steel base plates must be provided at the bottom of all standards.



c. Platform and Decking

- The decked width must be not less than 700 mm, with sufficient additional width to leave 450 mm minimum clear walkway at all times. The distance between the outer edge of the platform to be guarded and the projection of the inner vertical face of a guardrail must not exceed 200 mm.

- Scaffold planks must be so placed, locked or secured as to prevent tipping or displacement during normal use, or movement by strong wind. End overhang must be 80 mm minimum to 220 mm maximum.

- It is good practice to butt planks in a decked platform. When butted, each end bearing should be not less than 75 mm. When lapped, the amount of overlap must be not less than 150 mm. Decking planks which are lapped must be fitted

with wedge cleats or fillets to reduce the risk of tripping or facilitate the wheeling of loads.

- Every working platform must be decked as close as practicable to the working face of the structure it is being used with. Where the height is greater than 3 m, a guardrail or other protection must be provided within 200 mm of the outer edge of the plank

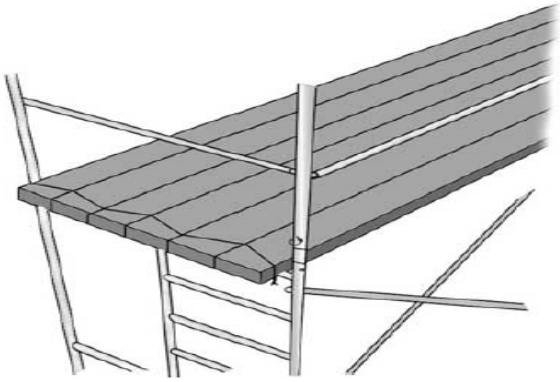
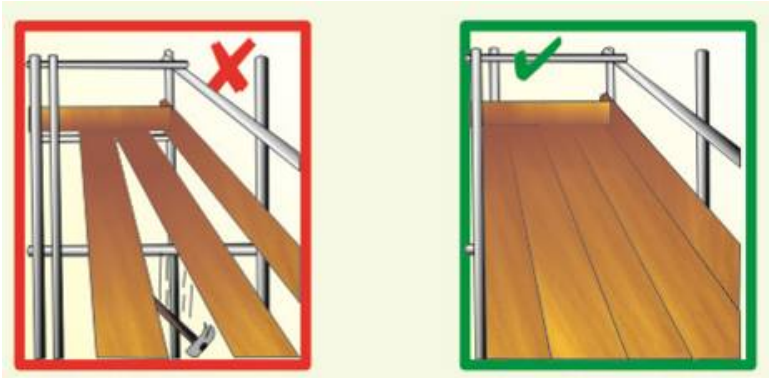


Figure-2 Platform Decking



d. Guardrails and Mid-rails and Toe board

- Guardrails, including mid-rails, must be provided on the exposed sides and ends of all working platforms more than 3 m in height. The height to the top of the guardrail must be not less than 0.95 m or more than 1.1 m from the deck to be protected.

- A midrail is required on a working platform which should be placed exactly half of the height of the top rail

- Each rail, when secured to the standards or upright members, must be capable of sustaining without failure or undue deflection a force at any point of 70 kg (690 N) vertical and horizontal, acting separately

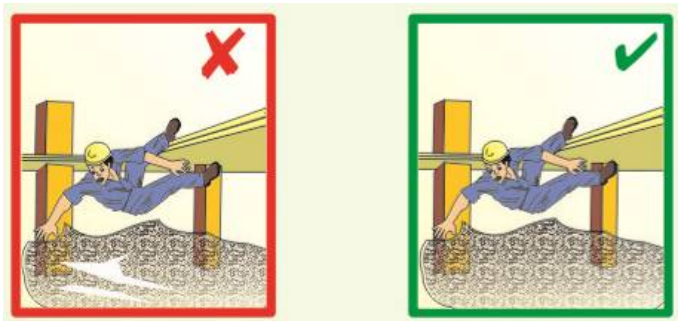
- A toe-board of 150 mm minimum height should be provided for protection against fall of materials from the platform.

e. Screens/Nets

- Where the scaffold platform is above a public thoroughfare, and due to the nature of the work falls of material are possible with injury to passers-by, special precautions must be taken. Special protection may consist of:

- Screening the working platforms with robust screens or steel mesh to a height of at least 1 m. The mesh opening should not exceed 50 mm.

- Providing catch screens where the horizontal distance from the scaffolding is more than half the vertical distance between the screen and the middle of the topmost working platform of the scaffold.



- Containment sheeting may be used to provide protection to the public from the construction works being carried out or to provide weather protection for construction workers working on or about the scaffolding.

- Containment sheeting increases the dead load on the scaffold, and greatly increases the wind load on the scaffold. It is unlikely that black wire ties commonly used to tie scaffolds will be sufficient where containment sheeting is used. *For this reason it is essential that scaffolds that are to be sheeted be designed and approved by a competent person such as a registered engineer experienced in scaffold design.*

f. Bracing

1. **Plan Bracing**: Where the horizontal tie spacing cannot be complied with, plan bracing should be provided. Even with this bracing provided, the maximum horizontal distance between tie points should not exceed 10 m.
2. **Dogleg Bracing**: Where it is impracticable to fit ties at the vertical spacing specified, dogleg bracing should be provided. With such bracing the distance between tie points should not exceed 8.4 m or 4 lifts.
3. **Diagonal Bracing**: Longitudinal diagonal bracing must be fixed to the external face of the scaffold, and at regular intervals along its length. The bracing, which is required to resist wind and earthquake forces in particular, must be capable of withstanding a horizontal force of not less than one-tenth of the total of the weight of the scaffold and the full live load on the working platforms. Some methods of arranging diagonal bracing for scaffolds are illustrated
4. **Cross Bracing**: Scaffolds are to be provided with cross bracing at each stage to take care of diagonal/shear load acted on it.

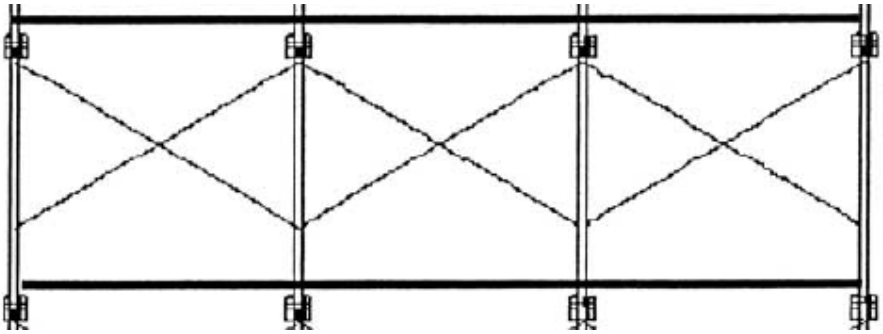


Figure- 3 Cross Bracing

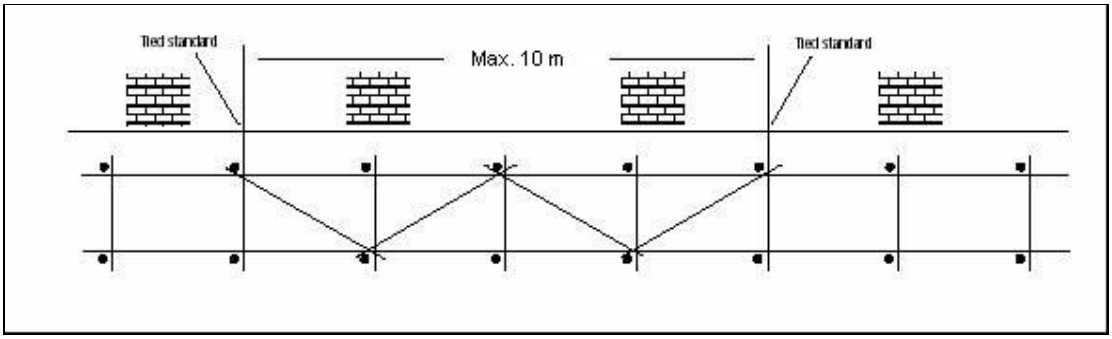


Figure - 4 Plan bracing

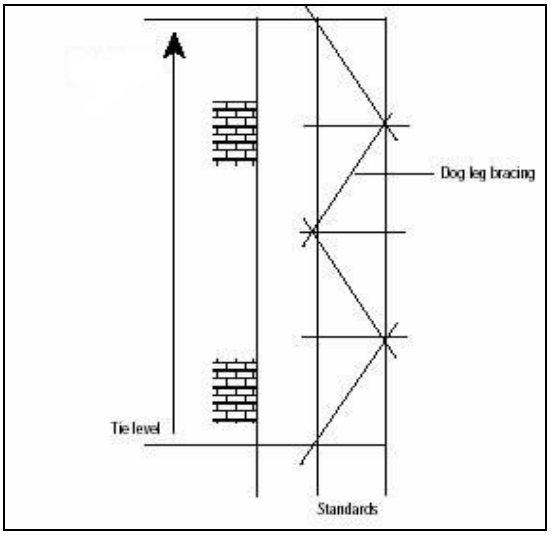


Figure-5 Dogleg bracing

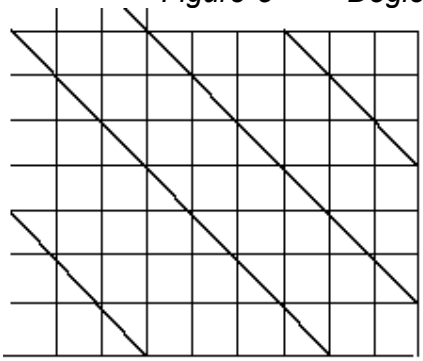


Figure-6 Diagonal bracing

g. Clearance from Electrical Lines

Scaffolds seldom make contact with overhead electrical lines, but when it does happen it almost always results in a fatality. Failure to maintain safe distances from overhead power lines while moving scaffolds is a major problem. Before attempting to move rolling scaffolds in outdoor open areas, check the route carefully to ensure that no overhead wires are in the immediate vicinity. Partial dismantling may be necessary in some situations to ensure that the scaffold will make the required safe clearances from overhead power lines. The required minimum safe distances are listed in Table 1. Hoisting scaffold material by forklift or other mechanical means requires careful planning and should be avoided in the vicinity of power lines. Transporting already-erected scaffolds by forklift, particularly in residential construction, has been the cause of many electrical contacts – this is a dangerous practice. Workers handling materials or equipment while working on the platform must also take care to avoid electrical contact.

Table - 1

Voltage	Safe Clearance
750-15, 000 Volts	3.0 meter
15, 001-250, 000 Volts	4.5 meter
Over 250, 000 Volts	6.0 meter

Hazard management and Information to Employees

a. **Hazards on Scaffolding**

- Fall of persons
- Fall of materials and articles
- Failure of the scaffold due to overloading
- Failure of the scaffold members during erection and dismantling
- Contact with energized power lines
- Environmental

b. **Problem areas**

- Erecting and dismantling scaffolds
- Climbing up and down scaffolds
- Planks sliding off or breaking
- Improper loading or overloading
- Platforms not fully planked or “decked”
- Platforms without guardrails
- Failure to install all required components such as base plates, connections, and braces
- Moving rolling scaffolds in the vicinity of overhead electrical wires
- Moving rolling scaffolds with workers on the platform.

c. **Information for Employees**

Before employees begin work, they must be informed by their employer of:

- Hazards employees may be exposed to while at work;
- Hazards employees may create which could harm other people;
- How to minimize the likelihood of these hazards becoming a source of harm to themselves and others;
- The location of safety equipment; and

- Emergency procedures.
- Employers are also required to inform employees of the results of any health and safety monitoring. In doing so, the privacy of individual employees must be protected.

d. ***Assigning Personnel***

- Assign a responsible person to oversee the scaffold selection, erection, use, movement, alteration, dismantling, maintenance and inspection.
- Assign only trained and experienced personnel to work on scaffolding.
- Be certain they are knowledgeable about the type of scaffolding to be used and about the proper selection, care and use of fall protection equipment (perimeter protection, fall protection/work positioning belts and full harnesses, lanyards, lifelines, rope grabs, shock absorbers, etc.).

e. ***Training***

- Employees should receive instruction on the particular types of scaffolds that they are to use.
- Training should focus on proper erection, handling, use, inspection, removal and care of the scaffolds.
- Training must include the installation of fall protection, particularly guardrails, and the proper selection, use and care of fall arrest equipment.
- The competent person(s) should receive additional training regarding the selection of scaffolds, recognition of site conditions, scaffold hazard recognition, protection of exposed personnel and the public, repair and replacement options, and requirements of standards.
- Site management personnel should also be familiar with correct scaffolding procedures so they can better determine needs and identify deficiencies.

f. ***Fall Protection***

- Guardrails must be installed on all scaffold platforms in accordance with required standards and at least consist of top rails, mid-rails and toe-boards (if more than 3 meter above the ground or floor).
- When it is necessary to remove guardrails (for example, to off-load materials), supervision must ensure that they are replaced quickly.
- Hard hats should be worn at all times to protect against falling objects.
- Mesh, screens, intermediate vertical members or solid panels should be used to safeguard employees and the public at lower levels.
- Ground-level safety can be further provided by erecting canopies; by prohibiting entry into the fall hazard area by policy, barricades and signs; and by the proper placement of materials, tools and equipment on scaffolding.
- Workers on suspended scaffolds must use a fall arrest system as protection against the failure of the scaffold or its components.
- Care must be taken to ensure that rope grabs are properly connected to lifelines so the cam will work correctly.
- Independent vertical lifelines (not scaffold suspension lines) of fibre rope should be used for each person working on the suspended scaffold.
- In the presence of flame or heat, wire rope lifelines should be used with lanyards containing shock absorbers.
- Vertical lifelines should extend from the anchorage point to the ground or a safe landing place above the ground.

- The anchorage points are independent points on structures where lifelines are securely attached.
- These points must be able to support at least 2270 kgs per employee and preferably 2450 kgs for a fall of up to two meter.

Guidelines for Proper Erection

- Supervision while erection of scaffolding should be done by a person competent by skill, experience and training to ensure safe installation according to the manufacturer's specifications and other requirements.
- Know the voltage of energized power lines. Ensure increased awareness of location of energized power lines; maintain safe clearance between scaffolds and power lines (i.e., minimum distance of 1 meter for insulated lines less than 300 volts; 3 meter for insulated lines 300 volts or more).
- Identify heat sources like steam pipes. Anticipate the presence of hazards before erecting scaffolds and keep a safe distance from them.
- Be sure that fall protection equipment is available before beginning erection and use it as needed.
- Have scaffolding material delivered as close to the erection site as possible to minimize the need for manual handling.
- Arrange components in the order of erection.
- Ensure the availability of material hoisting and rigging equipment to lift components to the erection point and eliminate the need to climb with components.
- Examine all scaffold components prior to erection. Return and tag "Do Not Use" or destroy defective components.
- Prohibit or restrict the intermixing of manufactured scaffold components, unless:
- The components fit together properly, without force,
- The use of dissimilar metals will not reduce strength, and
- The design load capacities are maintained.
- All scaffold decks should be planked as fully as possible (beginning at the work surface face) with gaps between planks no more than 25 mm wide (to account for plank warp and wane).
- Platform units must not extend less than 150 mm over their supports unless they are cleared or contain hooks or other restraining devices.
- When platform units are abutted together or overlapped to make a long platform, each end should rest on a separate support or equivalent support.
- Wood preservatives, fire retardant finishes and slip-resistant finishes can be applied to platform units; however, no coating should obscure the top and bottom of wooden surfaces.
- If fire retardants are used, an engineer should ensure that the plank(s) will carry the required load since fire retardants can reduce the plank load capacity.
- Provide suitable access to and between scaffolds. Access can be provided by portable ladders; hook-on ladders; attachable ladders; stairway-type ladders; integral prefabricated scaffold rungs; direct passage from another scaffold, structure or personnel hoist; ramps; runways; or similar adequate means.
- Cross braces and scaffold frames should not be used for access scaffold platforms unless they are equipped with a built-in ladder specifically designed for such purpose.

Guidelines for Use

- Make sure that scaffolds and components are not loaded beyond their rated and maximum capacities.
- Prohibit the movement of mobile scaffolds when employees are on them.
- Maintain a safe distance from energized power lines.
- Prohibit work on scaffolds until materials that could cause slipping and falls are removed.
- Protect suspension ropes from contact with sources of heat (welding, cutting, etc.) and from acids and other corrosive substances.
- Prohibit scaffold use during storms and high winds.
- Remove debris and unnecessary materials from scaffold platforms.
- Prohibit the use of ladders and other devices to increase working heights on platforms.

Guidelines for Alteration and Dismantling

- Scaffolds be altered, moved and dismantled under the supervision of a competent person.
- Alteration and dismantling activities should be planned and performed with the same care as with erection.
- Tag any incomplete scaffold or damaged component out of service.

Inspections

- Inspect all scaffolds and components upon receipt at the erection location.
- Return, tag “Do Not Use” or destroy defective components.
- Inspect scaffolds before use and attach a tag stating the time and date of inspection.

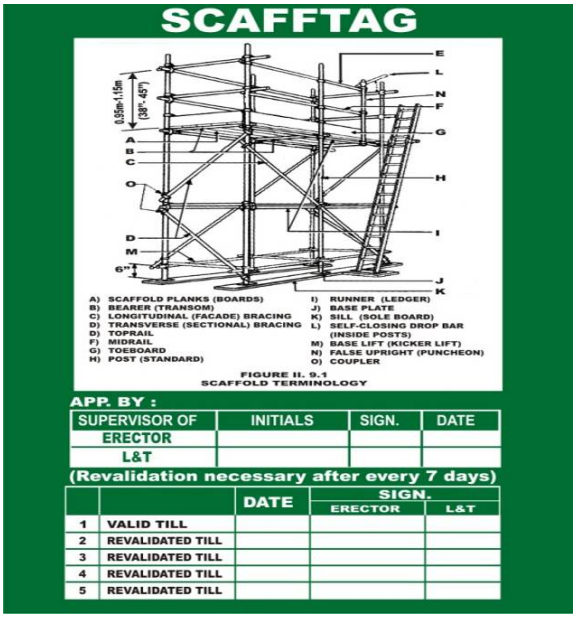


FIGURE II. 9.1
SCAFFOLD TERMINOLOGY

- Inspect scaffolds before each work shift and especially after changing weather conditions and prolonged interruptions of work.
- Check for such items as solid foundations, stable conditions, complete workin7 and rest platforms, suitable anchorage points, required guardrails, loose connections, tie-off points, damaged components, proper access, and the use of fall protection equipment.

Maintenance and Storage

- Maintain scaffolds in good repair.
- Only replacement components from the original manufacturer should be used.
- Intermixing scaffold components from different manufacturers should be avoided.
- Fabricated scaffolds should be repaired according to the manufacturer's specifications and guidance.
- Job-built scaffolds should not be repaired without the supervision of a competent person.
- Store all scaffolding parts in an organized manner in a dry and protected environment.
- Examine all parts and clean, repair or dispose of them as necessary.

CHAPTER 24: LADDER SAFETY

AIM:

Correct & safe method of use for ladders so that worker does not fall while working on ladder or cause injury while handling the same.

Legal :

Legal aspects as per Factories Act 1948,

Rule 7A – General duties of a occupier-

sub rule (d)

The maintenance of all places of work in the factory in a condition that is safe and without risks to health and provision and maintenance of such means of access to and egress from, such places as are safe and without such risks.

Rule 44 – Responsibility of employer

An employer shall be responsible for providing constant and adequate supervision of any building or other construction work in his establishment as to ensure compliance with the provisions of this act relating to safety and for taking all practical steps necessary to prevent accidents.

The Building and other Construction Workers' (Regulation of Employment and Conditions Of Service) Act, 1996 And Rules, 1998

Rule 5 – Duties & responsibility of employers, employee & others

Sub rule 5

It shall be duty of every employer not to permit an employee to do anything not in accordance with generally accepted principles of standard safe operating practices connected with building and other construction work as specified by the central government.

Sub rule 6

No employee shall do anything which is not in accordance with the generally accepted principles of standard safe operating practices connected with building and other construction work as specified by the central government.

Sub rule 7
No person related with any building and other construction work shall willfully do any act which may cause injury to himself or to others.

All the rules applicable to ladders **(172-174)**

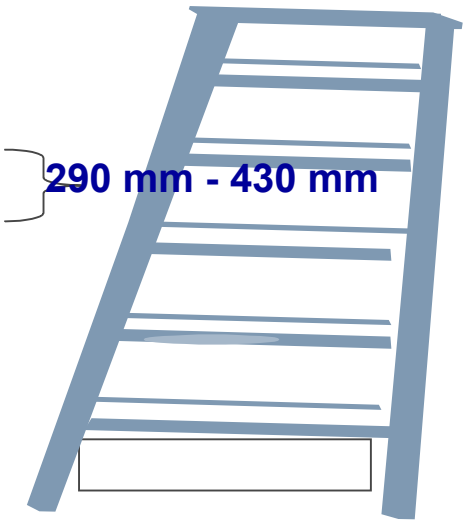
- The design of ladder should confirm to IS 3696 (Part 2): 1991. Make shift ladders should not be permitted.

- Metal ladder should be either of steel complying with IS-1977:1975, or of aluminium alloy complying with the suitable grade of IS 617:1975.
- All ladders should be designed to carry their intended load safely.
- Slide rails (Stiles) of metal ladders should be of sufficient cross-section to prevent excessive deflection in use.
- Slip-resistant shoes, lashing or other effective means should be used to avoid danger of slipping.

a. **Stock ladders**

- Overall length of stock ladders should not exceed 10 m.

- The width between side rails at the base should in no case be less than 290 mm for ladders upto 3 m in length. In the case of metal ladders, metal rungs should be made of solid round steel rods or steel pipe and securely fastened to the slide rails by riveting, bolting or welding.
- Length (L) not more than 10 m
- Distance between rungs
- NOT LESS THAN 250 mm
- NOT MORE THAN 350 mm



b. **Step Ladders**
- The overall height of step ladders should not exceed 6 m.
- Ladders should be provided with an automatic locking device or spreader to hold it in an open position.
- The minimum width between side rails at top step, inside to inside, should be not less than 300 mm with a spread of 25 mm for each 300 mm of length of spread ladder.

c. **Extension Ladders**
- The overall length of the extension ladder should not exceed 18 m.
- The sliding section should not exceed two in number.
- Locks and guides should be of such design and construction as to make the extension ladder equal in strength to a ladder of equal length constructed of continuous slide rails.
- When using an extension the overlap of any two sections should be as follows

  - Closed length of less than 5 m – 1½ rungs
  - 5m – 6m-2½ rungs
  - Over 6 m-3½ rungs

d. **Trestle Ladders**

- Trestle ladders should not exceed 6 m in length
- The sections should be so hinged at the top that when the ladder is spread, they form equal angles with the base.
- The rungs should not be less than 30 mm in diameter should be spaced not more than 450 mm apart centre to centre.
- The minimum distance between side-rails of trestle ladders should be not less than 300 mm.
- A locking device or spreader should be provided to hold the front and back sections securely in an open position.

e. **Built up Ladders (Fixed Ladder)**

- All surfaces of the ladder should be plane, free of splinters and edge of hand rails used should be beveled.
- Rung spacing should be uniform and not over 300 mm on centres. Rungs should be recessed at least 12 mm into rails / stiles.
- When height exceeds 9m, landing platform to be provided.
- Other dimensions of the fixed ladder should conform to the details shown in the above sketch.
- Top and bottom of built-up ladder should be securely fastened to the structure.

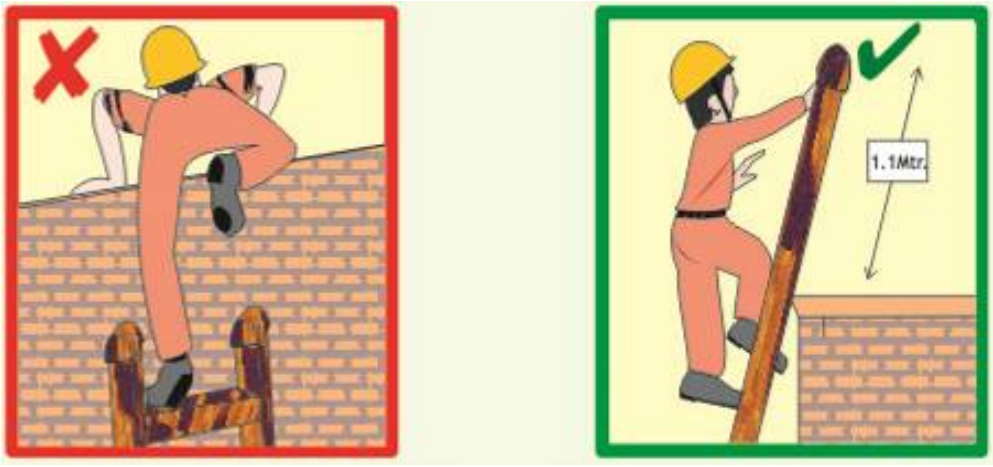
a. **Inspection of Ladders**

- Before use, all ladders should be tested for load test. They should have not only adequate strength but rigidity as well.

- Metal ladders should be inspected at least once in three months and all parts checked for wear, corrosion and structural failure.

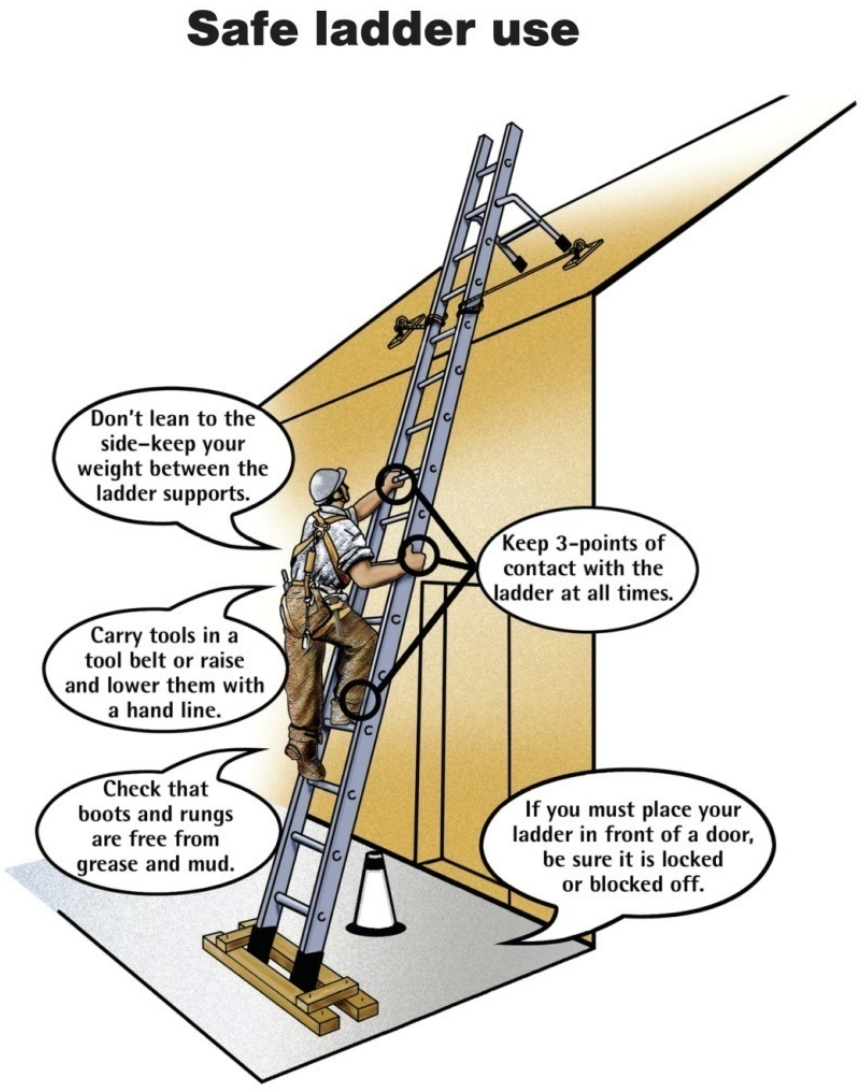
- All ladders should be carefully inspected, if incidentally dropped or otherwise damaged in use.

a. **Usage of Ladders**



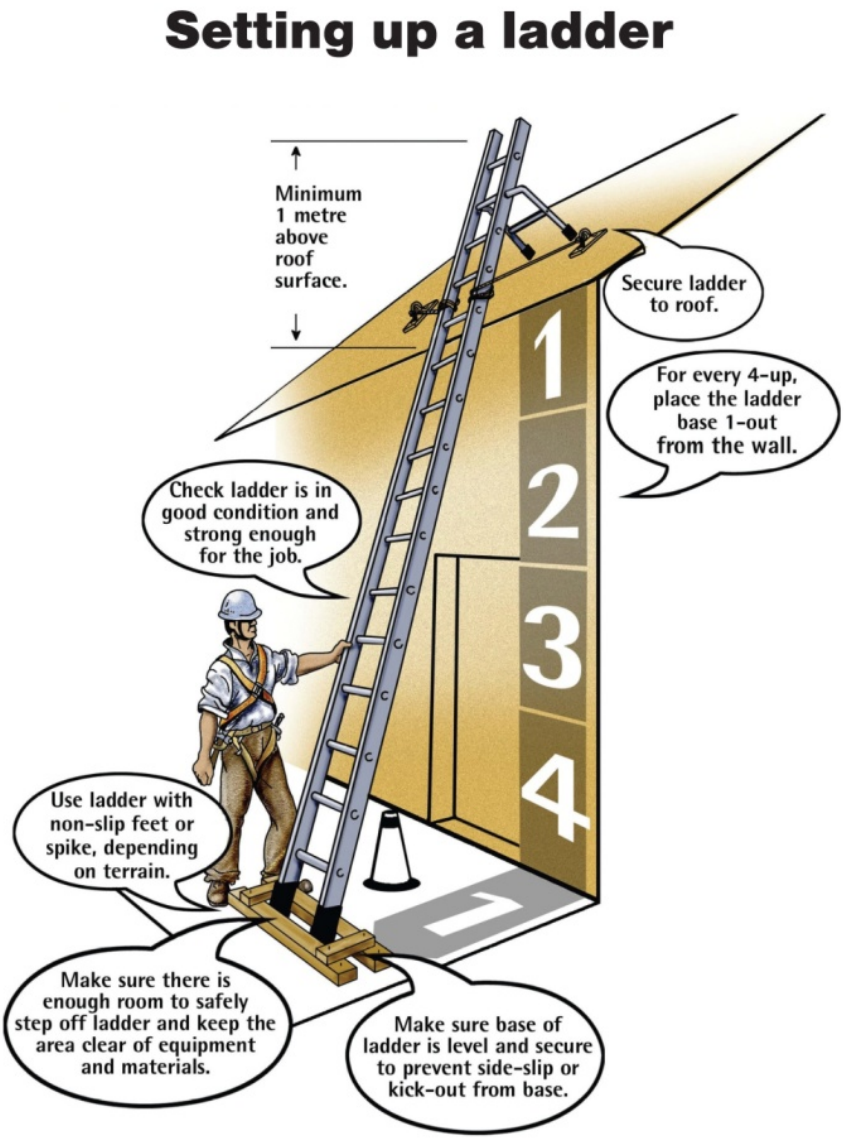
- Ladders leading to landings, walkways or Working Platform should extend at lease one metre above the landing and should be secured at the upper end as shown in the above sketch.

- Ladder should be placed on a firm, level ground. It should be provided with slip-resistant feet or someone should hold the ladder so that it does not slip. As a further precaution, the ladder should be placed at a slope as shown in the sketch below.



- If the use of ladder is essential during strong winds, it should be securely secured in position.
- No ladder should be placed against window panes, sashes or such other unsafe or yielding objects, nor placed in front of doors opening towards it.
- When ascending or descending, the user should face the ladder, use both his hands and place his feet near the ends of the rungs rather than near the middle.
- The user should always maintain three-point-contact as shown in the above sketch.

- No ladder having a missing, defective rung or one which depends for the support solely on nails, should be used. Defective ladders should be promptly and properly repaired or replaced.
- Hand tool and objects should not be carried in hands while climbing up or down. Waist-bag should be used for this purpose.
- Ladders made of metal / conductive materials should not be used in the vicinity of overhead electrical lines.
- Ladders should not be used as guys, braces or skirts or for any other purpose for which they are not intended. They should not be used in horizontal position as runways or crossover.
- Ladders should not be spliced to increase the height.
- Use of items such as a chair, barrel or box as a makeshift ladder should not be permitted.



CHAPTER 25: SAFETY IN WORKING PLATFORM

AIM:

Working at height is a risky activity. Workers fall from height & are injured. Working platforms that are stable with edge protection helps for enhancing safety at work.
Legal :

The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 and Rules, 1998

Chapter XIX : SCAFFOLD
All the rules applicable **(188-205)**

General
The scaffold boards which make up a working platform should rest squarely and evenly on transoms to prevent the risk of tripping. Where the ends of boards meet, transoms must be doubled and so spaced that no board overhangs by more than four times its thickness. Too much overhang will cause the board to tip if you step on it, while too little – less than 50 mm – will mean that it is easily dislodged. Normally, each board should have three supports to prevent it bending or sagging. The space between the edge of the working platform and the face of the building should be as small as possible. The width of a working platform should be sufficient for the work which is to be carried out from it, and recommended widths are:

- not less than 60 cm if used as footing only;
- not less than 80 cm if used also for the stacking of material;
- not less than 1.1 m if used for the support of a trestle platform.

Gangways or runs should be of adequate width for their purpose and should preferably be horizontal. If the slope exceeds 20^0 or the surface is likely to become slippery with rain, laths should be fixed at 90^0 across the slope, allowing a small central gap to accommodate wheelbarrow wheels. Finally, precautions must be taken to prevent boards lifting in high winds.

Guard-rails and toe boards
The provision of secure guard-rails and toe boards at every point at which you may fall more than 2 m is critical if falling accidents are to be prevented. Both should be fitted on the inside of the uprights. Guard-rails should be between 90 cms and 115 m above the platform to prevent you from easily falling over or under the rail. Toe boards, which are also intended to prevent material being knocked over the edge of the platform, must rise at least 15 cm above the working platform to achieve this, and if materials are stored to greater than this height then additional boards may be necessary or the space filled in with wire mesh (figure 14). If guard-rails and toe boards are removed for the passage of materials, replace them as soon as possible.

Single pole or putlog scaffolds
A common type of scaffold for smaller jobs is a single pole or putlog scaffold which consists of a platform resting on horizontal putlogs (called transoms in independent scaffolds) fixed at 90^0 to the face of the building (figure 15).

The outer ends of the putlogs are supported on horizontal ledgers fixed parallel to the face of the building and secured to a single row of uprights or standards, also parallel to the wall. The flattened inner end of the putlogs rests flat on the wall, or in holes in the wall, rather than on ledgers. It follows that the scaffold cannot stand without the support of the structure. Putlog scaffolds are mostly used where brick structures are being built. The same principles of goods construction as for independent scaffolds are generally applicable.

A good base for the single row of uprights is essential and the base plates for each upright should again rest on a timber sole board – a sole board should be long enough to support at least two upright. The uprights should be not more than 2 m apart and set at 1.3 m from the wall to allow for a five-board platform. Ledgers should be connected on the inside of the uprights, at a vertical distance of not more than 2 m – a lesser distance may be necessary for some types of work – and left in position as the scaffold rises.

Putlogs should rest on and be secured to the ledgers at horizontal gaps depending on the thickness of the boards used – of not more than 1.5 m for boards of 38 mm – while their flattened, or spade, ends should lie on the brickwork, or enter the wall to a depth of at least 75 mm. For re-pointing old brickwork, the spade ends can rest vertically in joints in the brickwork. Tying into the building is of even greater importance than with independent scaffolds, as putlogs can easily work loose in brickwork. In this type of scaffold, bracing along the face and to the full height of the scaffold is required. Bracing should be at an angle of about 45^0 to the horizontal and at 30-metre intervals. The requirements already described for the construction of working platforms and gangways and for the erection of guard-rails and toe boards apply equally to putlog scaffolds.

A scaffold should not be left partly constructed or dismantled unless adequate notices warning against its use are displayed and all points of access are blocked off.

With both types of scaffold, there is often a need to provide sheeting, boarding, netting, fans or brick guards to prevent materials falling from the scaffold into the street or public places (figure 16). Scaffolding is often easily accessible from the street and positive steps such as the removal of access ladders should be taken to prevent children climbing a scaffold, particularly after the close of the working day.

Tower scaffolds

A tower scaffold consists of a platform resting on horizontal ledgers connected to four uprights supported on base plates if static or on castor wheels if mobile. It is devised for painters and others who do lightweight work of limited duration mainly in one place.

Mobile tower scaffold wheels should be locked when in use; ladder access should be inside the tower

Causes of accidents

Accidents can happen when a tower topples over. This is likely to happen in any of the following cases:

- the ratio of the height of the tower to the width of the base is excessive;
- the top working platform is overloaded causing the tower to become unstable;
- a ladder is placed on the top platform to extend the height of the tower;
- work involving percussion tools produces an outward horizontal or lateral force at the top of the tower;

- a mobile tower is moved with persons or materials carried on the top platform;
- the tower is used on sloping or uneven ground;
- the tower is not tied to the building or structure where this is necessary;
- access to the platform is via the outside of the tower

Height limitations
The first precaution with tower scaffolds is to achieve stability. For this the ratio of height to base width should not be more than 4 : 1 for a static tower which you are using indoors. For a static tower used outdoors the ratio is reduced to 3.5:1, while for a mobile tower used outdoors it should not be more than 3:1. Any loading on the platform will raise the centre of gravity of the tower and too great a load will endanger its stability.

Static towers should not exceed 12 m in height when free-standing, and above this height they should be tied. Mobile towers should not exceed 9.6 m in height when free-standing or 12 m when tied to a structure.

Structure
Towers should be vertical, have a single platform and be used only on a firm and level base, with the uprights of static towers on adequate base plates. Dimensions will vary according to need but corner standards should never be less than 1.2 m apart. The uprights of mobile towers should have castor wheels of not less than 125 mm in diameter which are locked into the base of the uprights. The castor wheels should be fitted with locks or brakes which cannot be accidentally released, and you should ensure that the brakes are applied whenever the tower is stationary.

Working platform
The platform should be equipped with a cover for the ladder access opening which is able to be fixed in both open and closed positions with a latch. This prevents an accidental step into the opening. The cover should be provided with a suitable handhold to provide support when you are climbing through the opening. Guard-rails and toe boards will be necessary for the sides of the working platform, erected as for independent scaffolds. The ladder provided for access to the working platform should be positioned inside the tower as a precaution against overturning.

CHAPTER 26: FALL ARRESTING EQUIPMENT

AIM:

Working at height is always associated with falls – falls of workers due to lack of use of Personal Protective Equipments which can protect them from falling from heights. As the height increases so is the level of risk increases.
Fall arrest equipment is to be used mandatory while working at height.
Below is the detail of such fall arrest equipment.

Legal:Section 7A – General duties of a occupier-

Sub section (d)

The maintenance of all places of work in the factory in a condition that is safe and without risks to health and provision and maintenance of such means of access to and egress from, such places as are safe and without such risks.

Central Rule 1998

Section 5 - Duties & responsibility of employers, employee & others

Sub section 5
It shall be duty of every employer not to permit an employee to do anything not in accordance with generally accepted principles of standard safe operating practices connected with building and other construction work as specified by the central government.

Sub section 6
No employee shall do anything which is not in accordance with the generally accepted principles of standard safe operating practices connected with building and other construction work as specified by the central government.

Sub-section 7
No person related with any building and other construction work shall willfully do any act which may cause injury to himself or to others.

Chapter XIV – Construction, repair & maintenance of steep roof

Section 169 – Work on steep roof
The employer shall ensure at a construction site of a building or other construction work that all practicable measures are provided to protect the building workers against sliding when carrying out work on steep roofs.

Fall restraint systems **prevent** you from falling. Examples include:

- Work-positioning systems using either safety belts or full body harnesses that attach you to an anchor and leave both your hands free to work
- Travel-restriction systems of guardrails or personal fall protection equipment used to prevent you from travelling to an edge from where you may fall.
- Fall arrest systems protect you after you fall by stopping the fall before you hit the surface below.

Examples include:

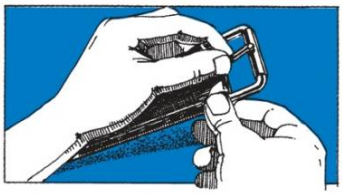
- Full body harnesses connected by lanyards or lifelines to secure anchors
- Safety nets

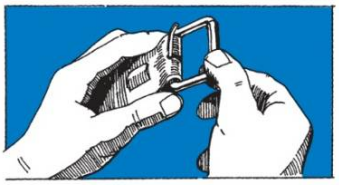
In choosing a fall protection system, you should first consider installing guardrails or barriers. They provide a high degree of protection once installed properly. However, installing guardrails or barriers at a work site is not always practical that is when you may need personal fall protection equipment.

Safety Belts

When to use a safety belt
You must never wear a safety belt in a fall arrest situation. If you fall into a safety belt, you could still suffer severe back and abdominal injuries. Restrict the use of safety belts to fall restraint systems only. If there's a chance you could fall, install guardrails or wear a full body harness in a properly configured personal fall protection system.

Inspecting your safety belt
Inspect your belt before each use. Check the buckle, the webbing, the D-rings, and the manufacturer's label for additional user information. If the belt is damaged or worn, do not wear it.



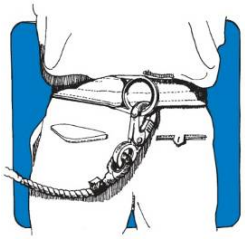


Buckle
Make sure the buckle's tongue overlaps the buckle frame, moves freely, and is not bent or worn down. Check the roller to make sure it turns freely on the buckle frame.

Webbing

Look for frayed, cracked, cut, burned, or otherwise damaged webbing.

D-rings
Check to see whether D-rings are bent, cracked, nicked, or gouged.



Do not use safety belts that show signs of damage.

Manufacturer's label
Inspect the manufacturer's label on the belt. Safety belt will contain the following information:

- Manufacturer or vendor identification
- Belt's waist size
- Material the belt is made of
- Date the belt was manufactured
- Model number
- "Warning - not to be used for fall arresting"

Putting on a Safety Belt
Before putting the belt on, make sure you have the right size.
Fasten the belt snugly around your waist. Wear it high on your waist, not low around the hips or pelvic area. Position the belt buckle at the front of your body, and make sure the belt tail is secure in the belt loop and not hanging out loosely.

Full Body Harnesses

When to use a full body harness

When using personal fall protection equipment, wear a full body harness if you are at risk of falling.

A full body harness consists of straps passed over the shoulders, across the chest, and around the legs. In a fall, a full body harness protects you more than a safety belt, because it distributes the force of impact over a greater area of your body.

No fall protection provided.

Fall protection provided.

Using the Right Full Body Harness

A full body harness designed to arrest falls should have
A back-mounted D-ring located between the shoulder blades
The letter "A" stenciled on each shoulder strap below the D-ring

An arrow stenciled above each letter “A” pointing up at the D-ring

The arrows on the shoulder straps point to the only D-ring on the harness designed to safely arrest a fall.

This is a full body harness worn to arrest falls. Note that the D-ring is located between the shoulder blades.

Inspecting your Full Body Harness
Inspect your harness before each use. Check the buckles, the webbing, the D-rings, and the manufacturer’s label for additional user information.
If the harness is damaged or worn, do not wear it.

Buckles
Many full body harnesses have interlocking buckles called friction buckles. Look for bent, cracked, or nicked buckles. Test the buckles to make sure the coupling is secure.

Safety harness
The majority of fatal accidents in construction are due to falls from heights. Where work cannot be done from a scaffold or ladder, or from a mobile access platform, the wearing of a safety harness may be the only way to prevent serious injury or death.
Another common situation in which a safety harness may be used – sometimes supplemented by the use of a safety net

– is maintenance work on steel structures such as bridges and pylons.

There are many types of safety belt and safety harness available in preference to a safety belt.

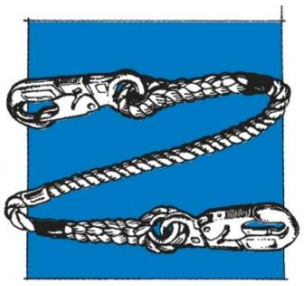
The manufacturer or supplier asked for advice on suitable types for the intended purpose and for instructions on use and maintenance. A full safety harness should always be used.

A safety harness and its lanyard must:
- limit your fall to a drop of not more than 2 m by means of an inertia device;
- be strong enough to support your weight;
- be attached to a strong structure through a firm anchorage point above the place at which you are working

Lanyards and Anchors
A lanyard is a flexible line of webbing or a synthetic or wire rope used to secure a safety belt or full body harness to a lifeline or anchor.

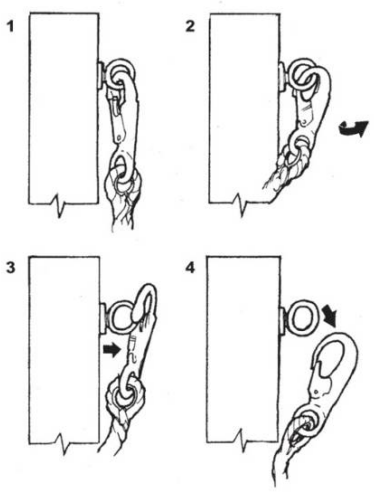
Using the Right Lanyard
Keep lanyards as short as possible to reduce the distance you could fall. Try to arrange the lanyard to limit a free fall to no more than 1.2 m (4 ft.) in a fall arrest situation.
When using a wire rope lanyard for fall arrest, a personal shock absorber must be incorporated as part of your personal fall protection system in order to keep the arrest force at a safe level.

Inspecting your lanyard
Inspect the lanyard before each use. Check the rope or webbing, the snap hooks, and the manufacturer's label for additional user information.



Rope or webbing
Inspect along the length of the lanyard and the eye splices. If you have a three-strand rope lanyard, carefully twist the rope open to look for worn, broken, or cut fibres. Do not overtwist, or you could permanently deform the rope.
Web lanyards should be discarded if the webbing has cuts or holes, is worn or frayed, or if the load-bearing stitches are damaged.
If you find any signs of deterioration, burns, or broken or damaged strands, or if you have any reason to suspect the lanyard, do not use it.

Snap Hooks
Requires to be self-locking to prevent accidental roll-out. Roll-out can occur when small D-rings, or other attachment hardware, cause the snap-hook gate to push open in a twisting action —thus separating the two components.



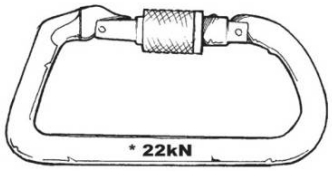
Carabiners

A carabiner is an oblong-shaped connecting device used to attach different components of a personal fall protection system.

Requirements of carabiner should:

Have gates that are both self-closing and self-locking
Have a breaking strength of at least 22 kN (5,000 lb.)
Have the manufacturer's identity and load capacity clearly marked on it

Inspect your carabiner before each use. Make sure it is free of damage, deformities, or excessive wear.

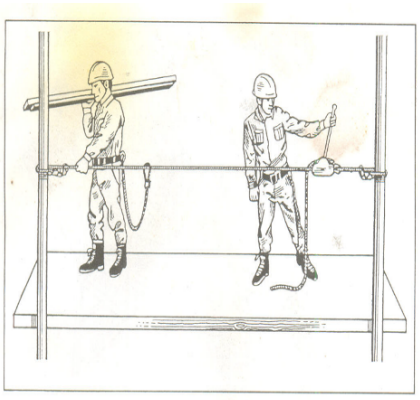


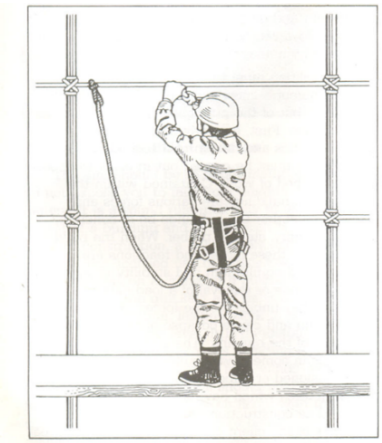
Anchors
An anchor - what you connect your lanyard or lifeline to is a key element of any personal fall protection system. An anchor may consist of a load-rated strap or sling wrapped around a substantial structural member on a building. An anchor may also be a manufactured component that permanently or temporarily attaches to a structure.

Selecting an Anchor
The selection of a suitable anchor depends on whether you want to restrain or arrest a fall.

Lifeline

- 20mm diameter polypropylene rope or 8 mm wide rope should be used as a lifeline and properly anchored to an anchorage point.
- Horizontal lifelines should be positioned so as to provide points of attachment at shoulder level or higher for personnel utilizing them.
- Lifelines should not be used for any purpose other than fall protection.
- The sag of the life line should not be more than 15 degree.

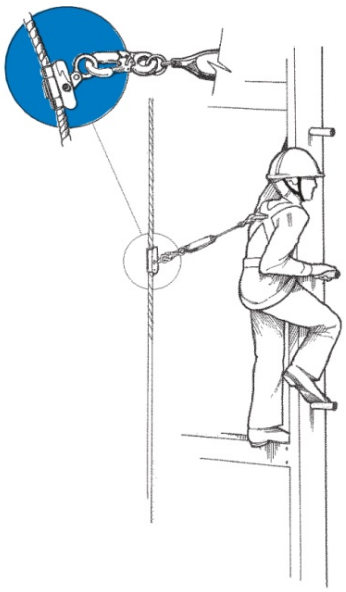




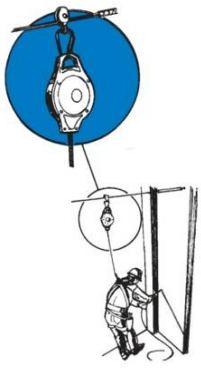
Use of Safety Belts and harnesses – different ways of providing safe anchorage points for safety lines.

Swing Falls
Swing fall occur when the anchorage point is not directly above the point where a fall occurs. The force of striking an object in a swing fall may cause serious injury or death. Minimize swing falls by working as close to the anchorage point as possible.

Rope Grab Fall Arrestor
Rope grab type fall arrestors should be used to protect fall of workers during vertical movement such as ascending or descending Scaffold towers, vertical ladders etc.



Retractable Type Fall Arrestor
Retractable fall arrestors should be used in places where high risk of fall of workmen persists. This fall arrestor can be directly anchored to the anchorage or can be used in conjunction with a lifeline.



Energy Absorber
It is an optional attachment, which may be used in conjunction with the lanyard to connect the harness to the anchorage point. In case of fall it reduces the impact energy passed on to the worker considerably by absorbing part of the energy. Energy absorber should be used only while working above 6 m.

Safety Net

Providing adequate platforms and edge protection may not always be possible or reasonably practicable. If so, safety nets will be required. They do not stop people falling, but minimize the potential injuries if they do.

If nets are used make sure that they are properly installed by competent riggers as close as possible below the roof involved to minimize the distance fallen. Installing a net does not mean proper working platforms and edge protection can be ignored, because the first priority is to stop people falling in the first place. Refer IS 11057- Specification for Industrial Safety Nets for more details.

CHAPTER 27: TEMPORARY STAIRS & SUSPENDED JHOOLAS

AIM:
Access & egress at construction sites especially on scaffolds is through staircase. Temporary staircase has to be sturdy and well designed for the safety of the employees who have to reach heights or access areas. Employees should be safe & not fall from such temporary stairs.
Suspended access for external work is normally being done by Jhoolas where in one person sits on a plank which is lowered from the top and held manually by ropes. Such practice is highly dangerous.
With safety concerns equipments like Boatswain's chair are being used for safety of the employees and at times suspended mechanism with winch system are introduced where in at a time 2 or 3 people can work safely.

Legal :
The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 and Rules, 1998
Chapter XIX : SCAFFOLD
All the rules applicable **(188-2O5)**

Internal staircases
Internal stairs should be constructed of non-combustible materials throughout.

Internal stairs should be constructed as a self-contained unit with an external wall of the building constituting at least one of its sides and should be completely enclosed.

A staircase should not be arranged round a lift shaft.

Hollow combustible construction should not be permitted.

No gas piping or electrical panels should be allowed in the stairway. Ducting in stairway may be permitted if it is of 1 h fire resisting rating.

Notwithstanding the detailed provision for exits in accordance with 4.3, 4.4 and 4.5, the following minimum width should be provided for staircases:

i. Residential buildings (dwellings) 1.0 m
ii. Residential hotel buildings 1.5 m
iii. Assembly buildings like auditorium, theatres and cinemas 2.0 m
iv. Educational buildings up to 30 m in 1.5 m height
v. Institutional buildings like hospitals 2.0 m
vi. All other buildings 1.5 m

The minimum width of treat without nosing should be 250 mm for internal staircase of residential buildings. This should be 300 mm for assembly, hotels, educational, institutional, business and other buildings. The treads should be constructed and maintained in a manner to prevent slipping.

The maximum height of riser should be 190 mm for residential buildings and 150 mm for other buildings and the number should be limited to 15 per flight.

Handrails should be provided at a height of 1000 mm to be measured from the base of the middle of the treads to the top of the handrails. Balusters / railing should be provided such that the width of staircase does not reduce.

The number of people in between floor landings in staircase should not be less than the population on each floor for the purpose of design of staircase. The design of staircase should also take into account the following:

- The minimum headroom in a passage under the landing of a staircase and under the landing of a staircase and under the staircase should be 2.2 m.
- For building 15 m in height or more, access to main staircase should be through a fire / smoke check door of a minimum 2 h fire resistance rating. Fire resistance rating may be reduced to 1 h for residential buildings (except hotels and starred hotels).
- No living space, store or other fire risk should open directly into the staircase or staircases.
- External exit door of staircase enclosure at ground level should open directly to the open spaces or through a large lobby, if necessary.
- The main and external staircases should be continuous from ground floor to the terrace level.
- No electrical shafts / AC ducts or gas pipes, etc. should pass through or open in the staircases. Lifts should not open in staircase.
- No combustible material should be used for decoration/ wall paneling in the staircase.
- Beams / columns and other building features should not reduce the head room / width of the staircase.
- The exit sign with arrow indicating the way to the escape route should be provided at a suitable height from the floor level on the wall and should be illuminated by electric light connected to corridor circuits. All exit way marking signs should be flush with the wall and so designed that no mechanical damage should occur to them due to moving of furniture or other heavy equipments. Further, all landings of floor should have floor indicating boards prominently indicating the number of floor as per bye-laws.
- The floor indication board should be placed on the wall immediately facing the flight of stairs and nearest to the landing. It should be of size not less than 0.5 m X 0.5 m.
- Individual floors should be prominently indicated on the wall facing the staircases.
- In case of single staircase it should terminate at the ground floor level and the access to the basement should be by a separate staircase. The second staircase may lead to basement levels provided the same is separate at ground level by ventilated lobby with discharge points to two different ends through enclosures.

External Stairs

An external staircase is desirable to be provided for high rise buildings.

External stairs, when provided should comply the following:

- External stairs should always be kept in sound operable conditions.
- All external stairs should be directly connected to the ground.
- Entrance to the external stairs should be separate and remote from the internal staircase.
- Care should be taken to ensure that no wall opening or window opens on to or close to an external stairs.
- The route to the external stairs should be free of obstructions at all times.

- The external stairs should be constructed of non-combustible materials, and any doorway leading to it should have the required fire resistance.
- No external staircase, used as a fire escape, should be inclined at an angle greater than 45^0 from the horizontal.
- External stairs should have straight flight not less than 1250 mm wide with 250 mm treads and risers not more than 190 mm. The number of risers should be limited to 15 per flight.
- Handrails should be of a height not less than 1000 mm and not exceeding 1200 mm. There should be provisions of balusters with maximum gap of 150 mm.

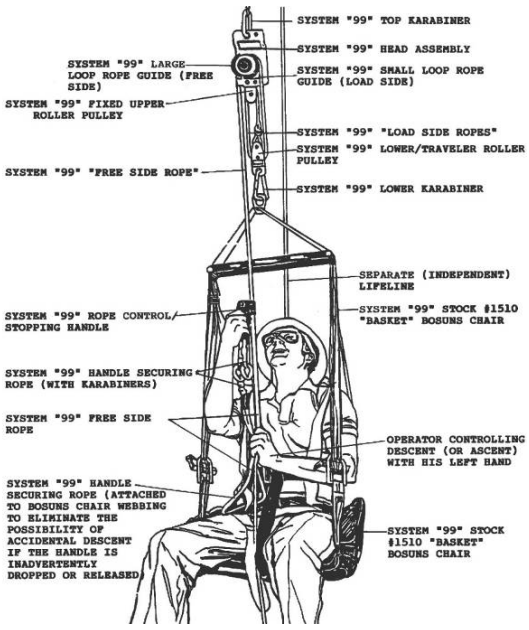
The use of spiral staircase should be limited to low occupant load and to a building not exceeding 9 m in height.

A spiral stair case should be not less than 1500 mm in diameter and should be designed to give adequate headroom.

Unprotected steel frame staircase will not be accepted as means of escape. However, steel staircase in an enclosed fire rated compartment of 2 h will be accepted as means of escape.

Suspended Jhoolas:
Suspended Jhoolas if being used the rope used to suspend the worker has to be of adequate strength and should be inspected regularly for wear and tear.
The rope end has to be anchored on the top to fasten & hold the weight of the person.
Training should be imparted to the person controlling the vertical movement of the Jhoola and should have appropriate physical strength to control & hold the weight or if possible winch system to be used.
Medical test of the person working on suspended jhoolas has to be conducted and if found fit only be allowed to work at site.
A vertical lifeline has to be used for additional safety in addition to the Full body harness & roper grab.

Boatswain's chair:



Mechanised system for suspended access equipment

CHAPTER 28: SAFETY IN FLOOR OPENINGS

AIM:

All construction sites have floor openings in the form of open areas, ducts, vents etc, which remain unguarded resulting in fall of workers from this openings. Falling from open floor openings should be safeguarded to avoid injuries and fatalities at sites.

Legal :

The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 and Rules, 1998

Chapter XIX : SCAFFOLD

All the rules applicable **(188-205)**

195 - Opening

FLOOR OPENINGS:
A floor opening is an opening in any floor, platform, pavement, or yard that measures at least twelve inches in its smallest dimension and through which a person can fall.
Examples of floor openings include duct and mechanical penetrations, stair or ladder openings, manholes, pits, or hatchways.

- Unprotected floor openings could result in injuries from falls and falling objects.
- You have two options to protect an opening over 6' above a lower level. You may install a standard guardrail with a mid-rail or use a hole cover.
- Cover or guard floor openings as soon as they are discovered, or as soon as they are created during new construction.
- All floor-opening covers must be made of adequate material that is strong enough to effectively support the weight of employees, equipment and materials that could be imposed on the cover at any one time. A rule is two times the expected load.

However, workers should not depend on the structural integrity of floor opening covers. The covering material could give out if it is defective or improperly constructed.

- Floor opening covers must be secured so they are not accidentally displaced. This may be done by blocking them underneath or nailing or bolting them in place. Remember, if you move the cover, you are responsible for replacing it.
- Finally, mark all floor hole covers with clearly readable signs or markings that say "Caution - Hole" or "Caution - Hole Cover." The signs should include yellow and black warning colours.
- Never sit on, lean against, or step on a skylight or any covering placed over a hole in a roof or floor. The material may not support your weight.
- Guard or securely cover all holes you have created or uncovered before you leave the work area. Other workers might not notice an uncovered hole and fall through.
- Ask your supervisor for safety procedures to follow when covering or guarding a hole.
- Always use a personal fall arrest system (PFAS) that includes a full-body harness, lanyard, connectors, and appropriate anchorage points (tie-offs) when working over an unguarded or uncovered opening more than 6 feet above a lower level—for example,

while you are installing a skylight or ventilation unit in an opening that cannot be guarded or covered.

- If you use a PFAS, inspect it daily and report any damage or deficiencies to your supervisor.
- Immediately tell your supervisor about any unguarded skylights, roof or floor openings, or other fall hazards in your workplace.
- Participate in all safety and health training programs.
- Conduct periodic scheduled and unscheduled inspections to ensure that the fall prevention system is used and maintained correctly and provides adequate protection against falls.
- Train workers to recognize fall hazards associated with working near skylights and roof and floor openings.
- Train workers in the correct fall prevention procedures they are to follow.
- If workers cannot read posted warning signs, warn them verbally.

CHAPTER: 29 SAFETY DURING DEMOLITION

AIM:

Demolition activity is very dangerous as falling material can cause severe injury and at times sudden & unexpected collapse of structure can cause severe damage as well. Hence, one has to plan & prepare for the unexpected.

Legal :

The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 and Rules, 1998
Chapter XII : Demolition
All the rules applicable to demolition **(108-118)**

Demolition
Demolition of structures and excavation jobs are quite common in construction. Hazards encountered during above operations and safety precautions to be observed are given below:

Demolition of Structures
During demolition the accidents are most likely due to :
(1) fall
(2) falling materials or things
(3) sudden collapse of some of the structures under for lifting demolished materials or machineries working near the structure to be demolished
(4) fire and explosion
(5) general accident due to lifting materials, obstructed access, striking against objects and poor housekeeping. The most important cause is the wrong methods of demolition, allowing the workers to work at unsafe place without paying attention to the site of work, bad housekeeping or work undertaken without proper assessment of the structure and absence of any thought to prevent against accidental collapse of any part of structure and absence of any supervision. This happens because the main contractor who may be an experienced engineer, but the practice is of giving sub-contract for demolition who brings his own men and there is no supervision on the method of work and over the actual work. The main contractor hardly gives proper guidance to sub-contractor who are mostly illiterate and only some or no previous experience. The following points should be noted and implemented whenever any structure is to be demolished.

Step required before starting any demolition
- Proper study of the structure to be dismantled and the nearby structures.
- The connection between the structure to be demolished and connected buildings which are likely to be affected by demolition.
- Planning regarding disconnection of electric line, water or steam line, whether to disconnect or bye pass.
- Study of drawings of constructions of structure to be demolished to get an idea of stages and method of construction, and if no drawings are available, a complete study of structure shall be made. Allowance shall be considered between drawings and the actual construction for any deviation that may be possible. If in doubt, consult a qualified and experienced structural engineer.

- Study of the manufacturing process, which was carried out in the structure to be demolished with a specific inquiry regarding use of flammable or explosive materials inside.
- The type of wall, load bearing partition or cross should be ascertained and study its bonding.
- Whether proper props and supports are provided on parts of structures not to be demolished.
- Study of supports to any cantilever construction.
- Plan properly about the stages of demolition and usually reverse methods than that followed in construction should be followed.
- Proper support shall be provided to structures likely to be affected by method or work of demolition to prevent sudden collapse.
- If there is a storage tank, find out about the material stored.
- If other parts of building are likely to be affected, inform the concerned about the possible impact.

During Demolition

- The demolition work should be done under experienced supervisor who has complete idea of methods of demolition and its steps.
- Instruct and train each worker about the method and procedure of work to be done.
- Tools to be used for demolition should be kept ready and in good condition.
- Whenever required provide protective wears such as shoes, helmet, safety belts etc. and explain to the workers the use of personnel protective equipment and the work requiring the use.

- The area around structure to be demolished should be cordoned off by the red lights provided during nights.
- Appropriate warning signs should be displayed to create awareness of the demolition activity in progress.
- Proper scaffolding and support provided prior to starting the work, whenever necessary.
- The demolition work should be started according to plan and in reverse order than during construction.
- The portion of structure not to be demolished should be provided with necessary strong support.

- The demolished material shall be stored away in such a way that no pressure is exerted on the site of the structure to be demolished.
- Scaffolding will be fixed and railing should be used where required and not neglected.
- It is dangerous to break RCC structure while sitting on it. A separate support structure should be provided. While demolishing the RCC structure keep in mind the distribution of load by studying the structural drawings and site.
- While cutting or demolishing steel parts, the remaining part should be suitably supported.
- Provision should be made to prevent any person coming near the structures to be demolished.
- While blasting, the work should be done as per accepted and prescribed methods and administration shall be informed before and about the time and date of demolition and it shall not be done until all clear is obtained.

CHAPTER 30: SAFETY DURING EXCAVATION

AIM:

Excavation activity is related to soil & earth moving during which subsidence of soil & falling back of debris is of great concern. Disposal of excavated material has to be done carefully so that the worker working at site is not injured or falls back in to the trench or is buried under the falling back of debris.

Legal :

The Building and Other Construction Workers' (Regulation Of Employment And Conditions Of Service) Act, 1996 And Rules, 1998
Chapter XIII : Excavation and Tunnelling Works
All the rules applicable to excavation & tunnelling **(119-168)**

Introduction
Most construction work involves some form of excavations for foundations, sewers and underground services. Excavations or trenching work can be highly dangerous and even some of the most experienced have been caught by the sudden and unexpected collapse of the unprotected sides of a trench. Buried under a cubic meter of soil, it is unable to breathe due to pressure on the chest, and quite apart from any physical injury one can quickly suffocate and even die with a comparatively small amount of soil weights over 1 tone.
Excavation work involves the removal of soil or a mixture of soil and rock. Water is nearly always present, even if only as moisture in the soil, and heavy rain is a frequent cause of soil slip. The possibility of flooding presents an additional hazard which should be always considered. Cracks are caused by pressure release as soil is removed, or drying out in hot weather.

Soil varies in its nature (e.g. fine sand which flows easily, and stiff clay which is more cohesive). However, no soil can be relied upon to supports its own weight and precautions always need to be taken to prevent the sides of the excavations of more than 1.2 meters in depth.

Common causes of accidents in excavation
The main causes of accidents resulting from excavation work are as follows:

- Workers trapped and buried in an excavation owing to the collapse of the sides;
- Workers struck and injured by material falling into the excavation;
- Workers falling into the excavation;
- Unsafe means of access and insufficient means of access in case of flooding;
- Vehicles driven into or too close to the edge of an excavation, particularly while reversing, causing the sides to collapse;
- Asphyxiation or poisoning caused by fumes heavier than air entering the excavation, e.g. exhaust fumes from the diesel and petrol engines.

Safety Precautions
The sides of the excavation or trench should be sloped or battered back to a safe angle of repose, usually 45^{0}, or be supported by timbering or other suitable means to prevent a collapse. The type of support necessary will be depending on type of excavation, the nature of ground and the ground water conditions.

Planning is vital. Make sure that there are enough material to support the length of the trench to be cut, for the trench support must be installed without delay as the excavation progresses. At least random timbering or piling is required in all excavations, but excavations 1.2 meter or more in depth should be provided with adequate timbering or sheeting (Fig-1) close boarding or sheeting is required if the ground is unstable or lacks cohesion. Never work ahead of the trench support.

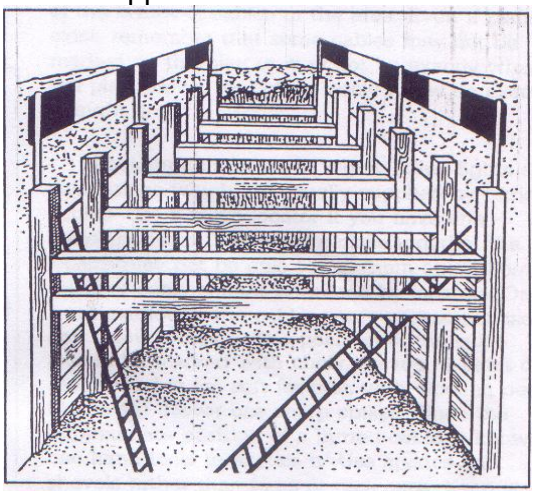


Figure-1: *Shoring to prevent the collapse of the sides of an excavation consisting of timber or steel frames with close boarding between frames*

Shoring should be erected, altered or dismantled only by a competent worker operating under supervision. Wherever practicable, it should be installed before excavating to the final depth of the trench—it is necessary to begin when the trench is less than 1.2 meter deep. The excavation and installation of shoring should then proceed by stages until the full depth is reached. One should be fully aware of the procedures to follow to rescue a fellow worker trapped by a fall of earth.
Workers often fall into excavations. Erect suitable barriers high enough (i.e. about 1 meter) to prevent falls (Fig-2). Projecting trench supports can often be used for this purpose.

Inspection
Excavations should be inspected by a competent person before work begins and at least once a day where work is in progress. They should be thoroughly examined by a competent person once a week and a record to be kept for such inspections.

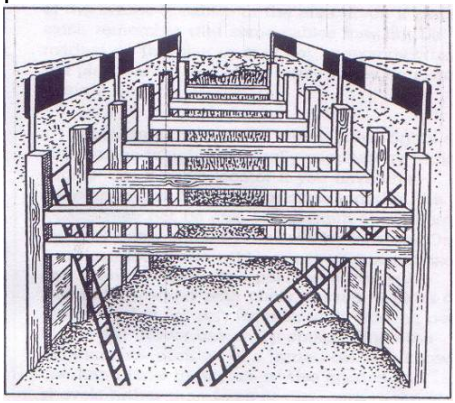


Figure-2: *Barriers along the sides of an excavation to prevent workers falling into it*

Protecting adjoining buildings

Wherever possible, an excavation should not be so close and deep as to undermine any adjacent or structure. Precautions should be taken by shoring, and so on, to prevent any collapse or fall when the stability of a building or structure may be affected by excavation work in progress (Fig-3).

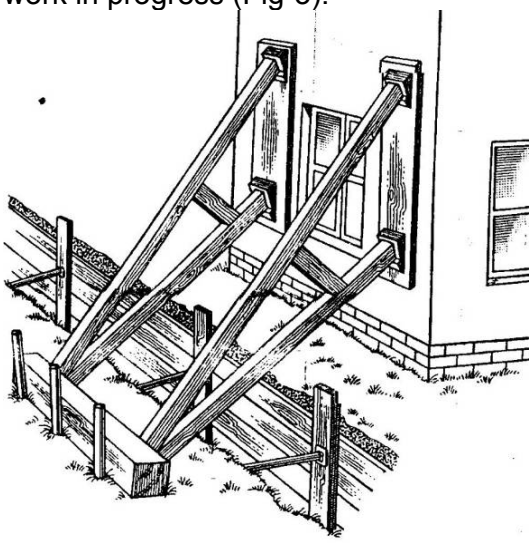


Figure-3: *Excavations near a building—shoring required to prevent collapse of the building*

Protecting the edges of excavation

One should not store, or move, materials and equipment near to the edge of an excavation. Danger may be caused by materials falling on those working below or by increased loading on the surrounding ground so as to cause the timbering or supports to the sides of the excavation to collapse. Spoil and waste heaps should similarly be kept well away from the edges of excavations.

Protecting the vehicles

Adequate and well-anchored stop blocks should be provided on the surface to prevent vehicles being driven into the excavation while tipping a particular hazard when reversing (Fig-4). The blocks should be placed at a sufficient distance away from the edges of the excavation to avoid the danger of it breaking away under the weight of the vehicles.

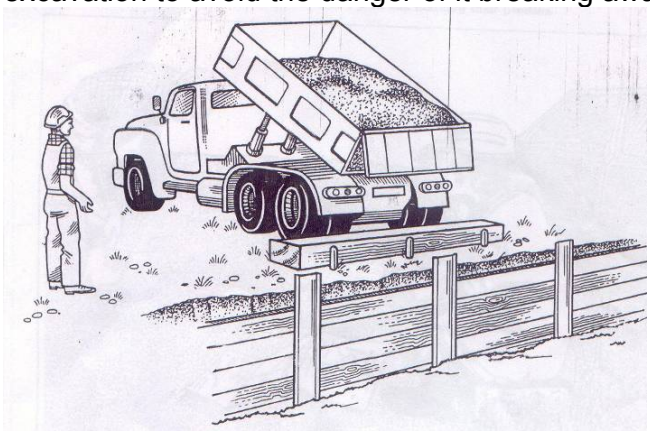


Figure-4: *Stop block to prevent vehicles being reversed into an excavation while tipping*

Access

If the depth of the excavation is more than 1.5 meter, make sure that there are safe means of access and egress, such as a properly secured ladder, if some one working in an excavation. This is of particular importance when there is a risk of flooding and rapid escape is essential.

Lighting

There should be adequate lighting around the area of an excavation, particularly at the access points and openings in barriers.

Buried or underground services

Before any digging is done, either by hand or with an excavator, one should remember that there may be underground services below the surface. In built-up areas, always assume that electrical cables, water services and sewers are present. In some locations there may also be gas pipelines. Some of these services look alike, so when some buried services are found it is to be assumed as worst. Striking electric cables may cause death or severe injuries by electric shock or severe burns. Broken gas pipelines will leak and may cause a fire or explosion. Water and sewer pipelines if broken may create sudden risks by flooding an excavation or by causing its sides to collapse.

Electrical Cables

Every year workers digging on construction sites suffer severe burns when they accidentally hit live buried electrically cables. Always treat buried electrical cables as live. Before excavating, inquiry of the electricity authority, the local authority or the site owner if they have any plans of the layout of the cables in the area. Even if plans exist, remember that some cables may not be marked on the plan or may not be where the plan shows, for cables rarely follow an exact straight line.

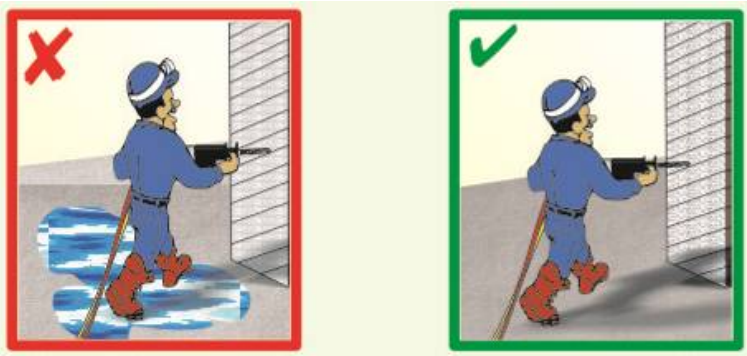
Look around for the traffic signs, street lights and substations which are usually supplied by buried cables. Use a cable locator if you have one—remember that if cables are close together the locator may not be able to tell them apart. Some types of cables cannot be traced by locations. Once such thing is found notify the supervisor and fellow workers. The position of the cable should be marked with chalk, crayon or paint or, if the ground is too soft for this, with wooden pegs (Fig-5). Never use sharp spikes. Once the approximate position of the buried cable is known, use hand tools to expose it. Use spades and shovels rather than forks or pick-axes. Keep a careful watch for evidence of cables during digging works. Power tools should not be used within half a meter of a cable.

Figure-5: *Locating buried electrical cables from a plan and marking their position*

Other Services

As with electricity supplies, inquire of the appropriate authorities and the site owner if plans are available of the layout of the gas pipelines, water pipelines, sewers and telephone cables, and then use similar working methods.

Do not use mechanical excavators within a half a meter of a gas pipeline. If gas is smelled, make sure that, there are no sources of ignition nearby such as lit cigarette or running vehicle engine. Keep away from the area, keep other people away and summon the gas authority. Do not use heavy plant or equipment over or near a gas pipeline, as the pipe may fracture.



All exposed pipelines and cables should be supported when an excavation is open. Do not use them to support equipment or as steps to get in and out of the excavation. Make sure when back-filling a trench with a gap pipe that the fill is adequately compacted beneath the pipeline to prevent settlement which could lead to pipe fracture.

CHAPTER 31: SAFETY WHILE WORKING IN DIFFERENT ELEVATIONS OR LOCATIONS IN HILLY AREAS, SAFETY WHILE WORKING IN RAINY AND FOGGY ENVIRONMENT

AIM:

Accident statistics prove that there is an increased risk of personal injury during rainy and foggy environment and it only adds to if the construction site is on hilly areas.

Additional hazards of rainy & foggy working are introduced by:

a) reduced daylight hours
b) rain/snow/fog/ice

Legal :

The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 and Rules, 1998

Chapter VI : GENERAL PROVISIONS
All the rules applicable **(34-54)**

Preparations for working in rainy and foggy condition should be made by checking:

- Lighting
- Heating
- Vehicles and mobile plant
- Supply of road salt/grit
- Snow/ice clearing equipment
- Personal Protective Equipment (PPE)
- Advance weather forecasts are important
- If adverse weather is predicted some simple precautions can be made in advance.

Lighting

- Particular attention should be paid to lighting requirements for staircases, pedestrian walkways, access roads, loading areas, plant yards, car parks etc. at the construction site. Illumination levels reduce drastically during foggy conditions and if it is on hilly location the visibility during the day is also reduced.
- Torches should be used if necessary

Snow/Frost/Ice

- Car parks, access roads and pedestrian walkways should be kept clear as practicable
- A suitable supply of rock salt/grit should be maintained on site and persons designated to take responsibility for snow/ice clearing duties
- Site personnel should report any areas requiring attention to management without delay

Mobile Plant

- Ensure access steps are clear of ice and snow before attempting to get on or off your machine

- When getting off your machine check the ground you are going to step onto is not icy
- At the start of your shift ensure the windscreen wash bottle is full and check at break-times
- Ensure that the concentration of washer fluid is sufficient as not to freeze during the shift
- Ensure there is a plentiful supply of de-icer on site
- Check the condition of the windscreen wiper blades to ensure they do not smear the windscreen when operating
- Ensure all lights and cameras if installed are clean and maintained.
- Check condition of tyres, especially for under inflation

(Cold overnight temperatures result in lower tyre pressures at the beginning of a morning shift.

Where tyres have been fitted with an inner tube, the air that is sometimes trapped between the tyre and the inner tube can reduce pressure to such an extent that the beading between the wheel and tyre can become detached when the wheel turns)

- Low sunlight can also be a problem – if you have difficulty seeing put on your headlights so others can see you!
- Wear eyewear or fit suitable sun blinds on windscreens of vehicles

During periods of poor visibility (e.g. fog):

- Consider suspension of operations during extreme periods of poor visibility
- Use headlights at the first sign of reduced visibility (many companies now insist that headlights are switched on at all times when a vehicle is moving)
- Provide road markers at the side of haul routes to delineate Roadways
- If you become lost in fog, STOP and radio for assistance - don't assume you think you know where you are
- Oils will be thicker during cold temperatures so allow your vehicle extra time to warm up before moving off to allow complete circulation of the oil through the engine/hydraulics
- Drivers should ensure there is adequate vision before moving off – i.e. defrost windscreens, clean lights etc.
- Vehicles should always be driven according to the prevailing ground, visibility and weather conditions
- Allow extra distance for braking under wet or icy conditions

Note: It takes <u>double</u> the distance to pull up in wet conditions and up to <u>TEN</u> times the distance in icy conditions

Personal Protection

- Appropriate footwear for the conditions should be worn at all times
- It is even more important during hours of darkness or reduced visibility to wear reflective jackets or waistcoats that are reasonably clean
- Persons working outside should wrap up warmly. Several layers of clothing are more effective than a single heavy layer. However, it is important that any additional clothing does not obscure high visibility waistcoats or jackets
- Do not be tempted to take shortcuts – keep to designated pedestrian routes and report if these need gritting

- Additional care should be taken when working near lagoons or watercourses in slippery conditions
- Make use of fog lights to increase visibility
- Leave your headlamps on low beam when driving in snow or fog.
- If visibility becomes poor, find a place to safely pull off the road as soon as possible.

Have on hand, especially in an emergency:

- Snow shovel.
- Scraper with a brush on one end.
- Tow chain or strap.
- Warning device (flares or reflective triangles).
- Brightly colored cloth to signal for help.
- Flashlight (with extra batteries)
- Compass, Warning light or road flares, Booster cables
- First Aid Kit

CHAPTER 32: SAFETY DURING BLASTING

AIM:

Blasting activity is an integral part of construction, but highly dangerous as it involves explosives. People working on sites where blasting activity is involved need to be very alert & clear that the blasting area is not occupied by people or else it may become a disaster.

Legal:

The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 and Rules, 1998
Chapter XXII : Explosives
All the rules applicable to Explosives **(212-213)**

Explosive rules-2008 for blasting applicable as per rule 98.

Blasting operation by shot firer in areas other than mines.—

(1) Blasting operation shall be carried out by a shot firer holding valid certificate issued by the Controller.
(2) A copy of the certificate shall be carried by the shot firer during blasting operations.
(3) The shot firer shall take all due precautions in handling or charging or blasting operations.

Safety Precaution
Blasting should be carried out only with the permission of the engineer-in-charge. The blasting operation should remain in the charge of competent and experienced supervisor and workmen, who are thoroughly acquainted with the details of handling explosives and blasting operations. All the materials, tools and equipment used for blasting operation should be of approved type.

No drilling should be started until the previous holes in blasted area are flushed with water.

No person should use explosives for blasting purposes unless he employs a qualified shot-firer holding a Shot-Firer's Permit granted under explosive rules.

The Blaster should be competent and qualified by reason of his training, knowledge or experience in the field of transporting, storing, handling and using of explosives and having a working knowledge of rules and regulations pertaining to explosives. The Blaster should be in good physical condition and not be under influence of drugs, alcohol, intoxicants, etc.

While planning drilling operations for blasting purposes, consideration must be given to the nature of stratum and the overburden with a view to avoiding the possibilities of landslides after blasting.

The face of rock should be carefully examined before drilling, to determine the possible presence of unfired explosive. No attempt should be made to drill at a site if undetonated (misfire) explosives are suspected.

The position of all holes to be drilled should be marked out with white paint.

The borehole should be cleared of water, dust, etc. before explosive is inserted.

The diameter of the borehole should be greater than the outer diameter of the explosive cartridge.

Surplus explosives should not be stacked near work-area during loading.

Loading and Drilling should not be carried out at the same time in the same area.

A borehole should not be loaded without making it sure that it is cool and that it does not contain any hot metal, burning or smouldering materials. Temperatures in excess of 65^0C are dangerous.

A borehole near another hole loaded with explosives should not be sprung.

Cartridges or explosive should not be forced down a borehole or on obstruction in a borehole.

Blaster should keep an accurate upto date record of explosive, blasting agents, blasting supplies used in a blast and should keep an accurate running inventory of all explosives and blasting agents stored at operation site.

No force should be used for inserting a detonator into explosive cartridge in order to make Primer. The detonator should be inserted into a hole made with a picker designed for the purpose. In case of electric detonation, a hitch of leading wires of the detonator is made on the Primer Cartridge so as to prevent pulling out of the detonator from the cartridge. In case of detonation with Safety Fuse, the fuse should be tied to the cartridge.

Every blaster should be aware about blasting tools and hazard and associated in their use:

A tool made of wood suitable for charging and stemming shot holes

Scraper made of brass or wood, suitable for cleaning out short holes;

Where fuses are used, a knife for cutting off fuses and unless machine capped fuses are provided also a pair of suitable crimpers for crimping detonators

Where detonators are used, a picker made of wood or a non-ferrous metal, for priming cartridges.

No attempt should be made to slit, drop, deform or abuse the primer.

No hole should be loaded except those to be fired on the next round of blasting.

Metallic devices of any kind should not be used in tamping the explosive cartridges. Wooden Tamping tools can only be used.

Electrically Non-conductive shoes (having no metallic nails etc.) should be used while handling and using explosives.

Drilling should not be resumed after the blasts have been fired until a thorough examination has been made to make sure that there are no unexploded charges n the remaining old holes.

Rock Drillers should be equipped with approved respirators for use in the silica-dust atmosphere in addition to other Safety gears like, Safety Helmet, Goggles, Safety Shoes, Earplug, etc.

Use of Cell Phones & Walkie-Talkies and Smoking & Creating Open Flames should be prohibited in the blasting area.

Electrical Shot-Firing Circuit

In deciding the sizes of wire, fuses, circuits blasting switches, etc. instructions issued by the manufacturers of these articles should be followed.

No person should attempt to uncoil the wires and open out the short-circuited leading wires of detonators during approach of dust storm or near any source of large charge of static electricity or near radio transmitter.

Firing circuit should be kept completely insulated from ground or other conductors such as bare wires, rails, pipes or other paths of stray current.

There should not be any electric live wires or cables of any kind near electric detonator (blasting cap) or other explosive.

No current from a signaling, lighting or power circuit should be used for firing shot.

All electric detonators should be tested and also when connected in a circuit in series using only an approved (DGMS**) type of ohmmeter or circuit continuity tester.

No attempt should be made to use in the same circuit either electric detonators made by more than one manufacturer or electric detonators of different designs or function even if made by the same manufacturers unless the manufacturers approve such use.

No attempt should be made to fire a circuit of detonators with less than the minimum current specified by the manufacturer of that electric detonator.

Care should be taken to ensure that all wire ends for electrical connections are bright and clean.

The leading wires of detonator should be kept short-circuited until ready to fire.

As far as possible, blasting should be carried out using suitable exploder with 25% excess capacity.

Copper wires with solid core of appropriate gauge should be used for firing lines; the wires should be adequately insulted and in sound condition.

Blasting operations in the proximity of overhead power lines, communication lines, utility line or other structures should not be carried out until the operator or the owner, both of such lines have been notified and the precautionary measures deemed necessary, have been taken.

All holes loaded on a shift should be fired during the same shift.

Each electric detonator should be tested with an approved galvanometer before and after tamping in a hole to determine whether it will carry the current.

The number of electric detonators used in a circuit should not exceed the tested capacity of the Exploder (Blasting Machine).

The circuit, including all detonators, should be tested with an approved (DGMS**) galvanometer before being connected to the firing line.

** DGMS Stands for Director General of Mines Safety

Blasting with Safety Fuse

The fuse should be carefully handled to avoid damaging the covering. In very cold weather, the fuse should be slightly warmed before using so as to avoid cracking of the waterproofing.

The length of fuse, in any case, should not be less than 750mm. The maximum burning rate of the fuse should be such that it will allow sufficient time to all concerned persons to reach a safe place before the blast occurs; the burning rate, in any case, should not exceed 600mm/min. As per IS 4081-1986, recommended minimum fuse lengths and maximum burning rates for normal conditions are given below:

Number of holes to be blasted
Minimum fuse length mm
Maximum burning rate Mm/min
4-10
1800
450
11-12
2150
450

The fuse should not be cut until all precautions have been taken up to insert it into a blasting cap (detonator). About 20mm to 50mm length of the fuse should be cut and removed to ensure a dry end. It should be squarely cut across with a clean and sharp blade. The fuse should be seated tightly against detonator charge and care should be taken to avoid twisting after it has been placed in position.

Blasting caps should not be crimped by any means other than a Crimper designed for the purpose. It should be necessary to make sure that the cap is squarely crimped to the face.

The fuse should be lighted with a fuse lighter designed for the purpose. If a match is used,

- The fuse should be slit at the end,

- The match head held in the slit against the powder core
- And then the match head rubbed against an abrasive surface to light the fuse.

The fuse should not be lighted until sufficient stemming has been placed over the explosives to prevent sparks of live match coming into contact with explosives.

Explosives should not be held in hands while lighting the fuse.

As per IS 4081-1986, not more than 12 holes should be loaded and shot at one time if detonation is done with safety fuse.

Before Blasting

All the approaches at the project site, where blasting operations are undertaken, should be sign-posted for warning the public and indicating the days and timings when blasting is to be carried out;

As per IS 4081-1986, all approaches to the project site, should be closed by barriers at a distance of not less than 400m.

Site perimeter fencing should be made as per standard construction safety norms. The fence height should be a minimum of 1.8m and it should prevent the entry of animals and unauthorized persons.

Minutes before firing is to take place; loud wailing note of not less than 1-minute duration should be sounded in sirens to warn the public before commencement of firing. The end of firing operations must be followed by sounding an all clear signal on the sirens as a continuous long not less than 1 minute duration.

Each borehole should be thoroughly cleaned before a cartridge is inserted. Wooden stemming rods (not pointed but cylindrical throughout) should be used in charging the holes. The cartridges should be gently placed and not rammed.

After Blasting (Dealing with Misfire)
The Blaster should not return to blasting site after firing until at least 5 minutes have elapsed. In case of electric shot firing, the shot holes should be examined after blasting and in case of misfire no person should be allowed to approach the blasting site.

In case of blasting with safety fuse, utmost care should be taken to count the number of loud reports to ensure that all the shots have fired. No person should be allowed to approach the blasting site for a t least 30 minutes after fuse blasting.

After notice of misfire all entrances to the misfire area should be barricaded or fenced so as to prevent inadvertent access, and no work other than that of locating or relieving the misfires should be done therein until the misfire has been located and relieved. In open excavation work it should be sufficient to mark the place of the misfire with a red flag.

In any case all the holes should be carefully inspected for residual undetonated explosives after firing the shots. No other person than those duly authorized should approach the holes until one of the following operations has been performed in respect of each of the misfired holes:

- If the misfire is due to faulty cable or faulty electrical connection, the defect should be remedied and shot fired.

- The stemming should be floated out by use of water or air jet from hose until the hole has been opened to within 60 cm of the charge, whereupon water should be siphoned or pumped out, then a fresh charge with new primer placed and duly detonated; and

- A new (relieving) hole should be drilled in the presence of blaster preferably same person who fired the shot. That hole which should be so placed and drilled in such a direction that at no point should it be nearer than 60cm from the misfired hole.

- After the relieving shot has been fired, a careful search for cartridges and detonators, if any, should be made in the presence of the blaster.

If shift change is unavoidable, the person in charge of the outgoing shift should before leaving the work, inform the person relieving him of any cases of misfired shots, point out to him their positions, duly cross-marked and also state clearly what action remains to be taken in each case. In order to prevent inadvertent drilling of misfired holes, they should be plugged with wooden pegs.

Dealing with sockets

Before commencement of further drilling in working area the competent person of the place should inspect that all loose rock is removed from there and the socket laying after blasting should be cleaned or washed thoroughly with water and carefully examined for the presence of misfires.

No one should try to bore out a hole that has once been charged or attempt to withdraw a charge either before firing or after a misfire, or deepen or tamper with any empty hole or socket left after shot firing.

Disposal

Explosive

No explosive should be abandoned. These should be disposed off or destroyed strictly in accordance with the approved methods and in doing so the manufacturers or the appropriate authority should be consulted.

Packing Material
Explosives, detonators, boxes lines or material used in packing explosives should not be left lying around in places to which children or unauthorized persons or livestock can access.

Paper or fibrous material used in packing explosives should not be put to any subsequent use. Such materials should be destroyed by burning in the presence of a responsible person.

Account
Inventory Register
An Inventory Register containing the details, Explosives received, placed in, removed from and returned to storage Magazines should be maintained current at all times.

Explosive Issue Register
A careful day to day account of the explosives should be maintained in an approved register and manner, which should be open to inspection at all times.

Explosives should be issued only by competent person upon written requisition signed by the blaster or by an official authorized for the purpose and only against the signature or thumb impression. Such requisitions should be preserved by the person-in-charge of the magazine.

Blasting Register

A register should be maintained to record the following details each blast:

- Date & Time of blast
- Number of holes
- Type of explosive used
- Amount of charge per hole
- Firing Pattern & Sequence

Blasting Checklist

Are warning boards provided at least 400m away from blasting area, at all the approaches?

Are only authorized and qualified persons permitted to handle explosives?

Are smoking, firearms, matches, open flame lamps and other fires, flame or heat producing devices and sparks prohibited in or near explosive magazines and while explosives are being handled, transported, or used ?

Is use of cell-phones/Walkie-talkies prohibited in or near explosive magazines and while explosives are being handled, transported, or used ?

Are registers maintained for inventory and use of explosives ?

Are explosives not in use kept in a locked magazine ?

Are precautions taken to prevent accidental discharge of electric blasting caps from current induced by radar, radio transmitters, lighting, adjacent power lines, dust storms, and other sources of extraneous electricity ?

Does the Blaster possess license ?

Do the Blasting Personnel use safety shoes of electrically non-conductive material ?

Is every vehicle or conveyance used for transporting explosives marked on both sides, front and rear with placards reading “EXPLOSIVES” in red letters not less than four inches high on white background ?

Are blasting caps and Primers transported in different vehicles ?

Are blasting caps, electric blasting caps, detonating primers, and primed cartridges stored in separate magazines ?

Is tamping done only with wooden rods or plastic tamping poles without exposed metal parts except for non-sparking metal connections of jointed poles ?

Is a loud warning signal given by the blaster in-charge before the blast is fired?

CHAPTER 33: SAFETY DURING TUNELLING

AIM:

Tunneling is a special task related with excavation. Use of modern equipment & falling of soil overhead is the biggest risk. Longer the tunnel higher are the risk. Material & equipment handling can cause lot of dangers to the employees. Precautions while handling of equipments and safety procedures to be followed for employee safety.

Legal:

THE BUILDING AND OTHER CONSTRUCTION WORKERS' (REGULATION OF EMPLOYMENT AND CONDITIONS OF SERVICE) ACT, 1996 AND RULES, 1998
Chapter XIII : Excavation and Tunnelling Works
All the rules applicable to excavation &tunnelling (**119-168)**
IS:5778-Part III (Code of practice for construction of tunnels)

Open Excavation Works
Open excavation is the initial phase of Tunnelling activity. Due to insufficient attention to the safety aspects, it sometimes becomes a major hazard and cause of many serious accidents. Major hazards in open excavation for tunnelling are unpredicted boulders rolling down from higher elevations of the hill, landslides, quicksand, water content or degree of saturation, vibrations from nearby sources, adjacent loose piles etc.
Basic principles, which take care of safety aspects involved in carrying out any open excavation work, are as below.

General Instructions:

i. All excavation works should be closely supervised by an experienced and competent executive / supervisor and he is made responsible for the strict observance of the safety rules.
ii. All the workers should follow the safety rules, use safety devices and appliances as necessary.
iii. Discourage the use of defective safety appliances, rigging tools and materials.
iv. All workmen should be briefed by the supervisor, about the plant of work before the work is started with a special emphasis on all potential hazards and precautions to be taken to overcome such hazards.
v. Safety measures for drilling & blasting are separately given in the chapter titled "Drilling, Loading & Blasting Operations", which shall be read in conjunction to this chapter.

Shoring

i. *Curb Wall:* Before start of open excavation, a sound curb wall to be build in such a shape and at such a distance from excavation line so that the boulders rolling down from the up hill side do not fall in the excavation area & injure the workers. The procedure will also provide a kind of retaining protection against landslide and contain & divert the soil mass, boulders etc., to a side away from excavated area.
ii. Wherever, loose soil / clay is encountered, shoring should be done for all excavations.
iii. In no case undercutting should be allowed.

iv. Approval quality of wood should be used for shoring. Any other structural material having strength not less than that of the approved wood may also be used for the purpose.
v. It should be ensured that no nails / sharp edges are protruding out of shoring arrangement to cause injury to workers.
vi. The supervisor should inspect shoring arrangements used therein before work is started and after explosives have been used in or near the excavation or earthwork.
vii. Open excavation with steep side slopes is carried out by means of blasting. After every blasting operation, the supervisor of the site should carefully examine the side slopes of excavations to prevent rock falls / splits.
viii. Work at the excavations should not commence until all loose rock on the sides is the first removed. All workers engaged in such excavations should use Safety helmets and safety shoes all the time.
ix. Refer IS:3764, code of safety for excavation works, for more details regarding shoring and timbering.

Loose Material on Sides*:*
All loose stones, projecting clumps of earth, pockets of unstable material on sides of the excavation may come down any time, which is a major potential hazard in open excavations. These should be either removed or excavated sides adequately braced and the bench suitably guarded.

i. On steep slopes workmen should not be permitted to work one above the other.
ii. Stockpiles of these materials should be so located, as to provide easy access for withdrawing.
iii. Material should not be piled against the walls as this may endanger the walls.
iv. The excavation tools or material, such as wheelbarrows, shovels, picks, tiles, cement, lumber etc. should kept far enough from the edge of the bench to prevent their being inadvertently knocked in to the lower bench.

Machinery, Vehicles and Tools:

i. Heavy equipment, such as excavating machinery and road traffic should be kept sufficiently back from the excavated sides.
ii. The use of trucks in and around the excavation area should be under the control of site in-charge. The vehicle should not be permitted to be driven near the lip of the excavation / edge of the bench.
iii. Care shall be taken in spotting the vehicles for loading. See that they are not backed into the edge of the bench and that when loading vehicles by hand, a constant which is kept for slides or boulders rolling down the slope.
iv. Adequate and well-anchored stop block should be provided on the surface to prevent operating vehicles from falling accidentally to the lower bench.
v. The workmen should be adequately spaced to avoid being accidentally struck by tools of fellow workmen.

Means of Access and Escape:

i. Pathways should be non-slippery and of adequate width (not less than 75 cm).
ii. Wherever pathways, gangways are suspended, these must have guardrails and side supports on both sides to prevent fall of workmen into the excavation.
iii. Ladders, if used, should be constructed, used, maintained and inspected in accordance with the requirements laid down in IS:3696 (Part 1&2 Safety code for Scaffoldings & Ladders).

iv. At every part of excavation likely to be frequented by the public such parts should be barricaded using specified caution tapes to caution the public from falling into the lower benches and they should be provided and maintained n place at all times.

Lighting and Warning Signals:

i. Adequate lighting should be provided at excavation area for night works.
ii. During the hours of darkness all public sidewalks and walkways should be adequately illuminated and warning lights should be placed to ensure safety of pedestrians and the vehicular traffic.
iii. At all approaches and exits of the site of excavations, danger and warning signals should be placed.
iv. At risky locations a flagman with a red flag should be posted to warn the public and approaching trucks and to guide them in proper direction.
v. Explosion – proof electrical installations should be used where inflammable substances are stored or present. Portable lamps/ flashlights, if required, should be of explosion – proof type only.

Use of Safety Rope

i. When a workman is required to enter a hazardous slopes or to scale rock from the side slopes, a safety rope should be securely tied to the safety belt worn by him so that, if necessary, he may be assisted or drawn to safety.
ii. Lifelines should be secured to at least two substantial anchorages or structural members. Manila lifelines, used for supporting personnel on safety belts, should be at least 20 mm in diameter and should have a wire core.

Overhangs, Slopes and Under Cutting:

i. Overhangs, if any, may come down unexpectedly. They should be removed before further material is taken from that part.
ii. Where power driven machinery is employed in the open excavation, steep working faces may necessarily result from the nature of the machinery used. These steep faces should be broken down to a stable slope as they occur, except at the working face. In such cases, however, every precaution should be taken to prevent unprotected workmen from entering the zone of danger either on the surface above the face or at the bottom of the face.
iii. The walls of the excavation, when operations in the pit are suspended temporarily or finally completed, should be maintained and left at such a slope that the danger from caving or sliding is eliminated.
iv. Walls rendered unstable by blasting, by the action of alternate freezing and thawing or by the operation or movement excavating or transporting equipment should be put in a safe condition by breaking them down until a stable slope is made; while these operations are underway no man should be permitted to work in the bench immediately below, and no material should be removed from the bottom of the slope until the breaking down is completed.
v. Borrowing or mining or what is known as ‘gophering’ should not be allowed.

Other Precautions:

i. Necessary precautions should be taken against hazards involving insets, snakes, poisonous plants / herbs etc. Soap and water should be made available for washing exposed parts and allergy drugs should be kept ready for such happenings.

ii. Taking lunch under the step walls of the benches is dangerous. Such unsafe practices are prohibited.
iii. Blasting timings should be notified and strictly followed. Notices in this regard should be displayed conspicuously at prominent places to caution the workers as well as the public.

Underground Tunnelling

The work involved in tunnelling is of specialized and hazardous nature. Cramped working space in the heading, mud & Slushy flooring, artificial lighting – all too often inadequate, difficult ventilation, obnoxious gases, unseen weakness in the rock, handling of explosives, leading and hauling musk, etc, might contribute to accidents. In order to avoid hazards, it is necessary to follow all possible safety precautions for the use of machinery, electrical installations and labour in tunnels, during the construction period

The engineer in-charge to look after the tunnelling work may also take the guidance about the bad reaches expected to be met in the tunnel from the geologists so that necessary safety measures could be adopted. Where the geological data collected so warrants advance probe holes by percussion or core drilling, as require, should be drilled ahead of the tunnel faces to locate any gas, flowing mass of rock, aquaferrous strata, geological disturbances, etc. In case presence of gases like methane is detected, further tunnelling work shall be stopped and the advice of Director General Mines Safety (DGMS) shall be sought about the supervising personnel to be entertained and additional safety precautions necessary. If the geological data collected and information from other sources indicate presence or likelihood of gases like methane, advice of DGMS shall be sought as referred above.

Some safety measures are given hereunder for tunnelling in rocks and soft strata and underground excavations in rocks.

Safety of Personnel

The personnel engaged in the tunnelling operations should wear safety helmet, gumboots and other required personal protective equipment compulsorily and should not wear loose garments or ragged clothing.

Sanitation and drinking water

Unless the worksite is within 500 m of the portal of the tunnel, sanitation facilities, washing and cleaning facilities should be closely.In any case the entire tunnel shall be treated with disinfectants periodically to eliminate unhygienic conditions. Closets shall be effectively and regularly cleaned and disinfectants provided. Drinking Water – Drinking water, at least 5 litres per person employed in the shift, should be stored in a clean container provided with light fitting lid. The use of salt tablets should be encouraged.

General Safety Measures:

i. The materials required to work in progress only should be kept inside the tunnel.
ii. The tunnel passage should always be kept clear to enable the workers to get out of the tunnel quickly in case there is any collapse or any other mishap inside the tunnel.
iii. Flammable liquids should not be stored inside the tunnel.
iv. All sources of ignition should be prohibited in areas where flammable liquids are temporarily stored, handled and processed. Receptacles containing flammable liquids should be stacked in such a manner as to permit free passage of air between them.

v. All combustible materials like rubbish should be continuously removed from such areas where flammable liquids are stored, handled and processed. All spills of flammable liquids should be cleared up immediately. Containers of flammable liquid should be tightly capped.
vi. Fire extinguishers and fire-buckets provided appropriate to the hazard should be properly maintained and used.
vii. Communication system like Walkie-talkie or two field magnet type telephone should be utilized properly to ensure a positive and quick method of communication between all controls locations inside tunnel and portal of the tunnels.
viii. Warning signals like, battery operated bells should be placed outside the tunnel and the position of the switch should be shifted with the progress of the tunnelling work. The position of the operating switch although temporary should be so chosen as to ensure proper accessibility and easy identification.
ix. Red and green lights of adequate size and brightness should be provided at suitable intervals on straight lengths and curves, cross over points etc, to regulate the construction traffic.

x. All the above communication and warning systems should be checked daily regarding proper serviceability.

Electrical Installations and Lighting

i. All parts of the electrical installations used in the tunnel should:
- ✓ have all conductors of adequate current carrying capacity and all joints in conductors should be properly soldered & insulated or otherwise efficiently mad;
- ✓ be so constructed, installed and maintained as to prevent danger of fire and electric shock;
- ✓ be of adequate mechanical strength to withstand working conditions underground;
- ✓ be earthed/ grounded properly from at least two distinct earthing sources;
- ✓ be not liable to be damaged by water, dust or electrical, thermal or chemical action, to which they may be subjected;
- ✓ be efficiently insulated or have all bare live parts enclosed or otherwise protected; and
- ✓ be installed at such a location that dumpers or wagons do not come in contract with the same.

ii. Usage of Earth leakage circuit breakers should be encouraged for distribution of power supply from the panels for foolproof safety of the personnel.
iii. A passageway not less than 60 cm wide should be maintained in front of switchboards.

iv. Rubber mats should be provided & maintained in front and in back of the switch-boards.
v. The space in front or back of a switchboard should not be used as a change room, locker or storage room.
vi. All electric wires carrying voltage 440 volts and above installed underground should be in the form of insulated lead covered cables, armoured effectively against abrasion and effectively grounded.
vii. All electrical equipment in use should bear the essential details of voltage, amperage and circuit diagrams etc.
viii. All places where electrical apparatus is installed should be adequately ventilated in order to ensure proper cooling of the apparatus and dilution of flammable gases.
ix. Lighting: The voltage in the ranges of 110 Volts or even lesser voltages should be used for lighting arrangements & operating portable hand tools inside the tunnel.
    - Adequate lighting should be provided at the face and at any other point where work is in progress, at equipment installations, such as pumps, fans and transformers. A minimum of 50 lux should be provided at tunnel and shaft headings during drilling, mucking and scaling. When mucking is done by tipping wagons running on trolley tracks a minimum of 30 lux should be provided for efficient and safe working. The lighting in general in any area inside the tunnel or outside an approach road etc should not be less than 10 lux.
    - Emergency lights (battery operated) should be used at the working faces and made available at intervals along the tunnel to help escape of workmen in case of accidents. All supervisors and gang-mates should wear cap lamps or carry hand torches. (It should be ensured that al least one cap lamp or hand torch is provided for every batch of 10 people).
    - Any obstruction, such as drill carriages, other jumbos and drilling and mucking zones in the tunnel should be well lighted.
x. Temporary Lighting: Most tunnels are wet or damp providing a perfect ground for short circuits. Electrocutions in tunnels are all too frequent. Steel forms and drill carriages should, therefore be properly grounded. The switches should be located on a high ground and these shall be properly grounded.

Use of Hand Lamps Underground – Hand lamps should be:

- Of low voltage lamps (55 v to 110v)
- Equipped with strong cover of glass or other transparent material,
- Dust and water proof,
- Equipped with a guard over the cover and,
- The exterior of all lamp sockets should be non-metallic.

xi. All electrical apparatus including portable tools should be connected only to an electrical supply system, which should have proper earthing and grounding.
xii. It should be ensured that Telephone lines are laid on the opposite side of the electric lines side of the tunnel. No blasting line should preferably be laid within 3 m of the light and power lines; its distance from a telephone line being immaterial so long as insulation can be ensured.

Protection against Fire:

i. No flammable material should be stored in rooms, recesses or compartments containing electrical apparatus, telephone, lighting apparatus and damp-proof apparatus. Adequate fire extinguishing equipment suitable for use on live parts should be kept ready for immediate use.

ii. On the occurrence of a fire caused by any electrical apparatus, the supply of electricity should be cut off from such apparatus or installation as soon as practicable and the fire should be attacked as soon as possible and reported to the nearest available control room.
iii. All waste and combustible rubbish should be removed daily from the tunnel.

Underground Excavation

Drilling Equipment:

i. All drilling equipment should be kept in good working order. Safe handling and proper lifting methods should be removed.
ii. Only wet drilling should be permitted.
iii. Jumbos or either drill platforms should be carefully designed, built and maintained to provide safe working conditions. The jumbo should be provided with a suitable railing around the top deck.

Shaft Excavation

Head Frame: The head frame (including hoists, cables etc) should be preferably of steel structure and properly designed with sufficient headroom and strong enough for possible overload and impact due to sudden drops.
Hoisting Equipment: It should be thoroughly inspected all hoisting equipments at least once a week and maintained in first class condition. A limit switch and a non-failing automatic brake shall be provided on the hoist to control speed.
There should be a fencing round the Tunnel inlet and outlet opening near the river banks and it should comprise two rail guards to prevent men and material from falling in.

Access through Shafts: Persons should not be lowered or raised in bucket used for mucking.
A special cage or a bucket should be used for lowering or raising personnel during the sinking of a shaft. For emergency use strong ladder made out of wire rope should be provided on one side of the shaft. After the shaft is sunk, a suitable arrangement for the workmen should be made in the shaft for access to the shaft and the tunnel.

Signals: Reliable means of communications, such as bells or whistles should be maintained at all times between the bottom of the shaft and the surface and telephone used, whenever possible. Any code of signals used should be kept conspicuously exhibited near workplace or entrance. Water Handling: The methods given below should be followed for water handling in the tunnels:

i. A study of boring data and geological formations should be made to have an indication of locations, where water can be expected.
ii. Water inflow may be reduced or even entirely stopped by grouting off the set seams. A wet area covering more than a single seam shall be scaled off by installing a suitable section of concrete lining.
iii. In case of a steady flow of water from the roof or side of the tunnel the flow shall be deflected down the sides to sumps by metal shields.
iv. Adequate no. of pumps should be provided at site on the basis of the estimated pumping needs.
v. In case of steeply inclined tunnels steps shall be provided for quick exit in case of failure or haulage.

vi. Gutters and sumps should be kept clean. Suitable arrangement should be made to indicate the position of sumps in case tunnel invert is flooded.

Machinery and Mechanical Equipment

i. The signalman should be instructed in his duties and positioned so as to have a clear view of the swing of load (pock line) and rear of the dumper / truck, the operator and the operation.
ii. All equipment having a drop type of skip plan should be provided with guards on both sides and open end of the skip plan area, to prevent persons from walking under the skip while it is in elevated position.
iii. Platforms, foot-walks, steps, guardrails, handholds and toe-boards should be provided on machinery and equipment as necessary, to ensure safe footing and access ways.

Ventilation

Necessity: The purpose of ventilation in tunnels is to make the working space safe for workers by keeping the air fresh and respirable and by eliminating harmful and obnoxious dust, dynamite fumes and other gases.

Mechanical ventilation shall be provided where necessary to force the air in or exhaust the air out from the working face to the portal through a pipe to achieve the safety as given below:

Purity Requirement:

The ventilation is required to remove polluted air, gases and smoke produced by explosives, dust formed by the disintegration of rock, exhaust gases from the diesel operated equipment like, loaders, boomers, dumpers, trucks, shovels etc and also to ensure temperatures or not more than 40^{o}C dry 29^{o}C wet at the working place.

The concentration of various gases in atmosphere inside the tunnel by volume shall be as follows:

i. Oxygen – not less than 19.5 percent.
ii. Carbon monoxide – not more than 0.005 percent.
iii. Carbon di-oxide – not more than 0.5 percent.
iv. Nitrogen fumes – not more than 0.0005 percent.
v. Methane – not more than 0.5 percent at any place inside the tunnel, for example, in a cavity in the roof etc.
vi. Hydrogen sulphide – not more than 0.001 percent.
vii. Aldehyde – as formaldehyde not more than 0.001 percent.

Testing – The test should be carried out once every 24 hours but in any after every blast or a major rock – fall. In case any of the gases mentioned above are detected to have crossed the threshold value indicated therein, the workmen shall be withdraw immediately till the percentage is brought down well below the threshold value by improving the ventilation or by other effective measures.

Records for the test of gases, as also for temperature measurements and ventilation measurements shall be properly maintained.

Dust Control – Adequate steps should be taken to prevent the liberation, accumulation and the propagation of air-borne dust.

Only wet drilling should be carried out inside the tunnel and other underground works.

The air-borne dust concentration at the working face should be tested once a month and if the air-borne concentration of total dust exceeds 10 mg/m3 ventilation should be adequately improved. If required water spraying of the air-borne dust will be resorted to.

Volume of Air Required

Ventilation and exhaust system for tunnel and shaft excavation should be of sufficient capacity to maintain an adequate supply of uncontaminated pure air at all points in the tunnel or shaft. The design of ventilation system should provide for size and design engines to be used as well as for safe hygienic limits for exposure of working personnel to the multiple toxic and objectionable gases in the tunnel or shaft.

The volume of air required should depend on the following:

i. Length of heading,
ii. Size of tunnel,
iii. Type and amount of explosives used,
iv. Frequency of blasting, and
v. Temperature and humidity.

On tunnel work 4.25 m^3 of air/min/man is usually considered the minimum requirement. In addition to this 2.00 m^3 of air/min should be supplied for such brake horsepower of diesel locomotive or other diesel engine used in the tunnel. Where the temperature is high or heavy blasting is resorted to suitably augmented volume of air should be provided.

Scaling and Mucking:

a. Scaling:

i. Scaling should not be commenced before dust & gases are exhausted.
ii. After blasting inside a tunnel or a shaft, scaling should not commence unless the roof and walls of the tunnel and sides of the shaft are carefully inspected by a responsible person.
iii. Scaling operations either manual or by loaders should be closely supervised by a responsible person.
iv. If the structure of the rock is weak, poor or structurally defective it should be adequately supported by providing either bolts or timber or steel supports with proper lagging and back filling and or by shot crating.
v. If the tunnel excavation is in loose strata, the strata should be supported by well designed members either of wood or steel immediately before further excavation is undertaken. Shot Crete should be sprayed immediately after the scaling to avoid further loosening of soil.
vi. For tunnelling in soft strata, the provision of IS:5778-Part III (Code of practice for construction of tunnels) shall be followed in respect of quick supporting of such strata.

Periodic Inspections: More accidents in tunnelling result from rock falls than from any other cause. Except for premature explosions, rock falls are also perhaps the most serious of all tunnel accidents.

i. Careful and frequent inspection of walls and roofs as well as of tunnel supports should be carried out.
ii. Through scaling of loose rocks at all weak spots are the best preventive against the rock falls.
iii. Periodic inspection of un-timbered sections of the tunnel from a travelling scaling platform should be carried out for locating weak spots.
iv. Supported sections should also be inspected regularly to make sure that the weakness of the formation has not spread beyond weak spots.
v. Loosened rock should be supported / removed forthwith. All supports should be checked occasionally to make sure that there is no member under distress.

vi. All scaling platforms should be equipped with safe ladders.

b. Mucking

i. The loading zones should be well lighted and workmen should be kept away from the vicinity of the vehicles being loaded to prevent injury due to rock falling off the car.
ii. Loading of muck into either cars or dumpers should be done evenly and the muck should not be piled dangerously high above the sides.
iii. A signal man should be deployed for a continuous vigilance to caution the people coming close to the swing of the loaders.
iv. As far as practicable no other person should be allowed at mucking area other than a operator, his helper and signal man.

Rolling Stock Track:

i. As far as possible, electric power should preferably be used. Whenever diesel engines are used, they should be provided with suitable filters, scrubbers etc, to remove all carbon monoxide and oxides of nitrogen etc. Petrol engines should not be used under any circumstances.
ii. Use of rolling equipment with link couplers should not be permitted. Rocker or cradle type dump cars should be provided with a positive type lock to prevent dumping in mucking yards.
iii. The trolley tracks should be properly laid with points, crossings and junctions and adequately maintained.
iv. At each end of the track suitable blocks or buffers should be provided.
v. Dead man switches or other installation necessary should be provided to check accidents occurring due to runway muck cars.
vi. A shovel should never be left unattended with engine running and brakes not set. When it is necessary to park it on a sloping ground, it should be securely blocked. The operator while leaving the machine should remove ignition key and keep with him or hand it over to some responsible person so that the machine cannot be operated by unauthorized person.

Transport of Material – Vehicles carrying pipe, rail and timber should be properly loaded for safe passage through tunnel. The load should be kept within the side limits for the vehicle. Loads projecting over the sides are dangerous to men working in the tunnel.

Transport of Employees: No one should be allowed to ride on front steps of loaders, dumpers etc. None other than trained men should ride the dumpers, loaders etc in tunnel at any time.

Concreting, Grouting and Guniting: Usually safety precautions that are taken for concreting in open should be applicable for the concreting of tunnels, shafts and other underground works also.

In addition, the following precautions should be taken where the pumpcrete or pneumatic placer s used:

i. The scaffolding supporting the pipe should be designed to carry the pipe when filled with concrete plus 100 percent overload plus the estimated weight of the maximum number of workmen that may work on the pipes while the pump is operating. A factor of safety of 4 should be used.
ii. The pipeline should be anchored at all curves and near the end. The toggle and flange connections should be inspected before each placement to ensure tight joints.

iii. Air-release valves should be installed at high points to release entrapped air. The use of these valves will assist in preventing line plugging and in turn reduce accident possibilities.
iv. Pipes and hose used to convey grout should be of proper size and strength to safety withstand the maximum operating pressures. Pumps should not be operated at pressures above their rated capacity.
v. Cleaning of pipeline should be carefully done.
vi. Adequate lighting and ventilation should be provided for all galleries and shafts where grouting is in progress.

Instrumentation
Frequent inspections should be carried out to avoid malfunctioning of instruments like Tensiometer, Digital thermometer, gas detectors, etc.

Pathways:
The walkways should be placed to the side of track. In long tunnels, shelter places for workmen should be provided at suitable intervals during hauling operations.

Public Safety
Shaft sinking and tunnelling fascinate the public. Authorized visitors should be equipped with safety hats & gumboots and should be accompanied by a guide competent to keep the visitors out of dangerous situations.

CHAPTER 34: SAFETY IN TRENCHES WORK

AIM:
Trenching is an integral part of excavation activity for laying of cables, pipes etc. While at work depending on the depth & width of the trench incidents like debris falling back and causing injury to the employees and collapse of trenches are known hazards. This incidents that cause injury are to be controlled by safety procedures & following safe working methods.

Legal :

THE BUILDING AND OTHER CONSTRUCTION WORKERS' (REGULATION OF EMPLOYMENT AND CONDITIONS OF SERVICE) ACT, 1996 AND RULES, 1998
Chapter XIII : EXCAVATION & TUNNELLING
All the rules applicable (**119-168)**

Collapses of trenches:
The greatest menace to workers in open excavations such as trenches is undoubtedly that of collapse. Workers can be crushed, buried or asphyxiated. Even when the head has not been buried, the pressure of the material on the rest of the body has been sufficient to kill. Workers who have been fortunate enough to have been freed have frequently been seriously shocked and often seriously injured as well. Experienced people have frequently been mistaken about soils or rocks which they did not expect to collapse but which have done so. There is no doubt that unless the excavation is in solid rock or unless the sides are sloped back to a safe angle, the sides should be supported to prevent them from collapsing, as soon as the depth is such that a collapse could bury a crouching man. Collapses have occurred ina wide range of different types of earth and rock and have included the sliding along bedding planes of steeply dipping rock, collapses of overlying sound rock situated above a layer of broken rock and many failures of sand and clay mixtures.

Causes of collapses of trenches:
These can be summarised as follows:
the failure of the soil because it cannot support its weight;weakening of the strength by moisture especially after heavy rain or frost. Hydraulic pressure can also build up behind the face;the weakening effects of vibration caused by the movements of traffic;failure due to the weight of loads placed near the edges of excavations;weaknesses created by the presence of pockets of sand or other loose soil;failure due to excavating on or near the site of a previous excavation;collapse of the sides due to their being struck by heavy loads.

Preventing collapses:
The first essential is that there should be available a supply of materials for providing the necessary lining, shoring and strutting in all cases where the sides of an excavation are not sloped back to a safe angle or possibly where the excavation is in solid rock. The sides can be lined with boards or sheeting supported laterally to prevent the excavation from collapsing. Such materials must be available as soon as digging starts and must be put into position as soon as the excavation has reached a depth where a collapse could seriously endanger anybody at work in the excavation.

Construction of supports:
Because the objects are the same there is little variation in the methods adopted in various countries for supporting the sides of a trench. In good terrain where the ground is cohesive

enough to support a depth of between 60-80 cm *(2 ft.-2* ft. 6 in.) and where the trench is being excavated in successive stages, lining boards can be placed horizontally against the sides of the trench. These are supported by vertical posts held firmly by struts across the trench. As the next course is being excavated reliance will be placed on the holding properties of the soil which should not be excavated to a depth of more than 80 cm (2 ft. 6 in.) before the sides are protected in the same way. In cases where the trenches are being excavated in a similar way but where no reliance can be placed on the cohesive properties of the soil the use of vertical posts against the sides supported by horizontal boards can permit of continuous extension of the vertical supports during excavating operations.
Where a trench has been excavated to its full depth by means of an excavating machine before any supports are erected it is possible to use sheet piling or prefabricated frames. For strutting purposes it is possible to use timber or adjustable steel struts. Some people favour the use of virgin timber struts rather than sawn timber. Whether a trench is closely boarded or not depends on the nature of the soil.

Installing supports for sides of trenches:
The chief problem is that of installing supports in a trench which has teen excavated to a considerable depth "by a mechanical excavator. It would obviously be most dangerous to enter any unsupported section of the trench for this purpose and the supports must therefore be fitted before any entry is made. Moreover, it would be unsafe to do any work ahead of a supported section. It is possible to fix supports, by methods which will be described, at one end of an excavation to give protection to workers while they fit an adjoining section under the protection of the supported part. Other methods include the use of cages, frames and trench boxes which can be lowered into a trench and from which workers can fix supports in safety. Methods have also been devised to enable materials to be placed in position from outside the trench. Prefabricated units and sometimes complete prefabricated assemblies can be fitted in this way.

A type of cage which has been used consists of a tubular frame on three vertical sides of which are welded sheets of perforated metal. Two such cages can be placed in a trench immediately after it has been excavated by a machine, the arrangement being that the open side of each cage is on the side opposite to that at which the excavator is working. The cages may be 2 m (6 ft.) high and, if necessary, can have platforms for two persons to work at different levels. Helped by workers on the outside of the trench, workers working from inside the cage and sheltered by it can fix boards, posts and struts in position. The cages are moved along the trench as necessary. These cages can be lifted by cranes.

In another method, a rectangular metal frame is used. This is lowered into the trench and supports the vertical boards which are put into position from outside the trench so that they are held against the sides by the frame which is strutted to take any lateral thrust. Then, from within the frame, workers can fix the longitudinal boards and the cross struts in safety. The frame can then be moved by amachine to the next position.

Another device, consisting of a tubular steel frame, has arrangements whereby an assembly of horizontal lining boards can be held on the outside of the frame by vertical rods which can be withdrawn upwards when the frame has been lowered into the trench, the boards then being retained between the frame, and the side of the trench while the final work of shoring and strutting is completed.

Further developments include the putting into position of pre-assembled units by means of lifting machines.

In all the cases so far mentioned it has been necessary for workers to enter a trench in order to complete the assembly but use is also now being made of suitably strengthened metal tunnels with arched roofs which enable workers to lay pipes or conduits at the bottom of a trench under their protection. These tunnels are lowered into a trench by means of a lifting machine, the trench being made wide enough to enable this to be done; ladders are used for access.

It should be noted that when any kind of frame or cage is used the surface of the sides of the trench should be free of any projections which would interfere with the lowering of the frames or the materials used for shoring.

In shallow trenches, one device used to permit vertical boards being placed in position by workers working above the trench consists of two circular metal rings with diameters rathe" larger than the depth of the trench. They are connected at four equidistant points along their circumference by adjustable metal struts so that the whole assembly can roll on the bottom of the trench. The vertical boards can be put into position between a ring and the side of the trench and while a section is being held by the rings, the necessary horizontal boards and struts can be secured in position from inside the framework of the two rings and their connecting pieces. The rings are then rolled to another position.

Another method which has been developed for shallow trenches requires the preliminary assembly of a panel of suitable size, consisting of horizontal lining boards and supporting vertical boards which can be lowered into the trench as a complete unit. Two such units are lowered opposite one another on each side of the trench. This operation can be performed by workers working above the trench and using long metal bars or trench jacks down which the preassembled units are slid to the bottom of the trench, the bars then being used to press the unit against the side and to act as temporary shores. Cleats to hold the struts have already been placed in position on the units and top struts are then placed in position in a cleat at one side, the other end of the strut being forced down by blows from a long handled tamper operated by a person working above the trench. These struts are then secured by workers safeguarded by the temporary and provisional safety measures described above. After the first section has been completed men can work under cover of the protection afforded by it when completing the erection of the supports in the adjoining one and so make further progress.

The erection of the supports for the sides of an excavation should only be undertaken under the supervision of a person with the necessary amount of knowledge and experience. He should examine all materials before they are used and reject any which are unsuitable. As far as possible the workers employed in erecting the supports should be experienced and, in any case, any inexperienced persons should be employed only with experienced workers. If any alterations are made to supports already erected, these should only be done under competent supervision. The supervisor should satisfy himself that the arrangements made for securing the sides of an excavation have been completed in a satisfactory manner before persons are allowed to work in it.

Inspection and maintenance of supports:
With the changes and deteriorations which can occur in the condition of an excavation and its supports it is necessary that they should be inspected every day that they are in use. Normally there should also be a thorough routine examination every week, but if explosives have been used in the vicinity or there have been any falls of materials or any other incident which might have affected the stability of the sides or of the supports, a thorough examination should be made immediately afterwards. After a. period of use, timber may dry out and shrink, or the ground may dry out and loosen the supports.

Other defects which may occur are:

- the ground may absorb moisture and swell causing the supports to be parts of the supports may be displaced by "being struck by materials or vehicles;
- soil may leak from behind supporting boards which may be loosened as a result;
- timber may rot.
- These are defects which can and do occur and it is most desirable that they should be looked for not only during routine or special inspections or examinations but at all times when the excavation is in use. Delay in effecting repairs may be dangerous; workmen if they notice any defects should report them at once.
- Where necessary pumps should be used to keep the floor free of water.

Excavations likely to cause damage to a structure:
Before any excavation is made in the vicinity of a structure it is necessary for the site to be examined by an expert so that the structure can be properly shored if there is any risk. It is not unknown for a comparatively shallow excavation to be the cause of a collapse. Pressure from a structure is exerted on the ground in such a way that disturbance of the soil within a certain distance from the footings of a structure may cause collapse.

Means of escape in case of flooding:
If there is any risk of flooding, means of escape should be provided.

CHAPTER 35: SAFETY IN HANDLING OF FLAMMABLE GASES

AIM:
In excavations & tunneling many times the employees are affected by poisonous gases which became a cause of fatality at times for the employees. Monitoring & pre assessment procedures are to be employed before the work starts for employee safety.

Legal :
THE BUILDING AND OTHER CONSTRUCTION WORKERS' (REGULATION OF EMPLOYMENT AND CONDITIONS OF SERVICE) ACT, 1996 AND RULES, 1998
Chapter VI : General Provisions
All the rules applicable to general provisions (**34-54)**

Gases and Flammable Substances
Gases and flammable liquids also play a vital role in the construction, installation and erection of different components of Tunneling. Gases for cutting, welding, etc. and flammable liquids like petrol, diesel, kerosene and various hydrocarbons and chemicals like sulphuric acid, hydrochloric acid and nitric acid, and chemical compounds like calcium carbide, acetone, air-entraining agents, epoxy, paints, polishes, varnishes etc., are also used. It is essential to take necessary precautions in storage, transportation, handling and use of these gases and hazardous substances.

Flammable liquids vapourise and form flammable mixtures when kept in open containers, when leaks or spills occur or when they are heated. The degree of danger is determined by the flash point of the liquid, concentration of the vapour in the air (whether the vapour-air mixture is in the flammable range or not) and possibility of a source of ignition at or above a temperature sufficient to cause the mixture to burst in to flame. In the handling and use of flammable liquids, exposure of large liquid surfaces to air shall be prevented.

Liquids themselves do not burn or explode, but the vapour-air mixtures, formed when they evaporate are explosive. Therefore, handling and storing of these liquids in closed containers and avoiding exposure of low flash point liquids in use are of fundamental importance.

As a safeguard against explosions, tests should be carried out for presence of flammable mixture in the containers. During construction of various underground works of river valley projects, it should be ensured that the workers employed in the confined space are not exposed to risk due to presence of insufficient oxygen or flammable liquids/dangerous gases. The tests should also be carried out for presence of various flammable liquids/dangerous gases, so as to ensure safety during working in the vicinity. In case, the presence of dangerous gases/flammable liquids is indicated, safety measures should be adopted immediately so as to avoid major mishap.

Locating Dangerous Gases/Flammable liquids in the containers/ confined pockets - Some times workers employed in some of the processes (may be underground or, overground) come across unavoidable or accidental contamination not only in the immediate work area, but also over a considerable territory

The presence of vapours or fumes of dangerous gases should be detected by the instruments in accordance with the relevant Indian Standards. Flammable limits of some of the gases are given below.

Flammable limits for dangerous gases:

	Gas	*Percent by volume*
	Acetylene	**2. 5 to 81**
	Ammonia	**16 to 25**
	Carbon monoxide	**12. 5 to 74**
	Coal gas	**5. 3 to 32. 5**
	Oil gas	**4. 8 to 32. 5**
	Hydrogen	**4 to 75**
	Hydrogen sulphide	**4.3 to 45**
	Methane	**5 to 15**

Detection of Dangerous /Flammable gases:

(a) Carbon monoxide– Carbon monxide gas is one of the most toxic gases. It can be found whenever/wherever there is incomplete combustion of carbonaceous materials Carbon monoxide gives no warning of its presence. Concentration of only 0.10 percent may produce unconsciousness in one hour and may prove fatal within two hours. Carbon monoxide can be detected with the help of carbon monoxide indicator/detectors.

(b) Combustible gases (acetylene, ammonia, hydrogen, etc.)–The combustible gas indicator is used to detect and measure these gases. Explosimeter has also a wide field of application wherever there is danger of gas explosions.

(c) Hydrogen sulphide - Hydrogen sulphide gas is harmful in concentrations as low as 20 PPM of air. Therefore, its early detection is vital. Hydrogen sulphide detector is used for this purpose.

(d) Methane – It is a colorless and odourless gas occurring in nature as the chief component of natural gas. It is lighter than air and has specific gravity of 0.554 in relation to air. It burns readily in air forming carbon monoxide and water vapour. The explosibility of methane gas is between 5 to 15 percent. There is no possibility of explosion when the percentage of Methane is less than 5 percent because heat liberated by combustion is dissipated into the surrounding area rapidly enough to prevent flame propagation. There is no explosion when the percentage of Methane is greater than 15 percent because enough oxygen is not present for rapid combustion. The percentage of Methane required for maximum explosive violence is 10 percent. The detection of methane is done with the help of *methanometer.*

(e) ***Detection of Flammable Liquids*** - Unless tests prove otherwise, flammable mixtures shall be assumed to be present in all tanks, which have contained or have been exposed at any time to flammable liquids. Tests for flammable vapour-air mixtures in tanks/vessels and confined pockets may be made either by chemical analysis of samples or with a combustible gas indicator.
A combustible gas indicator is an instrument operating on the principle that when a mixture of flammable vapour and air is passed over a heated electric filament, the

resistance of the filament will be increased in direct proportion to the amount of vapour present. When this filament is balanced against a cold filament in a wheatstone bridge device, resistance can be measured on a galvanometer in terms of the lower flammable limit of the mixture.

One type of combustible gas indicator has a meter with readings in parts of 100 percent, which represent percentage below the lower flammable limited, of the vapour-air mixture being tested. When samples of atmosphere are drawn through the sample hose by the aspirator bulb, the meter will indicate whether or not the atmosphere is in the flammable range or below flammable limit

Safety measures–

When the presence of flammable liquids/dangerous gases is indicated, following safety measures should be adopted:

(a) Whenever the percentage of dangerous gases/flammable vapours is indicated in a working area/vessel, above the permissible proportions, all the persons working in the area should be withdrawn and electricity cut off from the main source outside the tunnel.

(b) If there is any possibility of presence of dangerous gases/flammable vapours, while doing underground works/tunneling, only permitted explosives and approved type exploders (as advised by the dealers) should be used and flame-proof electric equipment and lights (as details in Electricity Rules) should be installed so as to avoid sparking from loose connections. Lights should be kept sufficiently away from the working faces. The battery operated machinery also be a source of ignition.

(c) Smoking - Smoking, and carrying of naked fires, matches, lighters or other spark-producing device is prohibited in the area where flammable liquids/dangerous gases are stored, handled or used.

(d) Ventilation and dilution- In case, the presence of dangerous gases/vapours is indicated, the same should not be brushed of wafted by any means and steps shall be taken to remove the gas by improving the ventilation after rendering it harmless by dilution through supply of air, if necessary.

(e) The working area should be examined for dangerous gases within 2 hours before the beginning and at least after every 2 hours during the working shift.

(f) The work should be restarted only after ensuring the accumulation of gases to be less than permissible proportions.

(g) To eliminate a spark from discharge of static electricity during filling operations proper bonding & grounding should be ensured to all containers.

(h) Preventing dangerous mixtures - Accidental mixing of flammable liquids should be prevented; for example, gasoline mixed with fuel oil may change the flash point sufficiently to make the fuel hazardous in ordinary use.

Inhalation - If a worker has been exposed to dangerous gases like carbon monoxide or methane emanating from some hidden source in underground excavations, he should be at once removed to an uncontaminated area.

(a) Under no circumstances should a rescuer enter the site of excavation to remove a victim of over exposure without proper respiratory protection.

(b) If breathing has stopped, an effective means of artificial respiration should be started immediately. If oxygen inhalation apparatus is available, oxygen should be administered but only by a person authorized for such duty or by a physician.
(c) The patient should be kept warm but not hot.
(d) Procedure as per Emergency Management Plan should be followed for summoning ambulance, physician or other agency promptly, so that such assistance will be enroute to the location before the rescue is accomplished.
(e) Oxygen content of the atmosphere in the confined space should be determined by pre-entry and subsequent tests made with approved instruments.
(f) No one shall enter or remain in a confined space where tests show less than 19.5 percent oxygen in its atmosphere or show presence of dangerous gases, unless he wears approved respiratory protective equipment such as a fresh-air hose mask or self-contained breathing apparatus conforming to IS: 8523(specification for respirators, canister type gas masks).

Compressed Gas Cylinders:

Gases like Oxygen, Acetylene, Carbon dioxide etc, are of immense use in tunneling. Their improper use may result in loss of life by fire and explosion. In accordance with the provisions of Gas Cylinder Rules, all accidents caused in using gas cylinders shall be reported to Chief Inspector of Explosives. Safety aspects in storage, handling and use of such gases, have been discussed below.

Storage - Compressed gases are usually contained in cylinders of different shapes and sizes. Gas cylinders are painted in different colours according to the contained gases to make the identification easier, following instructions should be observed in the storage of cylinders:

(a) Gas cylinders stores should be well-ventilated and empty cylinders should be stacked away from full cylinders.
(b) 'Full' or 'Empty' notices should be displayed on each relevant stack.
(c) When stacking the cylinders vertically, it should be ensured that they are properly secured by suitable brackets or stands so that they do not fall.
(d) If cylinders are stacked horizontally, proper blocks should be used at each end of stack to prevent their rolling. Large size cylinders should be placed at the bottom. One vertical stack should not contain more than four cylinders.
(e) It should always be ensured that the cylinders are protected from corrosive conditions.
(f) It should be ensured that cylinders do not come in contact with electrical apparatus or live wire.
(g) Cylinders should not be directly placed on wet soil. Proper dunnage shall be used.
(h) Cylinders should be stored away from sources of heat.
(i) Cylinders should not be exposed to direct rays of the sun. Tarpaulin or any other cover should not be used in direct contact with cylinders, as a protection against the sun.

Note - If cylinders are exposed to heat, the internal pressure will increase which may give rise to unsafe conditions particularly in the case of acetylene cylinders, in which the internal pressure increases by about $3.13 \times 10^{\sim 2}$ N/m^2 for every degree centigrade rise in

temperature. The pressure increase is caused due to decomposition of the acetylene, which makes it more liable to cause explosion. It has been observed that acetylene at pressure in excess of 0.186 N/mm^2 starts decomposing due to shock or heat.

(j) Under no circumstances should a cylinder used for storing one type of gas be used for storing another type. This is of paramount importance with such gases as oxygen on one hand and hydrogen or acetylene on the other. Mixing up of such gases would produce serious explosion risk.

Handling - Following instructions should be observed in handling of cylinders:

(a) Oil and grease ignite violently in presence of oxygen and may even lead to explosion in case oxygen is under pressure. Oxygen cylinders should be kept away from oil soaked debris, rags, etc.

Note - It has been experienced that oily rags and cotton wastes, which are in the vicinity at times lead to spontaneous combustion of an oxygen cylinder.

(b) It shall be ensured that grit, oil dirt of any sort does not enter regulator assemblies.

(c) Cylinder valves should not be lubricated.

(d) Only the standard key should be used for opening the valves and the key should be free from any oil or grease. Leverage of keys or spanners should not be increased and no attempt should be made to get gas from cylinders with broken valves thereby rendering the cylinder useless.

(e) Cylinder should not be used as rollers, work supports or jacks.

(f) Cylinders should not be loaded loosely in a vehicle as these will come in contact with each other and be subjected to jolting and damage during vehicle movement.

(g) Cylinders should be kept away from sparks, flames or slag from welding and cutting operations.

(h) Cylinders, which get damaged in transit or in the course of being used in the plant or for any other course, should be handled in the same manner as leaking cylinders.

(i) Handling of acetylene cylinders needs special attention, as acetylene is a highly flammable gas and in case it leaks, the acetylene-air mixture is likely to explode if ignited by flame, heat or spark present in the vicinity. Acetylene cylinders should, therefore, be handled very carefully to prevent damage, which might lead to bursting of cylinders or leakage through the cylinder valve. They should not be banged, jolted violently, dropped or thrown about. When being unloaded from a truck, the cylinder should be lowered gently.

Unloading of gas Cylinders - Gas cylinders should be handled with care. They should not be dropped or allowed to strike against each other, to ensure safety. The following method of unloading gas cylinders from road vehicles or railway wagon is recommended:

(a) Whenever possible, the cylinder shall be unloaded directly on a raised platform by rolling over a coir mattress.

(b) If a suitable raised platform is not available, each cylinder shall be slide down over a heavily reinforced 15 cm thick coir mattress of about 2m x 1m size taking care that the bottom end touches the mattress first and then it is rolled away over the mattress. Cylinders should not be dropped from a height.

(c) It should be ensured that the first cylinder has rolled away before the next one is slide down.
(d) Lifting magnet should not be used for loading and unloading.
(e) A fibre rope sling may be used to lift one cylinder but not more than one at a time, provided it is adequately strong and correctly adjusted toprevent slipping. Use of a chain sling is unsafe, as it is very likely to slip, over a cylinder.
(f) From the unloading platform to the storehouse or from storehouse to the plant, the cylinders should be transported by means of a handcart. Such a handcart should be provided with a chain or belt for securing the cylinders in proper position.
(g) If *a* cylinder is to be transported over a short distance and a suitable hand-cart is not available; it should be rolled over its bottom edge but never dragged.

CHAPTER 36: SAFETY IN PILING

AIM:
Piling activity is associated with fall of operators due to openings. Operators are to be protected from fall & injury while handling Pile driving equipments.

Legal :

The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 and Rules, 1998

Chapter XXIII: Piling (Rules 214 to 222)

General provisions, stability of adjacent structure, protection of operator, instruction to and supervision of building workers on a pile-driving equipment, restrictions on entry of unauthorized person, etc. are framed.

General Recommendations

Fencing should be provided around the working area to prevent on-lookers from trespassing into the construction sites.

The working area should, be investigated to ascertain the presence of any buried obstruction and actual position of all service lines passing through the work site should be known before the work commences. Particular attention should be given in case live electrical cables pass underground, which may interfere within the depth of foundation.

Every crane driver or hoisting appliance operator should be competent to the satisfaction of the engineer In-charge and no person under the age of 21 years should be in-charge of any hoisting machine including any scaffolding winch, or give signals to operator.

- Nobody should ever stand under a hammer and power driven pile drivers or extractors should, have adequate controls, efficient brakes and suitable stops for the hammer. A suitable cabin should "be provided for the driver wherever possible.

- Any helmet or crown should be of good design and construction, of sound and suitable material and free from patent defect. They should be examined before any period of work or shift commences.

- Frames and headers should be examined for loose bolts and all hoses and connections should be in good condition. The end of a hose should be tied to prevent it from "whipping" if a connection fails.

- All parts of any structure should be regularly and frequently examined and maintained in good condition.

- If a mobile vehicle is used to support boring equipment it should be stabilised.

Piling Rig

a. Erection of Rig

9 Piling Rig (Pile Drivers) should not be erected in dangerous proximity to electric conductors.

If two pile drivers are erected at one place these should be separated by a distance at least equal to the longest leg in either rig.

The frame of any rig should be structurally safe for all anticipated dead, live or wind loads. Whenever there is any doubt about the structural strength, suitable test should be carried out and the results of the test recorded. No pile-driving equipment should be taken into use until it is inspected and found to be safe.

Pile drivers should be firmly supported on heavy timber sills, concrete beds or other secure foundation. If necessary to prevent danger, pile drivers should be adequately guyed.

When the rig is not in use, extra precautionary measures for stability, such as securing them with minimum four guys, should be adopted to prevent any accidents due to wind, storm, gales and earthquake.

Access to working platforms and the top pulley should be provided by ladders and the work-platforms should be provided with guardrails.

In tall driven piling rigs or rigs of similar nature where a ladder is necessary for regular use, the ladder should be securely fastened and extended for the full height of the rig. The ladder should also be maintained in good condition at all times.

Exposed gears, fly wheels, etc. should be fully enclosed. Boilers, hoisting drums and brakes should be kept in good condition and sheltered from weather, wherever possible.

Pile driving equipment in use should be inspected by a competent engineer at regular intervals not exceeding three months. Also a register should be maintained at the site of work for recording the results of such inspections. Pile lines and pulley blocks should be inspected by the foreman before the beginning of each shift, for any excess wear or any other defect.

Defective parts of pile drivers, such as sheaves, mechanism slings and hose should be repaired by only competent person and duly inspected by Plant & Machinery (P&M) Engineer and the results recorded in the register.

No Air Equipment should be repaired while it is in operation or under pressure.

Hoisting ropes on pile drivers should be of Independent Wire Rope Core (IWRC) type.

All bolts and nuts, which are likely to get loosened due to vibration during pile driving should be checked regularly and tightened.

Airlines should be controlled by easily accessible shut-off valves. These lines should consist of armoured hose or its equivalent. The hose of air hammers should be securely lashed to

the hammer so as to prevent it from whipping if a connection breaks. Couplings of hoses should be additionally secured by clamps or ropes or chains.

When not in use, the hammer should be in dropped position and should be held in place by a clear, timber or any other suitable means.

Hoisting Appliances used for handling piles etc. should be marked with the safe working load and they should not be loaded beyond 'the safe working load except for the purpose of testing'.

Motor gearing, transmission, electrical wiring and other dangerous parts of hoisting appliances should be provided with efficient safe guards. Hoisting appliances should be provided with such means as will reduce, the minimum, the risk of accidental descent of the load and adequate precautions should be taken to reduce to the minimum, the risk of any part of suspended load becoming accidentally displaced. Sheaves on pile drivers should be guarded so that workers may not be drawn into them.

When loads have to be inclined:

- They should be adequately counter-balances; and
- The tilting device should be secured against slipping

Adequate precautions should be taken to prevent a pile driver from overturning if a wheel breaks.

Adequate precautions should be taken by providing stirrups or by other effective means, to prevent the rope from coming out of the top pulley or wheel.

Adequate precautions should be taken to prevent the hammer from missing the pile.

If necessary to prevent danger, long piles and heavy sheet piling should be secured against falling.

Where electricity is used as power for piling rig, only armoured cable conforming to the relevant Indian Standard should be used and the cable should be thoroughly waterproofed.

The pin of the D-Shackle, which connects Bailer / Chisel and winch rope is more prone to wear & tea. Frequent check is essential. Further, as the pin is liable to get removed from the shackle, it is preferable to use a shackle which has a provision to lock the pin as shown in the above sketch.

Bored Piling

a. Tripod

Base Support of the Tripod Leg should be suitably designed and it should have adequate Length and width.

Base of the tripod legs should be anchored in the ground at both ends.

Fastening arrangement of Tripod Leg with Base Support should preferably have HT bolt and nut with split pin.

Splice Joint is not recommended in the Rear (main) Leg of the Tripod. (Avoid Joints). If joint is unavoidable, the position of the splice joints should be at the lowest point so that the vibration is minimized. Vibration should be maximum at the centre. Frequent inspection should be ensured.

b. Winch

Rotating / Moving parts of winch should be guarded.

Winch should be tested at least once in a year by Competent Authority.

Friction Brake & Mechanical Brake (Ratchet and Paul) should be kept in tact and inspected at least once in a week.

Wire Rope should be free from defects. Splicing / Clamping of Wire Rope should be done as per standard.

Pulleys, D-shackles and Bulldog clamps should be in order.

Main Pulley and it's Pin are prone to wear & tear. Frequent check is essential.

Similarly, the pin of the D-Shackle, which connects Bailer / Chisel and winch rope is also more prone wear & tear. Frequent check is essential.

c. General

Distance between the piling rigs should be not less than the length of longest leg of the tripods.

Earth slush should be removed and passage should be kept clear.

Exposed reinforcement heads should be properly covered / barricaded.

Hard barricade should be provided around bentonite pit to prevent fall persons inside.

Workmen should not wear loose clothes as they may entangle with the rotating and moving parts of the winch.

Pile boreholes should be kept covered or barricaded.

CHAPTER 37: SAFETY IN STRUCTURAL STEEL WORKS

Structural AIM:

steel works are associated with heavy lifting & material handling during which fall of material can cause severe injury. To handle steel structures is a challenging task but needs to be done safely.

Legal :

THE BUILDING AND OTHER CONSTRUCTION WORKERS' (REGULATION OF EMPLOYMENT AND CONDITIONS OF SERVICE) ACT, 1996 AND RULES, 1998
Chapter XVII : STRUCTURAL FRAME AND FORM WORK
All the rules applicable to STRUCTURAL FRAME AND FORM WORK **(181-185)**
Commencement of steel erection

i. Structural steel erection should be commenced only when the concrete in the footings, piers and walls or the mortar in the masonry piers and walls has attained either 75 percent of the intended minimum compressive design strength or sufficient strength to support the loads imposed during steel erection.
ii. A scheme, which ensures stability of the structural framework and its components during erection and until completion, should be prepared before commencing structural erection works.

Foundation

i. The foundation of each column should be capable of withstanding both vertical load and also the additional horizontal thrust, which is developed as soon as temporary supports / props are removed.
ii. Pre-cast frame columns are usually inserted into sockets cast into the foundation blocks and consequently should be held temporarily in place after alignment. Wedges and props should be used for this purpose until the column is made secure by grouting.
iii. Foundation bolts are designed for the loads experienced by completed structure and are not always suitable for the more severe conditions encountered during early stages of construction. It is during this phase that excess loads if applied to them, will give rise to the danger of collapse unless adequate temporary bracing is provided in the form of props or guys.

As an alternative to the preferred method of bolts cast into foundation blocks, the use of rag bolts in open pockets is sometimes advocated to avoid the need for accurate setting out; this system should be discouraged.

iv. Adequate numbers of steel plate packing pieces should be provided for use in leveling prior to grouting operations. Once the frame is erected, lined and leveled, it is essential that holding foundation bolts are maintained tight.

Method statements

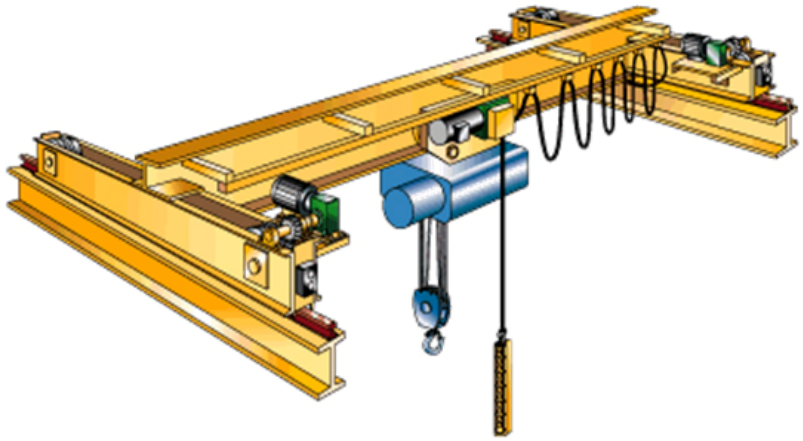
The preparation of a written method statement setting out the proposed erection scheme is an important part of planning for a safe system of work. It should:

- Be a single document and preferably with annotated diagrams;
- Be capable of being modified to cater for any plan change in a system of work;
- Be indexed for ease of reference;

- Follow a logical sequence, have each statement of the sequence clearly titled and be concise and unambiguous;
- Be clearly marked with the date of preparation and revision number;
- Reviewed and maintained updated, as necessary, so that it remains current;
- Be distributed to all those concerned with supervision of the erection.

Visual Inspection of Cranes

Cranes being used in steel erection activities should be visually inspected everyday prior to the commencement of work. At a minimum this inspection should include the following:



- All control mechanisms for adjustments;
- Control and drive mechanism for excessive wear of components and contamination by lubricants, water or other foreign matter.
- Safety devices including but not limited to boom angle indicators, boom stops, boom kick out devices and over hoist limit switch, load moment indicators;
- Air, hydraulic and other pressurized lines for deterioration or leakage;
- Hydraulic system for proper fluid level;
- Hooks and latches for deformation, chemical damage, cracks or wear ;
- Wire rope revving for uniformity;
- Electrical apparatus for malfunctioning, signs of excessive deterioration, dirt or moisture accumulation;
- Tires for proper inflation and condition; and
- Ground conditions around the hoisting equipment for proper support including ground settling under and around outriggers, ground water accumulation, or similar conditions.

Working under loads

Routes for suspended loads should be pre-planned to ensure that no employee is required to work directly below a suspended load except for workmen necessary for the hooking or unhooking of the load. While working under suspended loads, the following criteria should be met:

- Materials being lifted should be rigged to prevent unintentional displacement;
- Hooks with self-closing safety latches or their equivalent should be used to prevent components from slipping out of the hook; and
- All loads should be rigged by a qualified rigger.

CHAPTER 38: SAFETY IN CONCRETING WORKS

AIM:

Concreting is one of the most important activity at any construction site. Vehicular movements of trucks carrying ready mix concrete on uneven surfaces & trying to reach close to the site cause great concern for the safety of employees working at site. Also, in shuttering activity material handling leads to many incidents and injuries. Employees should work safely at site and around vehicular movement.

Legal :

The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 and Rules, 1998

Chapter XI : CONCRETE WORK
All the rules applicable **(96-107)**

Safety in Concreting and reinforced concreting operations:

Introduction:
Provided it is assumed that the design of the concrete parts of *a* structure and particularly of reinforced concrete sections is sound, safety in concreting operations depends initially on employing supervisors and workers who have the necessary knowledge and experience to avoid making errors which would lead to a part not being as strong as it was intended to be. In addition they should be aware of and take precautions against other risks which arise during the actual concreting processes.

Faulty reinforcing:
Such faults mainly arise because reinforcing rods, wires or sheeting have not been properly sited in the concrete. Sometimes this may not become evident immediately. For example, it was not until certain reinforced trestles, or arms, projecting from the sides of a series of columns were being taken into use for Carrying service pipes some considerable time after they had been erected, that one arm collapsed and caused a serious accident. It was then found that the reinforcement in each arm was situated near the base of the arm instead of being near the top where the arm was in tension.
In another instance an unskilled workman was told to place in position some reinforcing bars for a concrete slab. He was not supervised, placed them wrongly and the whole slab fell down when shuttering was removed.
It is most important that such work should be closely supervised and executed to ensure that the right reinforcing in the right position should be carried out according to plan.

Risks in reinforcing and precautionary measures - large assemblies:
When a large and complicated assembly of reinforcing bars is erected care should be exercised to ensure its stability. One example of failure to do this resulted in the collapse of a framework being erected for the purpose of constructing a culvert. This framework consisted of a series of vertical rectangular frames spaced about 15 cm (8 in.) apart and extending over a length of 37 m (110 ft.); the culvert when erected was to be 4.5 m (15 ft.) deep and 4.8 m (16 ft.) wide. A number of men were at work in the framework when it collapsed like a pack of cards, severely injuring three of the men. Although there had been some interference

witha number of longitudinal "bars which were tied to the vertical reinforcing bars, a collapse of the entire structure would not have occurred if it had "been traced diagonally or otherwise secured. Assemblies such as this should be braced to resist any temporary instability.

Pre-stressing:
Pre-stressed concrete is now being used in a variety of construction work, including piling, dam retaining walls, bridges, roads, beams, and so on. Two methods of stressing bars or wires are used, pre-tensioning and post-tensioning. During these operations and until the wires are firmly held inside the concrete, the considerable energy which is contained in the wires will, if it is suddenly released by failure of securing devices or breakage of a wire cause a wire to whip violently and seriously injure anybody unlucky enough to be in its path.

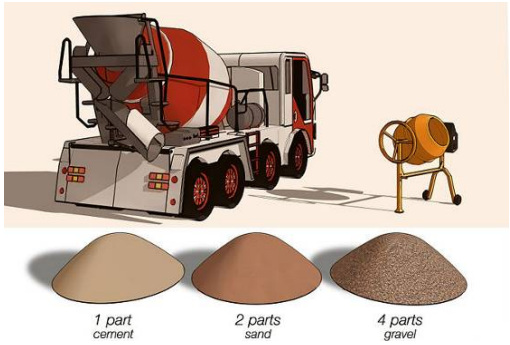
Pre-tensioning method:
In this method, reinforcing bars or wires are placed in moulds and stretched. The concrete is then poured and, until it is set, the wires must be firmly clamped and secured. The friction of the set concrete then holds them. Some of the moulds are very long but they should be covered by guards robust enough and adequately secured to contain any broken wire during tensioning and until the concrete has properly set. It is also necessary to protect the ends of the wires during tensioning and after they have been clamped when tensioning has been completed.

Post-tensioning method:
In this method the wires are tensioned after the concrete has set. Precautions, including the protection of the hydraulically operated jack, should be taken similar to those referred to above for "pre-tensioning" (apart from the guarding of moulds).

Both operations require skilled supervision and competent operators.

Use of steel fabric:
Sections of fabric for reinforcing may have to be cut from rolls of material and this can "be dangerous because of the "springiness" of the material. When a length has been rolled out on a suitable surface the rest of the roll should be anchored to prevent it from rolling back and the laid out length should also be firmly secured prior to its being cut, and afterwards.

Precautions in the delivery and pouring of concrete:



Pouring concrete into shuttering should always be done with care to avoid shock loading
To meet modern requirements maximum use has to be made of all available time. Where large areas have to be concreted this has led to the introduction of mechanised equipment.

In large projects, aerial cableways carrying skips containing several cubic metres (yards) of concrete are disposed so that concentrated effort can be exerted over comparatively small areas at a time. It is important both from a production point of view and from safety considerations that such plant must be maintained in a safe and sound condition and for special communication systems to be arranged both between the various operators of the machinery and also "between the dam workings and the operators. Accurate control is also essential of all the machinery involved. In mountainous country special aerial arrangements have also been made for the transport of building materials to a site.
Pumps and compressed air are used for conveying quantities of concrete to various parts of a site and compressed air is also used for grouting cement into the channels surrounding post-tensioned reinforcing "bars or wires.
Precautions about the use of compressed air machinery and receivers have already "been referred to, "but one point can "be emphasised again here, that is, the use of unsound, makeshift equipment. A man was killed when apparatus designed for paint spraying purposes exploded when it was being used to grout cement in a post-tensioned beam. Only apparatus designed for the purpose should be used.
The conveyance of concrete through ducting either by means of compressed air or by pumps gives rise to two main risks: risks due to blockages, and violent discharges at the outlets.

The following precautionary methods are suggested:

- This type of equipment should be operated only by persons who have been trained and who have knowledge of the risks involved and of precautionary measures.
- They should never station themselves in potentially dangerous places; the equipment must be of sound design and construction;
- The number of bends in any length of piping or ducting should be kept to a minimum and no sharp elbows or bends should be allowed. Their presence leads to blockages and is in any case inefficient;
- Pipes or ducting should be kept clean internally and scoured to remove hard deposits
- It is advised that a weak solution of concrete should be transmitted through piping before the normal consistency is delivered. This is suggested so that there will be less frictional resistance; care should be taken not to transmit through the pipes excessive amounts of concrete otherwise blockages may occur; great care must be taken when cleaning pipes or removing blockages. Many serious accidents have occurred when material has been forcibly ejected. Pressure should be cut off during these operations. Where compressed air is used there should be an expansion chamber or other device to prevent violent discharge at the outlet.
- Modern equipment has simplified the problem of providing adequate support for shuttering during the period that shuttering is in use, particularly where support is required under an extensive horizontal area. As well as traditional materials, use can be made of telescopic steel centres designed to carry loads over specified spans, and adjustable steel props.
- The erection of shuttering and of its support is a job which must be supervised by persons who have the necessary knowledge and experience and undertaken by workers who also have an understanding of the work. It is necessary to take account not only of thestatic loading "but of the dynamic forces applied during pouring and other operations, which must be done carefully. Where vertical supports are used, no movements should take place in their vicinity which could cause them to "be damaged or displaced and they should have a firm footing.
- The striking or removal of shuttering is also a matter for skilled persons.

CHAPTER 39: SAFETY IN WELDING, GAS CUTTING & GAS CYLINDER HANDLING

AIM:

Welding & gas cutting are highly prone to fire & burns to the operators. To make the worker safe while handling welding & gas cutting equipments and applicable gas cylinders is of utmost importance so as to make the worksites incidents & injury free.

Legal :

The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 and Rules, 1998

Chapter XIII : EXCAVATION AND TUNNELLING WORKS
SPECIFIC RULE FOR WELDING SETS **(163)**

General
Guidelines for Safe Storage, Handling of Gas Cylinders

a. **Labelling of cylinders**:

- Every cylinder should be labelled with the name of the gas and the name and address of the person by whom the cylinder was filled with gas.
- A warning in the following terms should be attached to every cylinder containing permanent or liquefiable gas, namely.
  - Do not change the colour of this cylinder.
  - This cylinder should not be filled with any gas other than the one it now contains.
  - No flammable material should be stored in the close vicinity of this cylinder or in the same room in which it is kept.
  - No oil or similar lubricant should be used on the valves or other fittings of this cylinder.
  - Please look for the next date of test, which is marked on a metal ring inserted between the valve and the neck of the cylinder, and if this date is over, do not accept the cylinder for filling.

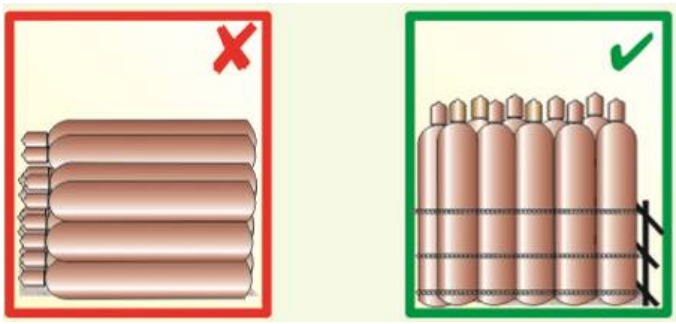
b. **Prohibition of smoking, fires, lights and dangerous substances**: -

- No person should smoke and no fires, other than blow pipe flames for repairs, or no articles or such other substances of flammable nature or liable to spontaneous ignition or to cause or communicate fire or explosion should be allowed at any time in proximity to a place where any cylinder for flammable gases is being filled, stored or handled.
- *No person in or near any place where cylinders containing flammable gases are filled, stored or handled should have in his possession any matches, fuses, mobile phones or any other appliances for producing ignition or explosion.*

c. **General precautions**.–

- Cylinders together with their valves and other fittings and the identification colours under these rules should always be maintained in good condition.
- No oil or similar lubricant should be used on any valves or other fittings of any cylinder.
- No cylinder should be subjected to any heat treatment or exposed to a high temperature or to the Sun or stored with any other flammable or explosive material.

- Every cylinder containing compressed gas should have its valve securely closed so as to prevent leakage. Valves fitted to the cylinders containing Liquefied Petroleum Gas and highly toxic gases like should be provided with security nut on the outlet to act as a secondary means of safeguard against leakage of gas.
- If a leak in the valve cannot be rectified by tightening the gland nut or the spindle, the cylinder should be removed to an open space where it is least dangerous to life and property and the filler should be informed. In the case of LPG cylinder, the safety cap should be fixed to arrest the leak and the cylinder should be moved to an open space.



d. **Special precautions against accidents**: -

- No person should commit or attempt to commit any act, which may tend to cause a fire or explosion in or about any place where gas under pressure in a cylinder is stored, handled or transported.

e. **Handling and use**

- Cylinders should be adequately supported during handling.
- Conveyors, trolleys and cradles of adequate strength should, as far as possible, be used when moving the cylinders.
- The cylinders should be handled carefully and not be allowed to fall upon one another or otherwise subjected to any undue shock.
- Sliding, dropping or playing with cylinders is prohibited.
- Liquefied petroleum gas cylinders and cylinders containing liquefiable gases should always be kept in an upright position and should be so placed that they cannot be knocked over.
- Cylinders used in horizontal position should be so secured that they cannot roll.
- Open flames, lights, mobile phones, lighting of fires, welding and smoking should be prohibited in close proximity to any cylinder containing flammable gases except those while in use for welding, cutting or heating.
- Working places should not be classified as storage places for the purpose of licensing.

f. **Storage of cylinders**

- Cylinders should be stored in a cool, dry, well ventilated place under cover, away from boilers, open flames, steam pipes or any potential sources of heat and such place of storage should be easily accessible.
- The storage room or shed should be of fire resistant construction.
- Thin wall cylinders such as liquefied petroleum gas cylinders and dissolved gas cylinders should not be stacked in a horizontal position.

- Cylinders containing flammable gases and toxic gases should be kept separated from each other and from cylinders containing other types of gases by an adequate distance or by a suitable partition wall.
- Cylinders should not be stored under conditions, which will cause them to corrode.
- Cylinders should not be stored along with any combustible material.
- Empty cylinders should be segregated from the filled ones and care should be taken that all the valves are tightly shut.

g. **Electrical installations**

In premises for filling and storing flammable gases in cylinders all electric meters, distribution boards, switches, fuses, plugs and sockets, all electric fittings, fixed lamps, portable hand lamps and motors, should be of flame proof construction.

h. **Cylinder subjected to the action of fire**

- A cylinder exposed to fire should not be used unless it has undergone proper examination and hydrostatic test or hydrostatic stretch test. If deleterious structural changes in the material due to the action of heat of the fire is apprehended to have taken place, the cylinder should have to be subjected to proper heat treatment, followed by hydrostatic test or hydrostatic stretch test, as the case may be, before the cylinder is taken into use.
- Dissolved acetylene cylinders, which have been damaged by fire should be condemned and destroyed by an experienced and competent person.

i. **Periodicity of examination and testing of cylinders**

No person should fill any cylinder with any compressed gas unless the cylinder has been examined and subjected to hydrostatic test or hydrostatic stretch test.

j. **Condemning of cylinders**

Any cylinder which fails to pass periodic examination or test or which loses in its tare weight by over 5 per cent or which for any other defect is found to be unsafe for use or after expiry of the service life of the cylinder, should not be filled with any compressed gas and should be destroyed by flattening it as a whole or after being cut into pieces in such a manner that the pieces cannot again be joined together by welding or otherwise to form a cylinder, under intimation to the owner of the cylinder.

k. Additional requirements for dissolved acetylene gas cylinders

Dissolved acetylene gas cylinder should comply with following additional provisions, namely:-

The porous substance should fill as completely as possible the cylinder into which the acetylene is compressed.

The porosity of the substance should not exceed 92 per cent and in no case should be less than 75 per cent.

Any solvent used should not be capable of chemical reaction with the acetylene gas or with the porous substance or with the metal of the cylinder.

If acetone is used as a solvent it should comply with the requirements, the quantity of acetone including the gas in solution should be such that the cylinder meets the requirements of additional tests.

The valves of the cylinders should not contain more than 70 per cent copper in their composition.

The pressure in the cylinder should not exceed 16 kg/cm^2 at a temperature of 15^{0}C. Every cylinder should before being filled with porous mass be tested by hydrostatic pressure to a pressure of not less than 60 kg/cm^2. This pressure may be reduced to 53 kgf/cm^{2}if the cylinder is fitted with fusible plug. No cylinder which shows a permanent stretch in excess of 7½ per cent of the total stretch suffered during hydrostatic stretch test should be allowed.

The safety relief devices if fitted, should operate at a pressure of 53 kgf/cm^2 or at a temperature of 100^{0}C + 4^{0}C/–2^{0}C.

Every cylinder should have permanently and conspicuously marked upon it or upon a brass plate soldered to it the name of the manufacturer and the words “Acetylene properly compressed into porous substance” and should bear the following markings, namely:-

Serial number and identification of manufacturer;
Number of the standard;
Test pressure;
The date of hydrostatic stretch test with code mark of the place where the test was carried out;
Date of filling of porous mass;
Water capacity;
A symbol to indicate the nature of heat treatment;
Identification of porous mass and porosity percentage;
Tare weight (inclusive of valve);
Inspector’s official mark;
Maximum gas capacity.

Gas Cutting Operation

a. General Safety Requirement

- Protective clothing and eye protection should be worn;
- Blowpipe should be shut off when not in use;
- Lighted blowpipe should not be left on a bench or the floor as the force of the flame may cause it to move;
- Work-piece should be clamped and not held by hand;
- Hoses should be kept away from the working area to prevent contact with flames, heat, sparks or hat spatter.

b. **Cutting Process**

The following sequence of operation should be followed for carrying out a safer cutting operation :

- Open the acetylene cylinder with the help of the cylinder key to half a turn.

- Adjust the regulator screw on the Acetylene regulator to the required pressure and then do the same for the oxygen line, in both the cases the Cutogen valves on the torch are closed.
- Now open the Acetylene cutover valve, purge the hose and close it. Then do the similar exercise for the oxygen.
- Close the oxygen line valve on the torch and ignite the torch.
- Adjust the oxygen to the required pressure.
- While closing, close the oxygen cylinder and regulator then the Acetylene cylinder and regulator
- Close the oxygen torch valve then the Acetylene valve.
- Correct gas pressure and for the nozzle size should be used as given in the following table :

Max. Materials thickness, MS in mm	Size of nozzle	Cutting oxygen pressure in kg/cm^2
12	1/32”	1.4
25	3/64”	3.0
50	1/16’	4.0
75	1/16’	4.0
100	1/16’	5.0
150	5/64”	5.5
200	3/32”	7.5
250	7/64”	8.0
300	1/8”	8.0

Acetylene pressure should be set in all cases at 0.15 kg/cm^2 depending on material

c. **Backfire & Flash Back**

- Backfire occurs when the flame burns back into the blowpipe often with a sharp bang. This may happen when the blowpipe is held too close to the work-piece, or if the nozzle is blocked or partly blocked. The flame may go out or it may re-ignite at the nozzle. Sometimes the flame burns back into the blowpipe, and burning continues at the mixing point. Backfires do not usually cause serious injury or damage but they indicate a fault in the equipment.
- Flashbacks are commonly caused by a reverse flow of oxygen into the fuel gas hose (or fuel into the oxygen hose), producing an explosive mixture in the hose. The flame can then burn back through the blowpipe, into the hose and may even reach the pressure regulator and the cylinder. The consequences of a flashback are potentially very serious. They can result in damage or destruction of equipment, and could even cause the cylinder to explode. This could end in serious injury to personnel and severe damage to property.

- If a backfire does occur:

⇒ The blowpipe valves should be shut off, oxygen first and then the fuel gas;
⇒ Oxygen and fuel gas cylinder valves should be shut off;
⇒ The blowpipe should be cooled with water, if necessary;
⇒ The equipment should be checked for damage or faults, particularly the nozzle.

- The following precautions will help to prevent flashbacks:

⇒ The hoses should be purged before lighting the blowpipe to remove any potentially explosive gas mixtures. Spark igniter should be used to ignite the gas quickly after turning it on;

⇒ Flashback arresters should be provided at both ends of the hoses to prevent backflow of gas towards cylinders;

⇒ Correct gas pressure and for the nozzle size should be used.

- If a flashback does occur:

⇒ Cylinder valves of both fuel gas and oxygen should be closed immediately, if it is safe to do so. The flame should go out when the fuel gas is shut off. If the fire cannot be put out at once, the area should be evacuated and emergency fire services should be called;

⇒ The blowpipe, hoses, regulators, flashback arresters and other components may have been damaged. The damaged ones should be replaced before reuse.

d. **When Acetylene Cylinder catches fire or gets heated.**

If an acetylene cylinder catches fire or gets heated due to severe back fire or external heat source, it should be dealt with promptly as follows :

- The valve should be shut.
- Try to extinguish the fire
- Regulator or other fittings should be detached.
- It should be immersed in water or water should be applied copiously at the bottom half of the cylinder.
- The valve should be opened for few minutes and the cylinder, kept cool in water until it becomes empty.
- No one should stand in the direction of the fusible safety valve fixed at the bottom of the cylinder.

e. **Welding Machine**

Installation

For individual welding machines, the rated current-carrying capacity of the supply conductors should be not less than the maximum primary current of the welding machines.

All the moving and rotating parts of the welding equipment should be guarded.

In case of Engine-run welding machines, refueling should not be done while the machine is running and spilling of oil should be avoided.

f. Welding Service Cable and Connectors

All welding cables should be of completely insulated, flexible type, capable of handling the maximum current requirements of the work in progress.

When it becomes necessary to connect or splice the cables, substantial insulated connectors of a capacity at least equivalent to that of the cable, should be used. If

connections are effected by means of cable lugs, then these lugs should be securely fastened together by means of bolts to give good electrical contact. The exposed metal parts of the lungs should be completely insulated.

The work lead (welding lead) should be attached firmly to the work.

Work lead should be as short as possible.

g. Manual Electrode Holders

Any current-carrying parts passing through the portion of the holder, which the welder grips in his hand should be fully insulated against the maximum voltage encountered to ground. Insulation of all, metallic or current carrying parts, including the jaws, which grip the electrodes, is recommended wherever service conditions permit.

The cable should be free from repair or splices up to a minimum distance of 3.0 m from the electrode holder.

Electrode holders should be provided with discs or shields to protect the hands of the operator from the heat of the arcs.

h. Earth Returns

Welding current should be returned to the welding machine by a single, cable from the work to the welding machine. Connection of a cable from the welding machine to a common conductor or structure on which the work rests, or to which the work is connected may be permitted.

Pipelines containing gases or flammable liquids or conduits carrying electrical conductors should not be used for a ground return circuit. Wire rope, reinforcement rods, etc. should not be used to carry welding current.

All earth connections should be checked to determine that they are mechanically strong and electrically adequate for the required current.

i. Electric Shock

The following precautions should be taken to prevent electric shock:

- Workmen / welders designated to operate arc-welding equipment should have a thorough knowledge of requirements with regard to safety. They should be educated the causes electric shock and avoiding the same.
- Voltages required for arc welding are low. Hence, welding cables, electrode holders and other parts of welding machines are liable to be handled carelessly. These voltages are, nevertheless, sufficiently high that under certain circumstances they may be dangerous to life. This danger is particularly marked in very hot weather, when the welder is sweaty or when he is damp.
- Welding should develop the habit of always keeping his body insulated from both the work and the metal electrode and holder. He should always wear shoes, gloves and apron.

- Particularly, he should never permit the metal part of air electrode, the electrode coverings, or any metal part of the electrode holder to touch either his bare skin or any wet coverings on his body. Consistent use of electrode holders with well-insulated jaws, well-insulated cables, dry protective coverings on the hands and body and insulations from ground would be helpful in avoiding contact.
- It should never be assumed that because contact with the electrode at one time is not harmful, similar contacts at other times would also be harmless.
- Electrode should be removed from holders when not in use to eliminate danger of electrical contact with persons or conducting objects. Electrode holders when not in use should be so placed that possibilities of electrical contact between them and persons or conducting objects are eliminated.
- Plant & Machinery Engineer should check welding machine regularly to ensure that electrical connections and insulation on the holders and cable are in good order.
- Anything that appears unsafe should be promptly reported to Plant & Machinery Engineer and use of such welding equipment should be discontinued until its safety has been assured. Only qualified personnel should make repairs.
- Welding (secondary) terminals should be so arranged that no current-carrying parts are exposed to accidental contact.

j. **Operation and Maintenance**

- Welding equipment should be maintained in safe working order at all times. Periodic inspection should be conducted.
- Printed rules and instructions covering operation and maintenance of welding equipment supplied by the manufacturers should be strictly followed.
- When the welder has occasion to leave his work or stop work for any appreciable time, or when the machine is to be moved, the power supply switch in the equipment should be open. The equipment should be disconnected from the source of power when not in use.
- Welding equipment should be maintained in good mechanical and electrical condition to avoid unnecessary hazards. Commutators should be kept clean to prevent excessive flashing. Gasoline and other flammable liquids should not be used for cleaning commutators. Fine sandpaper or commutator polish should be used.
- Welding equipment used in the open should be protected from inclement (rainy) weather conditions. Protective coverings should not obstruct the ventilation necessary to prevent overheating of the machine. When not in use, the equipment should be stored in a clean dry place. Machines, which have become wet, should be thoroughly dried before being used.
- It is good practice to blow out the entire generator type-welding machine occasionally with clean, dry compressed air.

k. **Cable**

- When, in the course of work, a welding cable becomes worn out, exposing bare conductors, the portion thus exposed should be adequately insulated with heat resistance tape.
- Welding cables should be kept dry where practicable and free from grease and oil to prevent premature breakdown of the insulation.
- When it becomes necessary to carry cables some distance from machines, they should be substantially supported overhead, if practicable. If this is not possible, and

cables are laid on the floor or ground, they should be protected in such a manner that they would not be damaged, entangled or interfere with safe movement of people. Special care should be taken to see that welding supply cables are not in proximity to power supply cables or other high-tension wires.

- Also, laying of cables should be so as not to created tripping hazard in the work place.

l. **Protection from Rain**

- Welding in wet, damp or humid conditions reduces the skin resistance of the body and insulating properties of accessories. Hence no welding should be done unless suitable protection is provided.
- If there is a risk of heavy rain, a cover for the welder, equipment and work piece should be in place.

m. **Fire Prevention and Protection**

- Either the work-piece should be moved to a safe location for carrying gas-cutting work or combustible materials and flammable materials should be removed from the work place.
- Spaces where welding fumes could accumulate should be ventilated.
- If combustible materials that cannot be moved should be protected from close contact with flame, heat, sparks or hot slag. Suitable guards or covers such as metal sheeting, mineral fibre boards or fire retardant blankets should be used; in such case hot work permit should be obtained.
- Guards or covers should be used to prevent cylinders from hot particles passing through openings in floors and walls;
- Fire extinguishers, fire buckets with water should be kept nearby.

n. **Prevention of Gas Leaks from Gas Cutting Sets**

- Hoses should be kept clear of sharp edges and abrasive surfaces or where vehicles can run over them;
- Hot metal or spatter should not be allowed to fall on hoses;
- Gas cylinders kept in upright position should be chained to prevent them from falling down or being knocked over. For example, cylinders can be chained in a wheeled hand trolley or against a wall or a suitable support;
- Gas Supply should be turned off at the cylinder when the job is finished;
- All the equipment should be kept in good condition;
- All the connections and equipment should be regularly checked for faults and leaks;
- Taking gas cylinders into a poorly ventilated rooms or confined spaces should be avoided.

CHAPTER 40: SAFETY IN GRINDING & MACHINING

AIM:

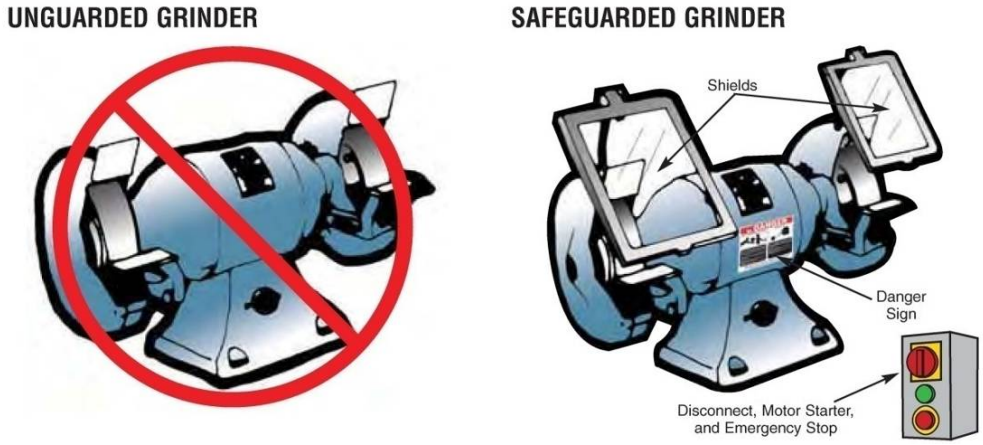
Abrasive wheels and grinding machines come in many styles, sizes, and designs. Both bench-style and pedestal (stand) grinders are commonly found in many industries. These grinders often have either two abrasive wheels, or one abrasive wheel and one special-purpose wheel such as a wire brush, buffing wheel, or sandstone wheel.

Breaking of wheels can be very dangerous. Employees need to protect themselves by using appropriate face shield & goggles for their own safety.

Legal :
The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 and Rules, 1998
Chapter XI : EXCAVATIONS & TUNNELING
All the rules applicable **(119-168)**

RULE : 159- Portable electric handtools

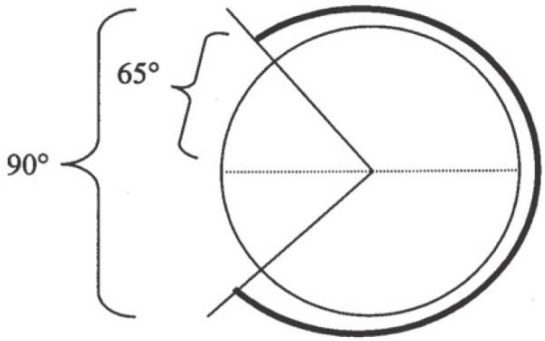
Hazard
Hand held portable, Bench-style and pedestal grinders create special safety problems due to the potential of the abrasive wheel shattering; exposed rotating wheel, flange, and spindle end; and a naturally occurring nip point that is created by the tool/work rest. This is in addition to such concerns as flying fragments, sparks, air contaminants, etc. Cutting, polishing, and wire buffing wheels can create many of the same hazards.
Grinding machines are powerful and are designed to operate at very high speeds.



If a grinding wheel shatters while in use, the fragments can travel at more than 300 miles per hour. In addition, the wheels found on these machines (abrasive, polishing, wire, etc.) often rotate at several thousand rpms. The potential for serious injury from shooting fragments and the rotating wheel assemblies (including the flange, spindle end, and nut) is great. To ensure that grinding wheels are safely used in your workplace, know the hazards and how to control them.

Solution
Abrasive wheels used on bench and pedestal grinding machines must be equipped with safety guards. The safety guard encloses most of the wheel — covering the flange, spindle

end, and nut projection — while allowing maximum exposure of the wheel periphery. The exposure of the wheel should not exceed 90 degrees or one-fourth of the periphery (see diagram below).



This exposure begins at a point not more than 65 degrees above the horizontal plane of the wheel spindle. Wherever the nature of the work requires contact with the wheel below the horizontal plane of the spindle, the exposure must not exceed 125 degrees.

This exposure begins at a point not more than 65 degrees above the horizontal plane of the wheel spindle. Wherever the nature of the work requires contact with the wheel below the horizontal plane of the spindle, the exposure must not exceed 125 degrees.

Because the safety guard is designed to restrain the pieces of a shattered grinding wheel, the distance between the safety guard and the top periphery of the wheel must not be more than 1/4-inch. If this distance is greater because of the decreased size of the abrasive wheel, then a “tongue guard” must be installed to protect workers from flying fragments in case of wheel breakage. This “tongue guard” should be adjustable to maintain the maximum 1/4-inch distance between it and the wheel.

An adjustable tool/work rest must also be installed and maintained at a maximum clearance of 1/8-inch between it and the face of the wheel. In addition to offering a stable working position, this small clearance must be maintained to prevent the operator’s hands or the work from being jammed between the wheel and the rest, which may cause serious injury or wheel breakage.

All abrasive wheels must be closely inspected and ring-tested before mounting to ensure that they are free from cracks or other defects. Wheels should be tapped gently with a light, non-metallic instrument. A stable and undamaged wheel will give a clear metallic tone or “ring.” If a wheel sounds cracked (dead), do not use it. This is known as the **“ring test.”**

The spindle speed of the machine must also be checked before mounting the wheel to be certain that it does not exceed the maximum operating speed marked on the wheel.
One of the most common portable tools found in virtually any shop, the portable grinder is incredibly useful for grinding and finishing material of all shapes and sizes.

Hazard
The hazards associated with portable grinders are similar to those of pedestal or bench grinders. First of all, serious abrasion or cuts can occur from contacting the rotating abrasive stone. There is also the potential for the abrasive stone to shatter, plus the dangers of exposure to the rotating wheel, flange, and spindle end from kickback. Finally, other concerns such as flying fragments and sparks are present during portable grinding operations.

Solution
These types of grinders normally come with the manufacturer’s safety guard covering most of the wheel. Abrasive grinder exposure must not exceed a maximum angle of 180 degrees and

the top half of the wheel must be enclosed at all times. The guard must be mounted so it maintains proper alignment with the wheel.

Vertical “right angle” grinders must have a 180-degree guard between the operator and wheel. The guard must be adjusted so that pieces of a broken wheel will be deflected away from the operator. The above picture depicts a properly guarded “right angle” grinder.

Cup wheel grinders must be guarded as described above or be provided with special “revolving cup guards,” which mount behind the wheel and turn with it.
All abrasive wheels must be closely inspected and “ring-tested” before mounting to ensure that they are free from cracks or other defects. The spindle speed of the machine also must be checked before mounting the wheel to be certain that it does not exceed the maximum operating speed marked on the wheel. Always follow the manufacturer’s recommendations.

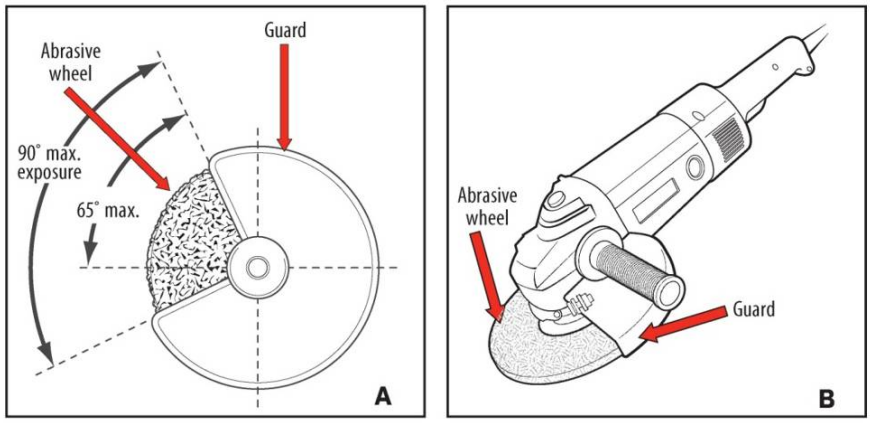


Figure 4.11. Maximum wheel exposures for different types of abrasive wheel guards.

CHAPTER 41: SAFETY IN USE OF HAND TOOLS & POWER OPERATED TOOLS

AIM:

Incorrect use of tools can cause injury to the user. Lack of knowledge to use electrical or powered tools can be disastrous. Appropriate safe practices & knowledge will help in reduction of hand tools & powered tools related incidents.

Legal :

The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 and Rules, 1998

Rule 5 – Duties & responsibility of employers, employee & others

Sub rule 5
It shall be duty of every employer not to permit an employee to do anything not in accordance with generally accepted principles of standard safe operating practices connected with building and other construction work as specified by the central government.

Sub rule 6
No employee shall do anything which is not in accordance with the generally accepted principles of standard safe operating practices connected with building and other construction work as specified by the central government.

Sub rule 7
No person related with any building and other construction work shall willfully do any act which may cause injury to himself or to others

General

- Hand tools should be used only for the specific purposes for which they are designed.
- If there is a danger of an explosive atmosphere being ignited by sparks then non-sparking type of hand tools should be used.
- Only insulated hand tools should be used while working on electrical machines / systems.
- Hand tools should be suitably heat-treated, finished and repaired by suitable skilled persons.
- When not in use, sharp edged hand tools should be provided with proper protection for the edges. Hand tools should not be left unattended in the passageways. Suitable cabinets or covers should be provided for hand tools.
- Hand tools should be replaced or repaired when found defective.
- Operators should be properly instructed and trained in the safe use of hand tools.

Hammers & Mallets

- Hammer should be used in the right way as indicated in above sketch.
- Hammer should not be held close to the head as it reduces the force of the blow. Hammer should be held at such an angle that the face of the hammer and the surface of the object being hit are parallel in order to prevent damage both the surface being struck and the face of the hammer.

- Hammers should be kept free from grease and oil and repaired if necessary before they are used.
- Hammers with defective handles should not be used.
- Handles should be fitted carefully to the hammer head and securely fastened to them by means of a wedge. A hardened steel surface should not be hammered otherwise small pieces of sharp, hardened steel may break from the hammer and also from the hardened steel. Besides causing damage to the work and/or the hammer, a serious injury may result.
- A hammer handle should not be used for bumping parts in assembly or as a pry bar, as such abuses may cause the handle to split and a split handle may cause bad cuts, injury or pinches to the operator. When a handle splits or cracks, it should not be repaired by binding with string or wire. It should be replaced by a new handle.
- Hammering a hard metal plate / surface may cause the hammer to bounce and hit the user. Care should be taken while doing similar works.
- Wooden mallet should not be left in the sun, otherwise it may dry out and cause the head to crack.

Wrenches and Spanners

- While loosening jammed nuts, wrench or spanner should be pulled and not pushed as pushing may result in skinning of knuckles in case the wrench or spanner slips or the nut breaks loose unexpectedly. If it is impossible to pull the wrench or spanner then it may be pushed. The push should be applied with the open palm of the hand.
- Only that wrench or spanner should be used which fits the nut properly.
- Wrenches and spanners should be kept clean and free from oil, otherwise they may slip, resulting in possible serious injury or damage to the work.
- The leverage of a wrench or spanner should not be increased by inserting the handle inside a pipe. Increased leverage may damage the wrench or the work.
- All wrenches should be provided with case or kit and should be returned with the case or kit after usage. This saves time and trouble and facilities selection of tools for the next job. Most important, it eliminates the possibility of leaving them, where they can cause injury to workers.
- It should be known in which way a nut is to be turned before trying to loosen it.
- Hammering on wrenches and spanners should be avoided.
- Wrenches and spanners with cracked or worn-out jaws or other defects should not be used.
- Use of wrenches / spanners as hammer should not be allowed.

Metal Cutting Tools

a. **Snips**

- Attempt should not be made to cut hardened steel wire or other similar objects with tin snips, it may dent or nick the cutting edges of the blades.
- Snips should be oiled and adjusted to permit ease of cutting. If the blades of the snips are too far apart they should be adjusted.
- Snips should not be used as screwdrivers, hammers or pry bars. They break easily. Attempt should not be made to cut heavier materials of thicker gauges than the snips are designed for.

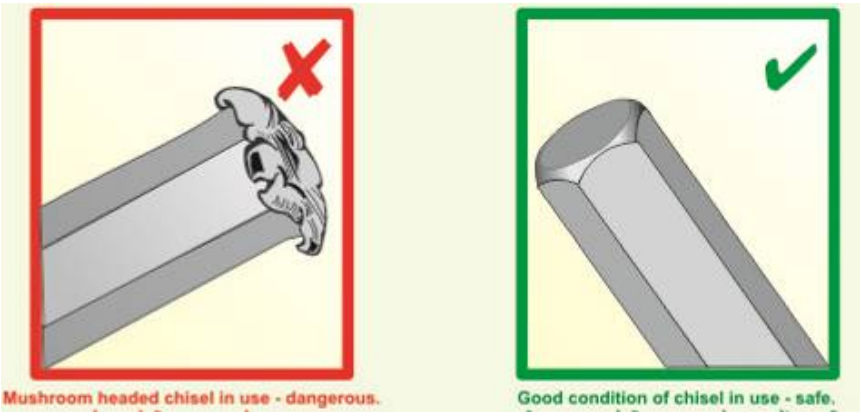
- Snips should not be tossed into a tool box, where the cutting edges can come into contact with other tools. This will dull the cutting edges and may even break the cutting edges.
- When not in use, snips should be hung on hooks or laid on an uncrowded shelf or bench.

b. Hacksaw

- The blades in the hacksaw frame should not be loose. Too much pressure should not be applied on the blade during working, otherwise the blade may break causing injury to the hand.
- The material in the vice should be tightened enough, otherwise it may slip, twisting the blade sufficient to break it.

c. Chisels

- The chisels should be of suitable shape and edges kept sharp. Only that hammer should be used which matches the chisel, that is, larger the chisel, heavier the hammer.
- Goggles / face shield should be used to protect eyes while using a chisel for chipping. If other workmen are close by, they should be protected from flying chips by erecting a screen or shield to contain the chips.
- The chisels with mushroom head should be removed and dressed, before use.



- Heads of chisels should be kept free from grease and oil.
- The handle of chisels should be made of suitable materials, fitted with metallic ferrule on them to prevent from being chipped.

d. **Files**

- Files should not be used without a tight-fitting handle.
- File teeth should be protected by hanging files in rack when they are not in use, or by placing them in drawers with wooden partitions. Files should be wrapped in wax paper to protect their teeth and prevent damage to other tools before being stored.
- Files should be kept away from water and moisture so that they may not get rusted.
- Files should not be allowed to get oily, as it causes a file to slide across the work and prevents fast and clean cutting.

- The files should not be used for prying or pounding otherwise the tang will bend easily. The body is hard and extremely brittle, even a slight bend or a fall on the floor may cause a file to snap in two.
- Files should be cleaned by means of brushes. They should not be struck against bolts or vices for cleaning purposes.

Wood Cutting Hand Tools

a. **Handsaws**

- Ripsaws should be used only for cutting along the grain of the wood and cross-cut saws should be used for cutting across the grain of the wood.
- The use of oil or paraffin on the blade may ease the work, particularly while cutting green timbers.
- A saw which is not being used should be hung up or stored in a tool box. A tool box designed for holding saws should have notches that hold them on edge, teeth up Storing saws loose in a tool box may result in the saw tooth to become dull or bend by coming in contact with other tools.
- Tools should not be piled on top of the bench, it may distort the blades.
- There should be no nails or other edge destroying objects in the line of the cut.
- When sawing out a strip of waste, the strip should not be broken by twisting the saw blade. This will dull the saw and may spring or break the blade.
- When sawing, the waste side of work should be supported to prevent splitting off.
- It should be ensured that the saw should go through the full stroke without striking the floor or some other object. If the work cannot be raised high enough to obtain full clearance for the saw, the length of each stroke should be carefully limited.

b. **Screwdrivers**

- Screwdrivers should not be used for electrical live circuit. Screwdriver should not be turned with a pair of pliers.
- While using a screwdriver, the work should not be held by the hand, if the point slips it may cause an injury. The work should be held in a vice, with a clamp or on a solid surface and any part of the body should not come in front of the screwdriver blade tip.
- Edges of screwdrivers should be properly ground and should be free from oil or grease.
- Screwdrivers should have smooth-surfaced handles and should not be used as chisels.
- Screwdriver with correct tip size should be used for a particularly slot size of the screw. If screwdriver tip size is small than slot size of the screw, the tip may get twisted. Where as if tip is bigger than slot, the screwdriver may slip while turning screw.
- Screwdrivers with worn edges, bent shanks and splintered handles should be discarded or repaired.

c. **Pliers**

- Attempt should not be made to cut hard materials such as spring wire or hard rivets with the combination side cutting pliers, otherwise it may spring the jaws and if the jaws are sprung, it will be difficult thereafter to cut small wire with the cutters.
- Combination side cutting pliers should not be used to grasp large objects, tighten nuts, or bend thick sheets. Such operations will spring the jaws. When grinding the cutting edges, care should be taken that excessive material from the jaws should not be

ground off than it is necessary to remove the nicks. Same amount of stock should be ground from both jaws.

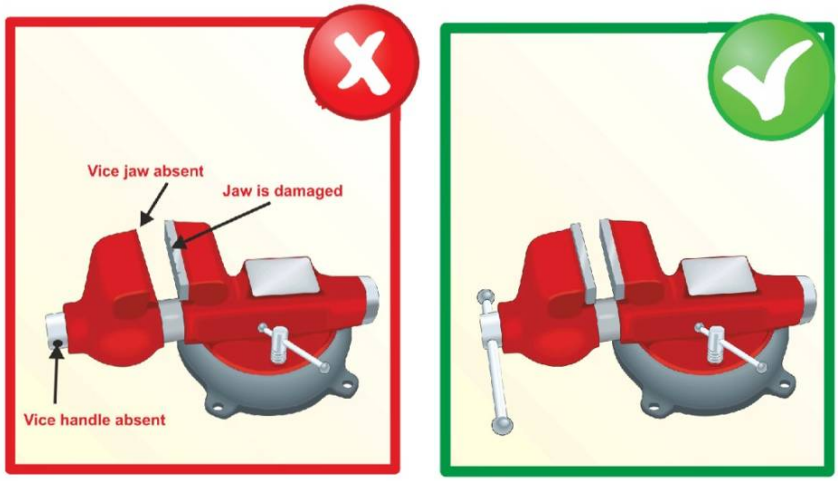
- Pliers should be coated with light oil when they are not in use. They should be stored in a toolbox in such a manner that the haws should not be damaged by striking hard objects. The pin or bolt at the hinge should be kept tight enough to hold the two parts of the pliers in contact and the pivot pin should be lubricated with a few drops of light oil.
- Pliers should not be used as substitutes for wrenches to tighten or loosen nuts.
- When cutting wire under tension or spring wire in coils by means of pliers, at least one end of the wire should be clamped or held down to prevent it from flying after being cut.

d. **Punches**

- Points of punches should be of suitable shape for the particular work to be done and should be kept sharp.

e. **Vices and Clamps**

- Vices should be kept clean and wiped with light oil after being used. Vices should not be struck with a heavy object. Large work should not be held in a small vice. These practices may cause the jaws to become sprung or otherwise damage the vice. The jaws should be kept in good conditions. The screws and the slide should be oiled frequently.When the vice is not in use, jaws should be brought lightly together or should be left with a very small gap. The handle should be left in vertical position.
- The swivel base of swivel jaw joint should not be oiled, otherwise its holding power will be impaired.
- Threads of C-clamps should be cleaned and kept free from rust. The swivel head should also be cleaned smooth and should be grit free. If the swivel head becomes damages, it should be replaced. For short storage the clamps should be wiped clean with a light coat of engine oil and should be hung on racks or pins, or should be carefully placed in a tool box. For long storage a rust-preventive compound should be applied to the C-clamp.
- When closing the jaw of a vice or clamp, part of the body should not come between the jaws or between one jaw and work.
- When holding heavy work in a vice, a block of wood should be placed under the work as a prop to prevent it from sliding down and falling on foot.
- The jaws of a vice should not be opened beyond its capacity otherwise the movable jaw will drop off, causing personal injury and possible damage to the jaw.



f. **Shovels**

- Shovels should not be used for heavy prying. This may break the handle or bend the blade.
- After use, shovels should be cleaned and oiled. When using a shovel, it should be ensured that working space is free, so that another worker should not be injured when the shovel is swung.
- The material should be thrown at a place where it should not have to be removed a second time and where it should do no harm.

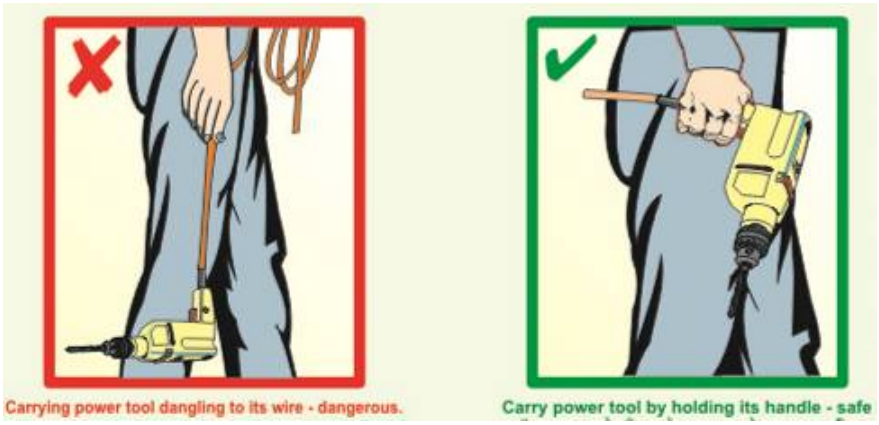
g. **Crowbars**

- Points or edges of crowbars should be kept in good condition, to minimize slipping hazards.
- When not in use, crowbars or similar tools should be laid flat in safe places on the floor or platform and not leaning against a flat surface.
- Carrying crowbars on shoulders should be avoided, as it may strike the persons walking aside.

Power operated tool :

General

- Employees should be trained in the use of all power tools. They should understand the potential hazards as well as the safety precautions to prevent those hazards from occurring. Cord or hose should not be pulled to disconnect it from the receptacle.
- Cords and hoses should be kept away from heat, oil and sharp edges.
- Tools should be disconnected from power source when not in use, before servicing, and when changing accessories such as blades, bits and cutters.
- Work piece should be secured with clamps or a vise, freeing both hands to operate the tool.

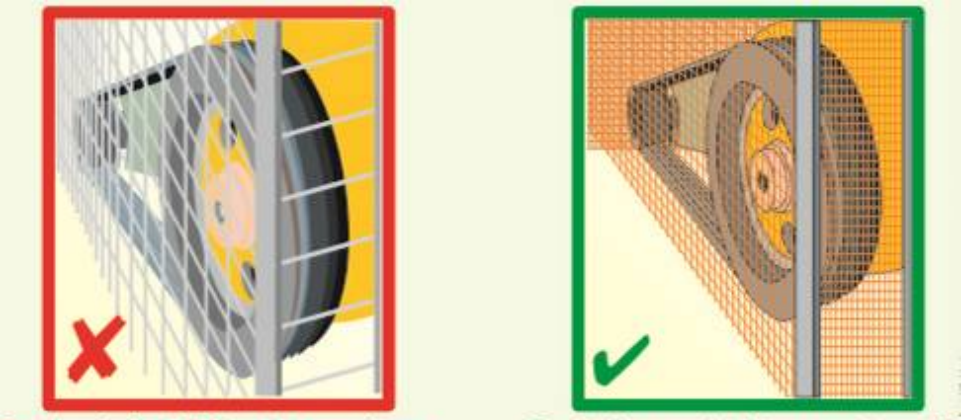


- The worker should not hold a finger on the switch button while carrying a plugged-in tool to avoid accidental starting.
- Tools should be maintained with care. They should be kept sharp and clean for the best performance. Maintenance and repairs should be carried out only by the authorized electrician / mechanic.
- Manufacturer's instructions in the user's manual should be followed for lubricating and changing accessories.

- Tool user should keep good footing and maintain good balance while using the tool.
- The proper apparel should be worn by the user. Loose clothing, ties, or jewelry can become caught in moving parts.
- Defective tools should never be used.

Guards

- Hazardous moving parts of a power tool should be safeguarded. For example, belts, gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, chains or other reciprocating, rotating, or moving parts of equipment should be guarded if such parts are exposed to contact by employees.
- Guards, as necessary, should be provided to protect the operator and others from point of operation, in-running nip points, rotating parts, and flying chips and sparks.
- Safety guards should never be removed when a tool is being used.



Control Switch

- Hand-held powered tools should be equipped with a momentary contact “on-off” control switch.

Electrical Tools

- Employees using electric tools should be aware of several dangers; the most serious is the possibility of electrocution.
- To protect the user from electric shock, tools should be
- Earthed / Double insulated.
- Provided with ELCB of 30 mA sensitivity
- Three-wire cords contain two current-carrying conductors and a grounding conductor. One end of the grounding conductor connects to the tool’s metal housing. The other end is grounded through a prong on the plug. The third prong should never be removed from the plug.
- Double insulation should be more convenient. The user and the tools are protected in two ways: by normal insulation on the wires inside, and by a housing that cannot conduct electricity to the operator in the event of a malfunction.
- These general practices should be followed while using electric tools:
  - Electric tools should be operated within their design limitations.
  - Footwear should be used during use of electric tools.

- When not in use, tools should be stored in a dry place.
- Electric tools should not be used in damp or wet locations.
- Work areas should be well lit.

Portable Grinding Machine

Do not use a bench or floor stand grinder when any of the following conditions exist :

- Guard(s) are not installed
- Grinder not securely anchored
- Work rest exceeds 1/8 inch distance from the wheel.
- Adjustable tongue exceeds ¼ inch distance from the wheel
- Excess wear is evident on the grinding wheel
- Wheel is chipped, cracked, out of round, or otherwise defective
- Do not use portable grinders without guards
- Before mounting a grinding wheel on a grinder, check the operating speed marked on the grinder and the rated safe speed of the grinder wheel. Grinding wheels are not to be mounted on grinders that operate in excess of the rated safe speed of the grinding wheel.
- Adjusting the work rest or tongue guard while the grinding wheel is in motion is prohibited.
- Inspect grinding wheel and discs on portable grinders before use for any cracks, damage, or wheels out of round or balance. Where any defect is evident, the wheel or disc must be removed from service immediately.
- Check the grinding wheel mounting flanges for equal sizes and correct diameters. Flanges are to be at least one-fourth diameter of the wheel diameter.
- Do not stand directly in front of any grinder when first starting it up.
- Allow the wheel to develop its full speed before beginning work.
- Never force the stock into the wheel of a fixed grinder or a portable grinder into the work to the point where the motor slows noticeably or the work becomes excessively hot.
- Ensure that the wheel is properly dressed at all times.
- Do not grind on the side of the wheel unless the wheel is specifically designed for this purpose.
- Store grinding wheels in a safe place designated for that purpose.
- Machines must be shut off when unattended.

Pneumatic tools

- Eye/face protection should be worn by the employees working with pneumatic tools.
- While working with noisy tools such as jackhammers requires hearing protection should be used.
- When using pneumatic tools, employees should ensure that they are fastened securely to the hose to prevent them from becoming disconnected. Clamp or positive locking device attaching the air hose to the tool will serve as an added safeguard.
- Screens must be set up to protect nearby workers from being struck by flying fragments around chippers, riveting guns, or air drills.
- Compressed air guns should never be pointed toward anyone. Users should never “dread-end” it against themselves or anyone else.
- Compressed air should not be used to clean or ventilate the body.

- Airline hose connections should be inspected regularly.

Hydraulic power tools

- The fluid used in hydraulic power tools should be an approved fire-resistant fluid and must retain its operating characteristics at the most extreme temperatures to which it will be exposed.
- The manufacturer's recommended safe operating pressure for hoses, valves, pipes, filters and other fittings should not be exceeded.
- Hose joints should conform to the recommendations of manufacturer.
- The tool should not be used when there is an oil leak.

Jacks

- All jacks (lever and ratchet jacks, screw jacks and hydraulic jacks) should have a device that stops them from jacking up too high.
- Manufacturer's load limit should be permanently marked in a prominent place on the jack and should not be exceeded.
- A jack should never be used to support a lifted load. Once the load has been lifted, it should immediately be blocked up.
- Use wooden blocking under the base if necessary to make the jack level and secured. If the lift surface is metal, place a 1-inch (25.4mm) thick hardwood block or equivalent between it and the metal jack head to reduce the danger of slippage.
- To set up a jack, following precautions should be taken up:
- The base should rest on a firm level surface
- The jack should be correctly centered,
- The jack head should bear against a level surface and
- The lift force should be applied evenly.
- Jacks should be inspected before each use and lubricated regularly. If a jack is subjected to an abnormal load or shock, it should be thoroughly examined to make sure that it is not damaged.
- Lever should be removed when it is not used, as it may create tripping hazard.
- If oil leaks from the hydraulic jack, it should not be used.

CHAPTER 42: SAFETY IN TRAFFIC MANAGEMENT & FENCING

AIM:

Vehicular movement that is not managed or designed appropriately can result in many incidents which can be dangerous to the life of the workers working on site. To make the workers safe & maintain a discipline traffic management with site perimeter fencing & controlled entry of vehicles is one of the fundamental tool to avoid danger to the well being of the workers as site.

Legal :Central Motor Vehicle Rules-1989

The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 and Rules, 1998
Chapter VI : GENERAL PROVISIONS
All the rules applicable **(34-54)**

Chapter X : TRANSPORT AND EARTH MOVING EQUIPMENT
All the rules applicable **(88-95)**

Traffic Management

For traffic management inside the factory premises the following guidelines are useful for drivers (four wheelers, two wheelers), cyclists, vehicle occupants, pedestrian, etc.

Guidelines to drivers

- Keep your vehicle in good working condition especially its critical systems like brakes, gears, electrical and tyres.
- Maintain your vehicle to keep auto emissions under control.
- Unlicensed persons should not drive.
- Obey the vehicular traffic signals and traffic signs.
- Always give way to the pedestrians.
- Drive Defensively: know traffic rules; have courtesy and consideration for other road users; be alert and keep allowance for illegal actions and errors of others.
- Drive within speed limits.
- Always keep to the left of the road.
- Follow lane discipline. Do not cut lanes.
- Drive carefully at blind corners.
- Overtake only from the right, unless the vehicle ahead intends to take a right turn. Check position of vehicles in the rear through the rear-view mirror.
- To avoid the risk of overturning, do not over speed while turning or cornering.
- When approaching an intersection, drive carefully to avoid collisions.
- When entering a main road at a junction, give way to traffic on the main road and stop if necessary.
- Maintain a safe distance between your vehicle and the one ahead.
- To prevent rear end collisions, signal your intention well before and slow down smoothly so as to give the following driver enough time to react.
- While driving at night, watch out for "One eyed Charlies" – vehicles with only one headlight on.

- Do not use headlights to dazzle the oncoming traffic. It can affect you too.
- Drive with additional care and at lower speeds, when the visibility is poor or in adverse weather conditions.
- While negotiating through water logged stretches, drive close to the centre of the road.
- Skids do not happen but are made. Every time you increase speed, brake or steer suddenly, you can go into a skid.
- To avoid skidding, be alert for polished or slippery road surfaces, especially after a drizzle; do not brake suddenly while cornering and replace worn out tyres.
- Don't drive when drowsy or tired; take rest while on long distance journeys.
- Drinks or drugs can impair a driver's judgement; therefore avoid intake of alcohol or other intoxicants before driving.
- Do not horn unnecessarily. It distracts other drivers.
- Park only at authorised and safe spots.
- When parking, set the hand brakes, leave the vehicle in gear and remove the ignition key.
- While reversing, lookout for children, ensure that there is sufficient space at the rear and give a proper signal.
- WEAR SEAT BELTS

Additional Guidelines to two wheeler riders

- Helmet is a must for both rider and pillion rider.
- A two-wheeler is for two; not for too many – Don't overload it.
- Do not ride on the painted road makings to avoid skidding.
- Avoid acrobatics on the road.
- Always use rear-view mirrors. Use proper hand signals while turning.
- Never park close to a big vehicle in the blind spot area of the driver.

Guidelines for cyclists

- Before moving out, check tyre inflation, brakes, bells and lights.
- Paint rear mudguard white and fit it with a reflector.
- Ride close to the kerb.
- Be careful about the open manholes at roadside.
- Always ride in a single file.
- Do not indulge in joy riding or hang on another moving vehicle.
- Keep safe lateral distance from fast moving heavy vehicles to avoid losing balance due to wind turbulence.
- While turning at an intersection, signal your intention well in advance.
- Always wear light coloured clothes while riding at night.

Guidelines for vehicle occupants

- Always check that the doors are locked.
- Do not project your hands out of the window.
- Do not throw cigarette stubs or other waste from the vehicle.
- Do not allow children to play the fool in the car.
- Do not do anything which may distract the driver.
- Do not do 'back seat driving'; do not give instructions to the driver.
- While opening doors, observe other traffic, cyclists and pedestrians.
- Do not get on or jump off moving vehicles or alight at road signals.

Guidelines to Pedestrians

- Always walk on the footpath and where there is no footpath, walk along the right hand side of the road facing the oncoming traffic.
- Watch out for obstructions on the footpath: open manholes and trenches, fruit skins, slippery surfaces etc.
- While crossing a two-way road without dividers, follow Kerb Drill: Stop at the kerb, look to your right, look to your left, look right again and cross the road if no vehicle is near you.
- Follow pedestrian traffic signals.
- Always cross the road at zebra crossings, overbridges or subways, wherever these exist.
- Help old and handicapped persons and children to cross the road.

Emergency measures in the event of an accident

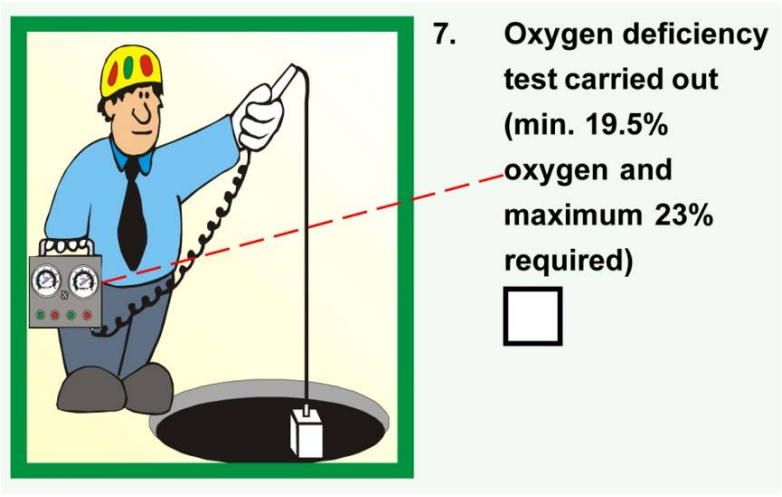
- Switch off vehicle ignition to avoid sparking which may start a fire.
- Warn all other traffic and contact the police.
- Scan casualties according to degree of injury and give first aid.
- Give priority to the 2 B's – restore Breathing and stop Bleeding.
- Do not handle the cases of fracture unless you are trained to do so. Wrong handling could prove fatal.
- Keep a cordon around the accident spot and particularly avoid crowds thronging around the victim.
- Take assistance of passing vehicles / bystanders to arrange for medical attention.
- Remember the first hour after the accident (Golden Hour) is a crucial period for saving human lives.

CHAPTER 43: PREVENTION OF UNAUTHORIZED ENTRY

Unauthorized entry shall be prevented by having a proper security system regulating entry through gate pass and permit. All work on major electrical installations shall be carried out under "permit to work" system. The permit to work certificate from the person -in-change of operation to the person in-charge of the group/team who wants to carry out any particular work shall ensure that the portion of the installation where the work is to be carried out is rendered dead and safe for working.

All work should be carried out under the supervision of a competent supervisor. If more than one department is working on the same apparatus, a permit to work should be issued to the person in-charge of each department. Permit to work ensures safe working conditions until it is surrendered.

No construction, repair or maintenance work in the proximity of high or EHV system / equipment (electrical or mechanical) where technical knowledge or experience is required to avoid danger, should not be carried out unless a permit of work on the prescribed form has been issued by the shift in-charge to an authorized person.



The person issuing a permit to work should ensure that the system/equipment is made perfectly safe to work on as follows:

1. In the case of electrical system/equipment, the isolation is complete, the metal parts adequately earthed and danger notices attached at suitable places,
2. In the case of mechanical equipment, the isolation is complete and conditions rendered safe and danger notices applied at suitable places.
3. Above conditions shall be maintained till the permit is surrendered and cancelled.
4. Work permit should be made in duplicate. Original copy of the permit is handed over to person in-charge of the work. The carbon/duplicate copy should be retained by the shift in-charge. Permit books are important records and should be compiled safety. All pages should be kept safely. No page should be detached or used for any other purpose. If a page is inadvertently detached, it should be recorded and duly signed in the book by the person concerned.
5. The Person in-charge should be responsible for identifying the isolated and de-energized circuit.

6. After completion of the works of removal of men/material (tools and tackles), the person in-charge of the works should inform the person issuing the permit regarding completion of work and shall surrender the original work permit for cancellation of it.

Chapter: Disposal of Waste Material

Adequate safety precautions shall the observed in accordance with best house keeping practices to dispose of waste material, especially that which is hazardous or inflammable. Effective arrangements shall be made for the treatment of wastes and effluents due to the manufacturing process carried on therein, so as to render them innocuous.

Chapter: Plant Perimeter Fencing

Site perimeter fencing shall be made as per standard construction safety norms. The fence height shall be a minimum of 1.8m and it shall prevent the entry of animals and unauthorized persons.

CHAPTER 44: SAFETY WHILE WORKING ADJACENT TO RAIL TRACKS: SAFETY WHILE WORKING ADJACENT TO LIVE ROADS: SAFETY IN ROAD CUTTING WORKS

Aim:

Working alongside railway lines is one of the most dangerous forms of work there is: the risk of a fatal accident is three times greater than in the construction industry.

Crossing railway lines does account for maximum deaths each year. Incidents and accidents that occur during work on railway lines can be prevented through the right approach to risk and by following safety procedures.

Live roads pose lot of inconvenience to vehicular traffic & pedestrians when construction activity is in action on the roads. Striking of vehicles on the construction sites is common cause of injury to the employees which has to be prevented by proper planning & visual awareness.

Legal :

The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 and Rules, 1998

Chapter VI : GENERAL PROVISIONS

All the rules applicable **(34-54)**

Conduct hazard identification &risk assessment (HIRA) before the initiation of work.

Design a Safe working Plan for the activities that are being carried out in the close proximity of the railway track.

Permitted length of work stay

Work must always take place at least 5 metres away from thecentre of the track.

When is it permitted to cross the track?

- During inspection/measurements to KB
- During inspection/surveillance of pipelines
- During inspection/maintenance of switching groups
- During surveying work
- When connecting a pipeline detector

When is it not permitted to cross the track?

- During new construction work
- During other large-scale projects

Procedure for crossing the track

- Always wear a yellow safety vest (red or orange clothing may never be visible!)
- Adequate line of sight
- Do not carry heavy tools and/or measuring equipment while crossing
- Cross no more than 3 tracks in one go
- Always tread on the ballast, not on the track itself
- Never step on a rail or railway sleeper. These are often slippery after rain, frost or oil
- Never walk on cable ducts
- Never walk across railway points. These are controlled remotely and can suddenly switch.

- Always make a “SPOTTER” person available when ever working near rail tracks who will be equipped with a whistle & a RED flag. If possible update from the railway department the timing of the trains passing by during the work hours.
- If possible barricade the working area if away from the railway track.
- Avoid working in foggy environment as the visibility is reduced & the approaching trains cannot be visible clearly.
- Always work safely in a manner so as NOT to touch or be in contact with the overhead power lines. Especially, during movement of earth moving equipment like JCB, hydra, Cranes articulating vehicles, etc.
- All employees are to be provided with appropriate PPE’s especially fluorescent reflective jackets /boiler suits etc., so that they are visible at site.

Safety while working adjacent to live roads:

‘road’ includes:

(a) any street, lane, footpath, square, court, alley orpassage,

(b) any bridge, viaduct, underpass, subway, tunnel,overpass, overbridge, flyover, carriageway (whethersingle or multiple), pavement or footway,

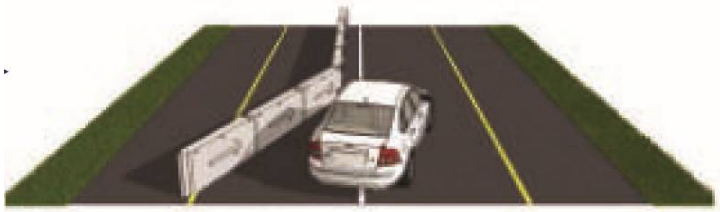
(c) any weighbridge or other facility for the weighingor inspection of vehicles, toll plaza or other facilityfor the collection of tolls, service area, emergencytelephone, first-aid post, culvert, arch, gulley, railing,fence, wall, barrier, guardrail, margin, kerb, lay-by,hard shoulder, island, pedestrian refuge, median,central reserve, channelliser, roundabout, gantry,pole, ramp, bollard, pipe, wire, cable, sign, signal orlighting forming part of the road, and

(d) any other structure or thing forming part of theroad and necessary for the safety, convenience or amenityof road users or for the construction, maintenance,operation or management of the road or for theprotection of the environment, or ‘roadway’ means that portion of a road which isprovided primarily for the use of vehicles.

Construction work on roads will often involve severalcontractors carrying out different tasks or elseworking together on a single task. But whetherperformed by one contractor or many, therequirement remains that the full extent of theconstruction works must be supervised andcoordinated. Signing, lighting and guarding at theroadworks must be supervised by a least oneperson.

- Signs, lights and guarding equipment must be secured against being blown over or out of position by thewind or by passing traffic.
- Do not use barrels, kerbstones or similar objects forthis purpose - they could be dangerous if hit by traffic.
- Check regularly that signs have not been moved or damaged or become dirty, including when the site isleft unattended for a period of time.
- On a two-way road, signs should be set out for traffic approaching from both directions.
- It is important that the signing, lighting and guardingaspects of the works are coordinated for the durationof the project.
- Implementation of the temporary trafficmanagement plan on site during the constructionwork, including responsibility for installing, modifying,maintaining and removing the temporary traffic management arrangements is the sole responsibility of the Project department who are responsible for planning as well.

- Legal permissions from local RTO (Road Transport Office) has to be obtained prior to the construction activity. Other permissions form local authorities are also to be obtained before commencement of the activitiy.
- In case of diversion appropriate barricading arrangement to be made indicating the directions & diversion paths by signs that are to be posted and made easily visible for the vehicles driver's passing by.



- During the night light blinkers or appropriate arrangement is to be made to indicate the diversions made.
- All the employees working on such live roads should wear Reflective jackets, helmets, shoes etc. and all appropriate PPE's that are required for working at the road site.
- Separate path way for the pedestrians to be maintained in the temporary traffic management plan associated with the construction activity.
- Where site or traffic conditions change, appropriate adjustments should be made to signing, lightingand guarding.
- You must include the works area, working space and safety zone in the area to be marked off with cones,and lamps placed where necessary. Never use a safety zone as a work area or for storing plant or materials.
- On completion of the works, ensure that all plant, equipment and surplus materials are removed promptlyfrom the site. All signs, lighting or guarding equipment should be removed immediately.
- It is your responsibility to make sure that pedestrians are safe during the works. This means protectingthem from both the works and passing traffic.
- You **must** take into account the needs of children, elderly people and people with disabilities, havingparticular regard for visually impaired people.
- A works site on the approach to a traffic signalled junction can cause significant disruption to the trafficflow at the junction. An adjustment of the traffic signals may be required, so consult your supervisor, whowill then consult the highway /Road authority.
- All electrical supply should be availed with safety components like ELCB etc.
- While working near live roads avoid contact with electric lamp post or any overhead HT electric lines.

Safety in road cutting works

Planning & project design department are to be involved in the road cutting activity.

- Once the legal permissions are obtained from the relevant authorities measurements are to be taken for conducting the road cutting activities.
- All the instructions and safety precautions mentioned in the above chapter of safety while working adjacent to live roads should be followed.
- Proper and separate path to be designed as lot of material for road building will be involved during which vehicular movement will be increased, thus affecting the regular traffic.

- Material dumping should be done in a pre designated area so that the dumped road material does not spread around and cause inconvenience in the form of obstruction to the on going traffic.
- The excavated debris if any should be removed immediately as it will cause obstruction for the vehicular movement at the site.
- Road building work if possible should be carried out during the late hours as the traffic will be less & it will be much convenient to execute the work by appropriate traffic management.

CHAPTER 45: SAFETY IN CONSTRUCTION OF DAMS

AIM:

Construction of dams is a very extensive activity which goes on for long depending upon the size of the dam. Though big or small all the construction activities are associated with the dam from excavation, tunneling, piling, concreting, material handling etc. which involve workers on the construction site of dam. Also, associated with is safety of the workers which has to be primarily focused on.

Legal :
The Building and Other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 And Rules, 1998

NOTE :

All the rules of bocw are applicable to the activities associated with construction of dams. Though few important ones are listed below:

To regulate the employment and conditions of service of building and other construction workers and to provide for their safety, health and welfare measures and for other matters connected therewith or incidental thereto.

Chapter I: Preliminary (Sections 1 to 2)

The BOCW Act extends to the whole of India and has come into force on 1st March, 1996. It applies to every establishment which, employs or had employed on any day of the preceding twelve months, 10 or more building workers in any building or other construction work.

Chapter VII: Safety and Health Measures (Sections 38 to 41)

This Chapter deals with safety and health measures in the construction establishments. The provisions include – constitution of safety committee and appointment of safety officers, notice of certain accidents, empowering appropriate Government to make Rules for the safety and health of building workers and framing of Model Rules for safety measures.

In every establishment wherein 500 or more building workers are employed, a Safety Committee has to be constituted and Safety Officer(s) should be appointed. In case of certain accidents which cause death or bodily injury by reason of which the person injured is prevented from working for a period of 48 hours or more immediately following the accident, or which is of such a nature as may be prescribed, the employer should give a notice to the prescribed authority in a prescribed form within a prescribed time.

Sec. 40 empowers the appropriate Government to make Rules concerning safety and health of building workers and the equipment and appliances necessary to be provided to them. Such Rules may provide for all or any of the following matters:

- safe means of access to workplace
- precautions in demolition under supervision of competent person
- safe handling or use of explosives under the control of competent person.

- erection, installation, use and maintenance of transport equipment and appointment of competent persons.
- erection, installation, use and maintenance of hoists, lifting appliances and lifting gear; testing and examination; appointment of competent persons.
- providing adequate and suitable lighting of every workplace and approach thereto, of every place where raising or lowering operations with the use of hoists, lifting appliance or lifting gears are in progress and of all openings dangerous to building workers.
- precautions to prevent inhalation of dust, fumes, gases or vapours, secure and maintain adequate ventilation.
- measures to be taken during handling, stacking or unstacking of materials.
- safeguarding of machinery
- safe handling and use of plant and tools and equipment operated by compressed air.
- precautions to be taken in case of fire.
- limits of weights to be lifted or moved by workers.
- safe transport of workers.
- steps to be taken to prevent danger to workers from live electric wires or apparatus.
- keeping of safety nets, safety sheets and safety belts.
- standards to be complied with regard to scaffolding, ladders and stairs, lifting appliances, ropes, chains and accessories, earth moving equipment, etc.
- precautions with respect to pile driving, concrete work, hot asphalt and demolition operations.
- preparation of a policy relating to steps to be taken to ensure the safety and health of the building workers, the administrative arrangements therefore and the matters connected therewith.
- to furnish information to the Bureau of Indian Standards regarding the use of any article or process covered under the BIS Act, 1986 in a building or other construction work.
- provision and maintenance of medical facilities for building workers.
- any other matter concerning the safety and health of workers working in any of the operations being carried on in a building or other construction work

In exercise of the powers conferred under Sections 62 and 40 of the Act, the Central Government made the Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Central Rules 1998. They came into force with effect from 19th November, 1998.

The Central Rules are applicable to (i) every establishment, in respect of which the appropriate Government under the Industrial Disputes Act, 1947 is the Central Government and (ii) Public Sector undertaking as defined under Section 617 of the Companies Act, 1956 which is owned, controlled or managed by the Central Government.

CHAPTER 46: SAFETY IN CONSTRUCTION OF COFFERDAMS AND CAISSONS

AIM:

Construction in low water levels is difficult & hence cofferdams are constructed so that the employees can work safely. Necessary precautions against water flooding in the cofferdams are to be taken & arrangement for evacuation should be handy for safety of the employees.

Legal :

The Building and Other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 And Rules, 1998

Chapter XX : COFFER DAMS & CAISSONS
All the rules applicable **(206-207)**

Cofferdams:
These vary greatly in size and methods of construction. Comparatively small ones of timber construction with three sides and a bottom are used for maintenance work on quay walls at low water level. The open side faces the wall and is sealed by rubber or clay to enable work to be done in relatively dry conditions. Others, of rectangular or circular shape are used to enable new constructional work to "be undertaken below water level in. open air. They are temporary and are used for river work, dam construction, and for foundation work for bridge piers. They may enclose quite considerable areas but must be stable and constructed so as to resist and prevent the entry of water whether they are constructed on a river bed or on land. The first precautionary measure is that they should be constructed and maintained by skilled persons under the control of a competent engineer.

The method of construction of cofferdams and the materials which are used will depend on circumstances. Interlocked sheet steel piles, or steel or timber piles either of single or double construction is used. Where double walls are erected the space between is puddle filled. Bracing across the internal area may be necessary, particularly with single wall structures and in strong running rivers.

Before any water or material can be removed from the area bounded by the cofferdam the piles must be sunk below an impermeable layer to prevent entry of water. If such a layer cannot be found at a convenient depth it may be necessary to sink further piles within the area to support a concrete base, the concrete being deposited in a suitable manner below the water surface.

Sheet piling should be watertight even if it is deflected by earth or water pressure on one side. Water may enter a cofferdam in two ways against which some precautions can be taken. The first is by entry between the sheets and the second by underflow. There should be regular inspections to ensure that conditions remain satisfactory.

Caissons:
These are used instead of cofferdams where the area of a foundation is small in relation to the depth of water at the site. They are retained in position, the caisson being later filled with concrete to form a foundation for a pier.

"Box" type caissons are used where a firm bearing strata which requires no excavation is available. They may be of timber or reinforced concrete construction, with a bottom but no top and are sunk either by weighting or placing the permanent concreting in position.
"Open" type caissons are circular or rectangular in plan made of steel or reinforced concrete with either single or double walls and are openat the top and "bottom. They have cutting edges at the bottom which are forced into the ground "by additional weighting at the top or "by the weight of concrete placed between walls as the earth material is removed from the inside. The depth or height of such a caisson can be increased as it sinks by joining additional sections at the top. When the caisson reaches a bearing strata its lower part is filled with concrete. Much of the work of excavating and concrete placing can be done from above water level; when it is necessary to secure dry conditions for excavation a pneumatic caisson is required.

Qualified people should be responsible for the design and construction of caissons. In pneumatic caissons, the total loads on the structure can be very high and any failure would be disastrous. Precautions in connection with work in compressed air are dealt with in a separate section.

Safety precautions applicable to cofferdams and caissons:
They should be of sound construction, designed by qualified persons and constructed or placed in position by persons with the requisite knowledge and experience.

They should be properly maintained, inspected at least once per day and thoroughly examined at least once per week, immediately after any explosives have been used which may have affected their strength and stability, and after any substantial damage. If any damage is noted which would make it dangerous for people to work in them, they should be prohibited from doing so until the damage has "been rectified. This of course would not apply to persons engaged in any inspection, examination or repair work for whom special precautions should be taken.
As far as it is possible, means should be available for people to reach places of safety in case of flooding.

Safety in use of Dams and Cofferdams

- Every cofferdam or caisson and every part thereof should be of good construction, suitable and of sound material and of adequate strength. It should be properly maintained. Its construction, additions or alteration and dismantling including all work connected therewith should be supervised by a competent person.
- A coffer dam or caisson should, where necessary, be specially secured in position so as to prevent movement in a manner dangerous to persons employed.
- In any coffer dam or caisson, there should be adequate means for persons to reach places of safety in the event of an inrush of water.

a) Inspection and Examination
No person should be employed in a cofferdam or caisson unless it has been inspected once a day by a competent person and after explosives have been used in or near the coffer dam or caisson in a manner likely to affect its strength and stability. Necessary entry to the effect that the cofferdam or the caisson has been inspected should be made in the register prescribed for the purpose.
No person should be employed as under-water diver except for shoulder depths where skilled divers should be employed, unless:

- A sufficient number of competent persons should be employed in attendance upon him as to ensure his safety, and
- There are provided and readily available, in good working order, sufficient and suitable diving plant and equipment, including air pumps, pressure gauges and means of access to and from water and including at least one diving dress in one complete set of woolen clothing in excess of the number of divers under water at any one time and
- Another diver above water provided with suitable equipment and plant is immediately available to the assistance of any diver under water in case of emergency.

b) Tests and Examination of Equipment

- All diving equipment should be initially tested and thoroughly examined by a competent person and thereafter thoroughly examined by him after every three months, and record of such test and examinations entered in a register maintained for the purpose.
- Air pump, airlines and driving helmets should be thoroughly examined for any defect every time before they are put to use.

c) Signaling

In all diving operations, efficient signaling system to enable the diver to be in communication with his attendant should be maintained.

d) Medical Examinations

No person should be employed under water as a diver, unless he has within the previous four days been examined by a project doctor or by certifying surgeon or by a medical officer of the contractor or corporation and certified by him as fit for diving.

CHAPTER 47: SAFETY IN QUARRIES, GRAVEL PITS AND BORROWED AREAS, CONTROL OF DUST, SILICA AND NOXIOUS GASES IN UNDERGROUND WORKS, SAFETY IN GROUTING, GUNITING & SHOTCRETING

AIM:

Quarries are having lot of vehicular movements & material handling activities which can cause injury to the employees in the area. Appropriate PPE's should be used as lot of flying air borne dust particles can be hazardous to health of the people working in the area.

Any construction site or activity is associated with dust & gases especially in underground works. All the employees working in such areas have to protect themselves from any mishap or effect on health. Hence, proper guidance is to be given to avoid any health hazards.

Grouting, guniting& shot creating is an integral part of tunneling activity. Collapse of sides can be disastrous for the employees working in thetunnelling work. Working at height and falling hazards are associated with this activity. Care to be taken that they do not fall & have health hazards.

Legal :

The Building and other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 and Rules, 1998

Chapter VI : GENERAL PROVISIONS
All the rules applicable **(34-54)**
Chapter XIII : Excavation & Tunnelling works
All the rules applicable **(34-54)**

Applicable for Chapter 3: SAFETY IN GROUTING, GUNITING & SHOTCRETING:

Safety in Quarries/Gravel Pits/Barrow Areas etc.

- All quarries should be fenced and signs for warning people of the danger of blasting of otherwise should be prominently posted.
- The rock face of the quarry should be scaled frequently to maintain safe working conditions. Scalars should wear hard hats and safety belts and be securely tied off while at work.
- So far as practicable, a minimum distance of 3 meters should be maintained between workmen unless two or more are required to accomplish the same task. Drillers and other workmen should wear respirators if dry-air drilling methods are used.
- Visitors should not be allowed to enter quarries in operation unless accompanied by a project official or his designated representative.
- Excavating or loading operations on frozen materials (quarrying other than rock) or in material sufficiently compacted to stand in a vertical or nearly vertical banks, are hazardous and require continuous care and alertness to avoid the possibility of being injured or buried by sliding of falling masses of the material.
- There should be no undercutting of banks at any time, and any overhanging banks occurring as a result of slides or caving should removed before beginning excavation operations beneath them. Extreme care should be exercised in the use of trucks and other equipment on or near the rim of the gravel pit, or on terrace or beams.

Chapter: Control of Dust, Silica and Noxious Gases in underground works:

- In every working place where persons are required to work in a confined place, adequate ventilation by the circulation of fresh air should be provided and no person should be allowed to enter any place where there is reason to apprehend that the atmosphere is poisonous or asphyxiating unless the person wears a suitable breathing apparatus and is equipped with life line held by a person stationed for the purpose in safe place.
- When workers are employed in sewers and manholes which are in use, it should be ensured that the manhole covers are opened and ventilated at least for an hour before the workers are allowed to get into manholes and manholes so opened should be cordoned off with suitable railing and provided with warning signals or boards to prevent accidents to the public.
- There should also be provided sufficient and appropriate rescue apparatus including:suitable breathing apparatus
  - suitable reviving apparatus
  - suitable safety belts of sound material and ropes of adequate length and strength
- All such apparatus should be placed in suitable position and they should be readily available. They should be in charge of a competent person conversant with their use and he should be available at all time while any person is working in the confined place. All such equipment should be properly maintained, tested and examined at intervals of not more than one month.

Chapter: Safety in Grouting, guniting & shotcreting:

Usually safety precautions that are taken for concreting in open should be applicable for the concreting of tunnels, shafts and other underground works also.

In addition, the following precautions should be taken where the pumpcrete or pneumatic placer s used:

i. The scaffolding supporting the pipe should be designed to carry the pipe when filled with concrete plus 100 percent overload plus the estimated weight of the maximum number of workmen that may work on the pipes while the pump is operating. A factor of safety of 4 should be used.
ii. The pipeline should be anchored at all curves and near the end. The toggle and flange connections should be inspected before each placement to ensure tight joints.
iii. Air-release valves should be installed at high points to release entrapped air. The use of these valves will assist in preventing line plugging and in turn reduce accident possibilities.
iv. Pipes and hose used to convey grout should be of proper size and strength to safety withstand the maximum operating pressures. Pumps should not be operated at pressures above their rated capacity.
v. Cleaning of pipeline should be carefully done.

Adequate lighting and ventilation should be provided for all galleries and shafts where grouting is in progress.

CHAPTER 48: PREVENTION FROM DROWNING

Aim: To protect the employees from falling in to water and having risk of drowning

Legal :

THE BUILDING AND OTHER CONSTRUCTION WORKERS' (REGULATION OF EMPLOYMENT AND CONDITIONS OF SERVICE) ACT, 1996 AND RULES, 1998

Chapter IX: WORK ON OR ADJACENT TO WATER
All the rules applicable (86-87)

Ensure at a construction site of building or other construction work that where, on or adjacent to the workplace of any construction site to which these rules apply, there is water into which a building worker employed for work on such site is, in the course of his employment, may fall and has the risk of drowning.

Suitable rescue equipment is provided and kept in an efficient state for ready use and measures are taken to arrange for the prompt rescue of such building worker from the danger of drowning and where there is a special risk of such fall from the edge of adjacent land or from a structure adjacent to or above the water or from floating stage on such water, secure fencing is provided near the edge of such land, structure or floating stage, as the case may be, to prevent such fall and such fencing may be removed or allowed to remain un-erected for the time and to the extent necessary for the access of building workers to such work or the movement of material for such work.

- Employees working over or near water, where the danger of drowning exists, shall be provided with approved life jacket or buoyant work vests.
- Prior to and after each use, the buoyant work vests or life preservers shall be inspected for defects which would alter their strength or buoyancy. Defective units shall not be used.
- Ring buoys with at least 90 feet of line shall be provided and readily available for emergency rescue operations. Distance between ring buoys shall not exceed 200 feet.
- At least one lifesaving skiff shall be immediately available at locations where employees are working over or adjacent to water.
- Training is to imparted regularly to all the employees for rendering CPR (Cardio Pulmonary Resuscitation) and appropriate use of life saving equipments.
- Mock drill should be conducted regularly to impart training to the employees.

CHAPTER 49: SAFETY AGAINST EARTHQUAKES / GEOLOGICAL SURPRISES, SAFETY AGAINST FLOODING AND FLASH FLOODING

AIM:
Nature is beautiful, but times it surprises us and affects us in a big way when natural calamities like earthquake, floods etc occur which are uncontrollable & converts into disaster in a short time. But, one has to prepare against all the odds & protect oneself if in such a situation & be safe.

Legal :

THE BUILDING AND OTHER CONSTRUCTION WORKERS' (REGULATION OF EMPLOYMENT AND CONDITIONS OF SERVICE) ACT, 1996 AND RULES, 1998

Chapter VI : GENERAL PROVISIONS
All the rules applicable **(34-54)**

In the event of an earthquake, it is important not to create panic and deal effectively with the situation by taking or adopting following general precautions:

Secure easily toppled items so that they do not fall over. Do not place heavy, pointed or hard objects on high shelves loosely in the workplace.

After an earthquake, report your whereabouts to the various designated contact people.

Make it a habit to keep flammable objects away from furnaces, fireplaces, and gas-run appliances. Fire is the most destructive result of an earthquake.

If an earthquake occurs at workplace, Extinguish all sources of fire. Turn off the main gas valve, all electric lights and appliances, and locate emergency supplies. Disconnect all electrical appliances.

Put on shoes to protect your feet from broken glass, etc. and secure an escape.

Get under a table or desk to avoid falling objects. Areas that have many pillars are free of heavy objects that may be apt to fall, and the areas beneath strong furniture, etc. are relatively safe. In the case of a two-story building the second floor is often safer as the ground floor may be destroyed.

Wear a helmet or quilted hood that will protect the head.

Place a cloth (preferably wet) across the nose and mouth to prevent smoke or dust inhalation.

Do not use elevators. Use only emergency stair case.

Watch out for glass, signs, or other falling objects.

Stay away from concrete block fences or automatic vending machines that could fall over.

Eventually, leave the work place and take refuge in a safe area. Even though the first large shock has ceased, aftershocks may continue for a considerable time. Therefore, do not attempt to return to workplace right away. It is important to know what the actual situation is in order to avoid further disaster.

If driving, pull over to the side of the road. If evacuating, do so on foot, leaving the key in the ignition. Do not attempt to drive during or after a severe earthquake.
Follow any other precaution which the situation demands.

SAFETY PRECAUTIONS AGAINST FLOOD
In the event of a flood, general precautions that need to be followed include

Before the Flood

- Learn to recognize environmental clues such as heavy rains, topography and flood history of the region.
- Know your elevation above flood stage and the history regarding flooding of your location.
- Keep on hand a battery-operated flashlight while mining or tunnelling operations.
- Have a prior knowledge of the evacuation routes.

During the Flood

- Avoid areas subject to sudden flooding.
- Do not attempt to cross a stream where water is above your knees. When in doubt, don't try it.
- Do not try to drive over a flooded road. The water can be much deeper than it appears and you could be stranded or trapped.
- Stay away from drains and ditches.

After the Flood

- Do not enter into the flood water; let the Security Officials take appropriate measures to pump out the flood water.
- Do not eat fresh food that has come in contact with flood waters.
- Boil drinking water before using.
- Report broken gas, electrical and water lines immediately to the Security Staff.
- Do not handle electrical equipment in wet areas.
- Submerged gas control valves, circuit breakers, and fuses pose explosion and fire hazards, and should be replaced as the water subsides.
- If your workplace has been flooded do not attempt to turn the power back on, have all wiring inspected by the security staff.

CHAPTER 50: SAFETY IN WHILE WORKING IN GASSY TUNNELS

AIM:

While working in tunnels employees may come in contact with poisonous gases like methane. How to avoid contact of gassy atmosphere in the tunnel & work safely to avoid incidents is the most important aspect of safe working for employees.

Legal :

The Building and Other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 And Rules, 1998

Chapter XIII : EXCAVATION & TUNNELLING
All the rules applicable (**119-168)**
Tunnels are classified as Gassy, Potential Gassy or Non gassy.
Sandstone can have small isolated pockets of methane gas so tunnels can be potential gassy.
Equipment and electrical have to be approved for potential gassy

Potentially Gassy Operations

Potentially gassy operations occur under either of the following circumstances:

- When air monitoring shows, for more than a 24-hour period, 10 percent or more of the lower explosive limit (LEL) for methane or other flammable gases measured at 12 inches 10.25 inch from the roof, face, floor, or walls in any underground work area; or
- When the geological formation or history of the area shows that 10 percent or more of the LEL for methane or other flammable gases is likely to be encountered in the underground operation.

Gassy Operations

Gassy operations occur under the following conditions:

- When air monitoring shows, for 3 consecutive days, 10 percent or more of the LEL for methane or other flammable gases measured at 12 inches, 10.25 inch from the roof, face, floor, or walls in any underground work area; or
- When methane or other flammable gases mandating from the strata have ignited, indicating the presence of such gases; or
- When the underground operation is connected to a currently gassy underground work area and is subject to a continuous course of air containing a flammable gas concentration.

When a gassy operation exists, additional safety precautions are required. These include using more stringent ventilation requirements; using diesel equipment only if it is approved for use in gassy operations; posting each entrance with warning signs, prohibiting smoking and personal sources of ignition, maintaining a fire watch when hot work is performed, and suspending all operations in the affected area until all special requirements are met or the operation is declassified. Additional air monitoring is also required during gassy conditions.

Air Monitoring

It is required to assign a competent person to perform all air monitoring required to determine proper ventilation and quantitative measurements of potentially hazardous gases. In instances where monitoring of airborne contaminants is required to be conducted "as often as necessary," this individual is responsible for determining which substances to monitor and how frequently, taking into consideration factors such as jobsite location, geology, history, work practices, and conditions.

The atmosphere in all underground areas shall be tested quantitatively for carbon monoxide, nitrogen dioxide, hydrogen sulfide, and other toxic gases, dusts, vapors, mists, and fumes as often as necessary to ensure that prescribed limits are met. Quantitative tests for methane shall also be performed in order to determine whether an operation is gassy or potentially gassy.

A record of all air quality tests (including location, date, time, substances, and amount monitored) is to be kept aboveground at the worksite and shall be made available upon request.

Oxygen

Testing is to be performed as often as necessary to assure that the atmosphere at normal atmospheric pressure contains at least 19.5 percent oxygen, but not more than 22 percent.

Hydrogen Sulfide

When air monitoring indicates the presence of 5 parts per million (ppm) or more of hydrogen sulfide, testing is to be conducted in the affected area at the beginning and midpoint of each shift until the concentration of hydrogen sulfide has been less than 5 ppm for 3 consecutive days. Continuous monitoring shall be performed when hydrogen sulfide is present above 10 ppm. Employees must be notified when the concentration of hydrogen sulfide is above 10 ppm. At concentrations of 20 ppm, an alarm (visual and aural) must signal to indicate that additional measures might be required (e.g., respirators, increased ventilation, evacuation) to maintain the proper exposure levels.

Other Precautions

When the competent person determines that there are contaminants present that are dangerous to life, the employer must post notices of the condition at all entrances to underground work areas and must ensure that the necessary precautions are taken.

In cases were 5 percent or more of the LEL for these gases is present, steps must be taken to increase ventilation air volume to reduce the concentration to less than 5 percent of the LEL (except when operating under gassy/potentially gassy requirements).

When 10 percent or more of the LEL for methane or other flammable gases is detected where welding, cutting, or other 'hot' work is being performed, work shall be suspended until the concentration is reduced to less than 10 percent of the LEL.

Where there is a concentration of 20 percent or more LEL, all employees shall be

immediately withdrawn to a safe location aboveground, except those necessary to eliminate the hazard, and electrical power, except for acceptable pumping and ventilating equipment, shall be cut off to the endangered area until the concentration of the gas is less than 20 percent of the LEL.

Potentially gassy and gassy operations require additional air monitoring. These include testing for oxygen in the affected work areas; using flammable gas monitoring equipment (continuous automatic when using rapid excavation machines; manual as needed to monitor prescribed limits); performing local gas tests prior to doing, and continuously during, any hot work; testing continuously for flammable gas when employees are working underground using drill and blast methods and prior to reentry after blasting.

Ventilation

There are a number of requirements for ventilation in underground construction activities. In general, fresh air must be supplied to all underground work areas in sufficient amounts to prevent any dangerous or harmful accumulation of dusts, fumes, mists, vapors, or gases. A minimum of 200 cubic feet of fresh air per minute is to be supplied for each employee underground. Mechanical ventilation, with reversible airflow, is to be provided in all of these work areas, except where natural ventilation is demonstrably sufficient. Where blasting or drilling is performed or other types of work operations that may cause harmful amounts of dust, fumes, vapors, etc., the velocity of airflow must be at least 30 feet per minute.

For gassy or potentially gassy operations, ventilation systems must meet additional requirements. Ventilation systems used during gassy operations also must have controls located aboveground for reversing airflow.

Fire Prevention and Control

In addition to "Fire Protection and Prevention", open flames and fires are prohibited in all underground construction activities, except for hot work operations. Post signs prohibiting smoking and open flames where these hazards exist. Various work practices are also identified as preventive measures. For example, there are limitations on the piping of diesel fuel from the surface to an underground location. Also, the pipe or hose system used to transfer fuel from the surface to the storage tank must remain empty except when transferring the fuel. Gasoline is not to be used, stored, or carried underground. Gasses such as acetylene, liquefied petroleum, and methylacetylenepropadiene (stabilized) may be used underground only for hot work operations. Leaks and spills of flammable or combustible fluids must be cleaned up immediately. Work also requires fire prevention measures regarding fire-resistant barriers, fire-resistant hydraulic fluids, the location and storage of combustible materials near openings or access to underground operations, electrical installations underground, lighting fixtures, fire extinguishers, etc.

Hot Work

During hot work operations such as welding, noncombustible barriers must be installed below work being performed in or over a shaft or raise. As mentioned earlier, during these operations, only the amount of fuel gas and oxygen cylinders necessary to perform welding, cutting or other hot work over the next 24-hour period shall be kept underground. When work is completed, gas and oxygen cylinders shall be removed.

Emergencies

At work sites where 25 or more employees work underground at one time, employers are required to provide rescue teams or rescue services, that include at least two 5-person teams (one on the jobsite or within one-half hour travel time and one within 2 hours travel time). Where there are fewer than 25 employees underground at one time, the employer shall provide or make available in advance one 5-person rescue time on site or within one-half hour travel time.

Rescue team members have to be qualified in rescue procedures and in the use of firefighting equipment and breathing apparatus. Their qualifications must be reviewed annually.

The employer must ensure that rescue teams are familiar with the jobsite conditions. Rescue team members are required to practice donning and using self-contained breathing apparatus on a monthly basis for jobsites where flammable or noxious gases are encountered or anticipated in hazardous quantities.

As part of emergency procedures, the employer shall provide self rescuers to be immediately available to all employees at underground work stations who might be trapped by smoke or gas. The selection, use, and care of respirators shall be in accordance with Mining standards.

A "designated," or authorized, person shall be responsible for securing immediate aid for workers and for keeping an accurate count of employees underground. Emergency lighting, a portable hand or cap lamp, shall be provided to all underground workers in their work areas to provide adequate light for escape.

RECORDKEEPING

Records of exposure to toxic substances and data analyses based on these records are to be kept for 30 years. Medical records are to be kept for at least the duration of employment plus 30 years. Background data for exposure records such as laboratory reports and work sheets need to be kept only for 1 year. Records of employees who have worked for less than 1 year need not be retained after employment, but the employer must provide these records to the employee upon termination of employment. First-aid records of one-time treatment need not be retained for any specified period.

Three months before disposing of records, employers must notify the Director of Industrial Safety & health. (DISH)

CHAPTER 51: SAFETY WHILE WORKING IN DIFFERENT ELEVATIONS OR LOCATIONS IN HILLY AREAS, SAFETY WHILE WORKING IN RAINY AND FOGGY ENVIRONMENT

AIM:

Accident statistics prove that there is an increased risk of personal injury during rainy and foggy environment and it only adds to if the construction site is on hilly areas.

Additional hazards of rainy & foggy working are introduced by:

a) reduced daylight hours
b) rain/snow/fog/ice

Legal :

The Building and Other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 And Rules, 1998

Chapter VI : GENERAL PROVISIONS
All the rules applicable **(34-54)**

Preparations for working in rainy and foggy condition should be made by checking:

- Lighting
- Heating
- Vehicles and mobile plant
- Supply of road salt/grit
- Snow/ice clearing equipment
- Personal Protective Equipment (PPE)
- Advance weather forecasts are important
- If adverse weather is predicted some simple precautions can be made in advance.

LIGHTING

- Particular attention should be paid to lighting requirements for staircases, pedestrian walkways, access roads, loading areas, plant yards, car parks etc. at the construction site. Illumination levels reduce drastically during foggy conditions and if it is on hilly location the visibility during the day is also reduced.
- Torches should be used if necessary

SNOW/FROST/ICE

- Car parks, access roads and pedestrian walkways should be kept clear as practicable
- A suitable supply of rock salt/grit should be maintained on site and persons designated to take responsibility for snow/ice clearing duties
- Site personnel should report any areas requiring attention to management without delay

MOBILE PLANT

- Ensure access steps are clear of ice and snow before attempting to get on or off your machine
- When getting off your machine check the ground you are going to step onto is not icy
- At the start of your shift ensure the windscreen wash bottle is full and check at break-times

- Ensure that the concentration of washer fluid is sufficient as not to freeze during the shift
- Ensure there is a plentiful supply of de-icer on site
- Check the condition of the windscreen wiper blades to ensure they do not smear the windscreen when operating
- Ensure all lights and cameras if installed are clean and maintained.
- Check condition of tyres, especially for under inflation

(Cold overnight temperatures result in lower tyre pressures at the beginning of a morning shift.

Where tyres have been fitted with an inner tube, the air that is sometimes trapped between the tyre and the inner tube can reduce pressure to such an extent that the beading between the wheel and tyre can become detached when the wheel turns)

- Low sunlight can also be a problem – if you have difficulty seeing put on your headlights so others can see you!
- Wear eyewear or fit suitable sun blinds on windscreens of vehicles

During periods of poor visibility (e.g. fog):

- Consider suspension of operations during extreme periods of poor visibility
- Use headlights at the first sign of reduced visibility (many companies now insist that headlights are switched on at all times when a vehicle is moving)
- Provide road markers at the side of haul routes to delineate Roadways
- If you become lost in fog, STOP and radio for assistance - don't assume you think you know where you are
- Oils will be thicker during cold temperatures so allow your vehicle extra time to warm up before moving off to allow complete circulation of the oil through the engine/hydraulics
- Drivers should ensure there is adequate vision before moving off – i.e. defrost windscreens, clean lights etc.
- Vehicles should always be driven according to the prevailing ground, visibility and weather conditions
- Allow extra distance for braking under wet or icy conditions

Note: It takes <u>double</u> the distance to pull up in wet conditions and up to <u>TEN</u> times the distance in icy conditions

PERSONAL PROTECTION

- Appropriate footwear for the conditions should be worn at all times
- It is even more important during hours of darkness or reduced visibility to wear reflective jackets or waistcoats that are reasonably clean
- Persons working outside should wrap up warmly. Several layers of clothing are more effective than a single heavy layer. However, it is important that any additional clothing does not obscure high visibility waistcoats or jackets
- Do not be tempted to take shortcuts – keep to designated pedestrian routes and report if these need gritting
- Additional care should be taken when working near lagoons or watercourses in slippery conditions
- Make use of fog lights to increase visibility

- Leave your headlamps on low beam when driving in snow or fog.
- If visibility becomes poor, find a place to safely pull off the road as soon as possible.

Have on hand, especially in an emergency:

- Snow shovel.
- Scraper with a brush on one end.
- Tow chain or strap.
- Warning device (flares or reflective triangles).
- Brightly colored cloth to signal for help.
- Flashlight (with extra batteries)
- Compass, Warning light or road flares, Booster cables
- First Aid Kit

CHAPTER 52: PREVENTIVE MEASURES AGAINST LANDSLIDES

AIM:

Landslides are a natural calamity , but at times due to improper excavations landslides or rather movement of soil result in landslides. Proper technical methods are to be employed for the employees safety so as to avoid confrontation of landslides.

Legal :

THE BUILDING AND OTHER CONSTRUCTION WORKERS' (REGULATION OF EMPLOYMENT AND CONDITIONS OF SERVICE) ACT, 1996 AND RULES, 1998
Chapter VI : GENERAL PROVISIONS
All the rules applicable **(34-54)**

Preventive measures against landslides.

Definition:
A landslide is a catastrophic event, where a block of earthen mass slides downhill which occurs along steep slopes of hills or mountains and may be sudden or slow. It causes immense loss of life & damage to the nature & property.
Although a basic understanding of the landslides is available, system that predicts the occurrence of a landslide do NOT exist.

- Preventative measures
- The main factors which contribute to landslides are *Slope, water content, geological structure, unconsolidated or loose sediments and human interference.*
- *Slope:* Retaining wall may be constructed against the slopes, which can prevent rolling down of material. Terracing of the slope is an effective measure.
- *Effect of water:* Make proper drainage network for quick removal of percolating moisture or rain water by constructing ditches and water ways along the slope
- *Geological structures:* Weak planes or zones may covered or grouted to prevent percolation of water, this increases the compaction of loose material.
- Plant ground cover on slopes and build retaining walls.
- In mudflow areas, build channels or deflection walls to direct the flow around buildings.
- Install flexible pipe fittings to avoid gas or water leaks.
  - Terraces
  - Planting fast growing grasses and shrubs
  - Sloping "sheds" or tunnels
  - Building roads in low landslide risk areas
- Radio-transmitted, real-time monitoring of areas that are prone to landslides
  - Especially places where roads might be affected
- Bedrock "stitching"
  - Basically drilling holes into bedrock and reinforcing with concrete and steel cable
- Education& mock drills to be imparted to the employees to create awareness.

CHAPTER 53: SAFETY OF STRUCTURES AND BUILDING

AIM:

During construction activity many structures are built which are temporary and are dismantled once the activity is completed.
Construction of Structural Frame work & formwork, scaffolding etc. are associated while the construction activity is in progress. These structures should be safe & stable so as to ensure safety of the employees working on such sites.
Collapse of scaffold leads to falls from height, severe injury and at times fatality of employees working on site.
Erection or dismantling of steel or prefabricated structures is an activity which can cause severe injury to the employees working at site.
During demolition also safety of the structure has to be taken into consideration or else the demolition activity can be very hazardous.

Legal :

THE BUILDING AND OTHER CONSTRUCTION WORKERS' (REGULATION OF EMPLOYMENT AND CONDITIONS OF SERVICE) ACT, 1996 AND RULES, 1998
Chapter VI : GENERAL PROVISIONS
All the rules applicable **(34-54)**

Rule 49 – Stability of structures.
Chapter XVII : STRUCTURAL FRAME NAAD FORMWORK
All the rules applicable **(181-185)**
Chapter XII : DEMOLITION
All the rules applicable **(108-118)**
Chapter XIX : SCAFFOLD
All the rules applicable **(189-205)**

Inherent safety while and during the construction activity and after completion of the structure is of great concern.
Material used for construction, design, soil conditions, wind direction and weather are responsible for the overall safety of the structure or the building constructed. Due to design fault or change in earth crust where the structure is standing is responsible for the collapse of the structure.
Standards and quality have to be maintained & monitored regularly. Post construction regular inspection and monitoring help in enhancing and ensuring safety of the structure.
Due to ageing post construction maintenance has to be carried out. This has to be done by regularly conducting structural audits from competent persons from time to time.
It is expected that the material and equipments used conform to the Indian standards which are being used at the construction site.
Fire safety is of utmost important for any structure or building. Electrical equipments& temporary connections cause massive fire incidents at construction site.
During demolition activity at times explosives are used which have to be handled safely. If the demolition planning goes wrong it can become disastrous**.**
Access & egress system has to be well designed so as to have ease of access during emergency.

CHAPTER 54: GUARDING OF HYDRAULIC WORKS AND MECHANICAL EQUIPMENTS

Aim :

Safeguarding is the first line of defence in ensuring the safety of workers operating and maintaining powered machinery and equipment. To avoid injury while working on equipments guarding & appropriate use of guards is a must by the employees. Bypassing guards while at work is an invitation to accidents and injuries to the operators.

Legal :

THE BUILDING AND OTHER CONSTRUCTION WORKERS' (REGULATION OF EMPLOYMENT AND CONDITIONS OF SERVICE) ACT, 1996 AND RULES, 1998
Chapter VI : GENERAL PROVISIONS
All the rules applicable **(34-54)**
RULE: 37- Fencing of Motors

Dangerous moving parts in these basic areas require safeguarding:

- Point of operation
- In running nip points
- Pinch points
- Power transmission
- Other moving parts

A "guard" prevents entry into the danger area.
There are four types of machine guards:

- Fixed
- Interlocked
- Adjustable
- Self-adjusting

An effective guard must:

1. **Prevent contact:** The safeguard must prevent hands, arms, or any part of a worker's body or clothing from making contact with dangerous moving parts. A good safeguarding system eliminates the possibility of the operator or other workers placing any part of their bodies near hazardous moving parts.
2. **Secured & well-constructed:** Workers should not be able to easily remove or tamper with the safeguard, because a safeguard that can easily be made ineffective is no safeguard at all. They must be firmly secured to the machine. Guards should be made of durable material that will withstand the conditions of normal use. They may be constructed of sheet metal, screen, wire cloth, bars, plastic, or any other material that is substantial enough to withstand whatever impact it may receive and to endure prolonged use.
3. **Protect from falling objects/contain the hazard:** The safeguard should ensure that no objects can fall into moving parts. A small tool which is dropped into a cycling machine could easily become a projectile that could strike and injure someone.
4. **Create no new hazards:** A safeguard defeats its own purpose if it creates a hazard of its own such as a shear point, a jagged edge, or an unfinished surface which can cause a laceration or creates a pinch point between the guard and moving machine

parts. The edges of guards, for instance, should be rolled or bolted in such a way that they eliminate sharp edges.

5. **Create no interference:** Any safeguard which impedes a worker from performing the job quickly and comfortably might soon be overridden or disregarded. Proper safeguarding can actually enhance efficiency since it can relieve the worker's apprehensions about injury.
6. **Allow safe lubrication:** If possible, one should be able to lubricate the machine without removing the safeguards. Locating oil reservoirs outside the guard, with a line leading to the lubrication point, will reduce the need for the operator or maintenance worker to enter the hazardous area.

Types of Mechanical motions

Basically there are three motions:

1. Rotary
2. Reciprocating
3. Combination of two

All three can produce crushing and shearing action.

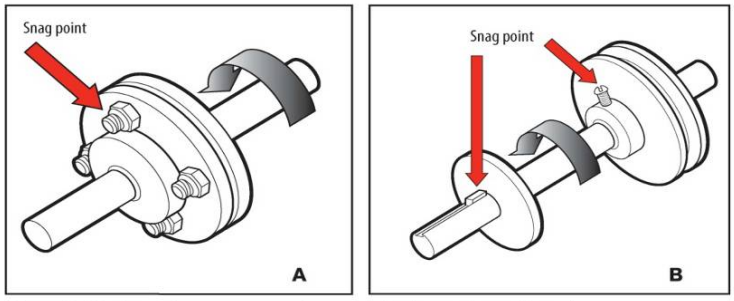


Figure 1.1. Single rotating parts presenting a snagging/entanglement hazard.
(A) Snagging hazard from projecting flange bolts on rotating coupling.
(B) Snagging hazard from projecting keyway and set screw on rotating shaft.

Figure 1.1 Single rotating parts presenting a snagging/entanglement hazard.

a) Snagging hazard from projecting flange bolts on rotating coupling.
b) Snagging hazard from projecting keyway and set crew on rotating shaft.

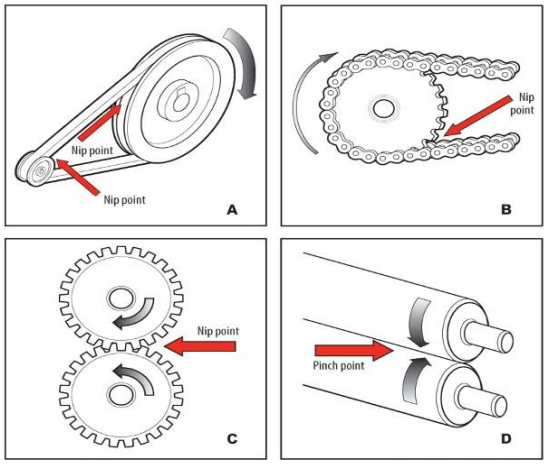
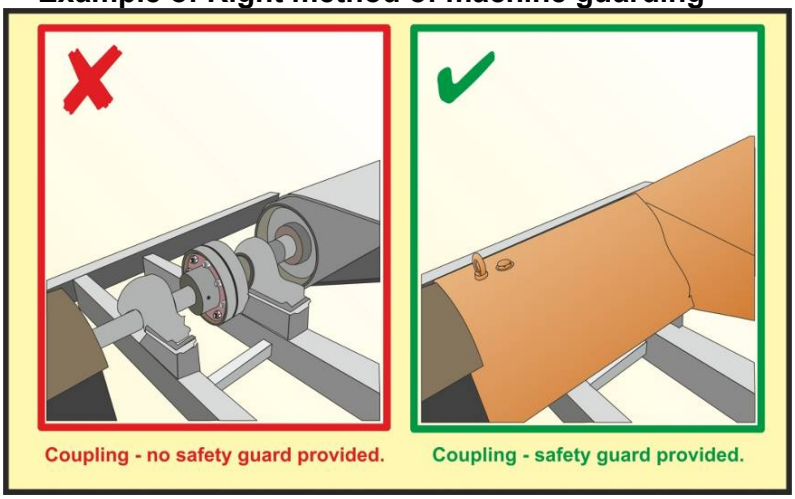


Figure 1.2. Multiple rotating parts presenting an in-running nip point hazard. (A) V-belt and pulley drive: a common source of in-running nip points on powered industrial machinery. (B) Typical chain-sprocket drive. (C) Typical exposed gears. (D) Typical feed rolls.

Example of Right method of machine guarding



Basics of Machine Safeguarding

The Point of Operation

The point of operation is that point where work is performed on the material, such as cutting, shaping, boring or forming of stock.

Power Transmission Apparatus

Power transmission apparatus are all components of the mechanical system that transmit energy to the part of the machine performing the work. These components include flywheels, pulleys, belts, connecting rods, couplings, cams, spindles, chains, cranks and gears.

Other Moving Parts

Other moving parts include all parts of the machine that move while the machine is working. These can be reciprocating, rotating and transverse moving parts, as well as feed mechanisms and auxiliary parts of the machine.

Figure 1.2 Multiple rotating parts presenting an in-running nip point hazard.

(a) V-belt and pulley drive: a common source of in-running nip points on powered industrial machinery.
(b) Typical chain-sprocket drive.
(c) Typical exposed gears.
(d) Typical feed rolls.

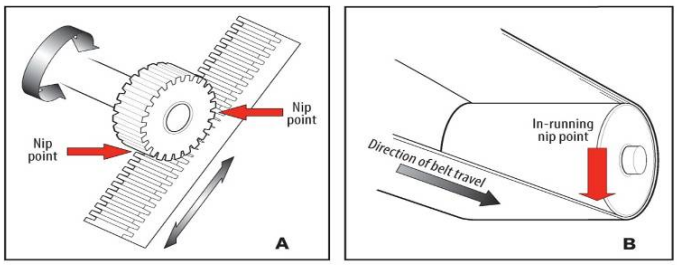


Figure 1.3. Combination of rotating and sliding parts and reversing parts, creating two in-running nip point hazards. (A) Rack and pinion gears. (B) Conveyor belt spool.

Figure 1.3 Combination of rotating and sliding parts and reversing parts, creating two in-running nip point hazards.

a) Rack and pinion gears.

b) Conveyor belt spool.

Mechanical hazards & Effects

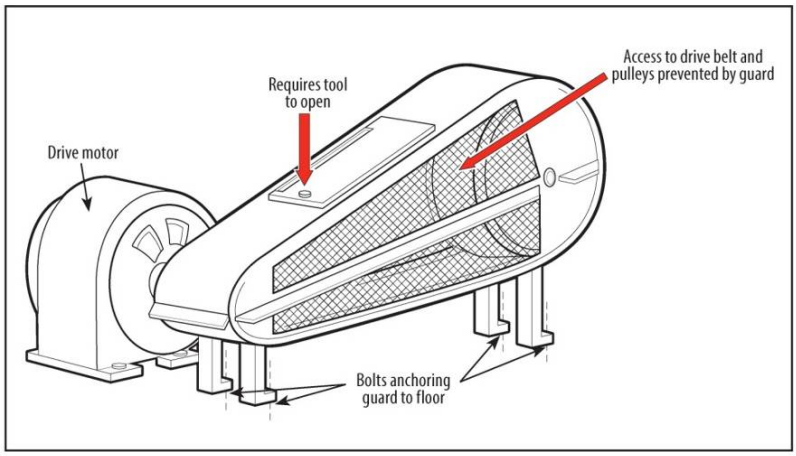
A good way to recognize mechanical hazards is to observe how the moving parts of a machine operate and how parts of a worker's body are likely to come into harmful contact with them.

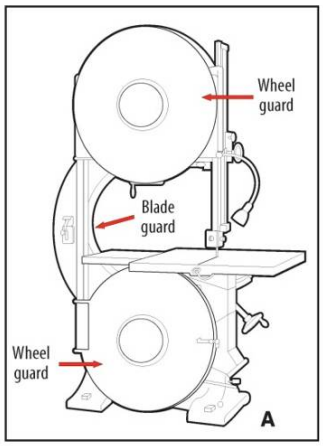
Machine parts generally move in one of three ways: they rotate, they slide, or they can rupture, fragment, and/or eject.

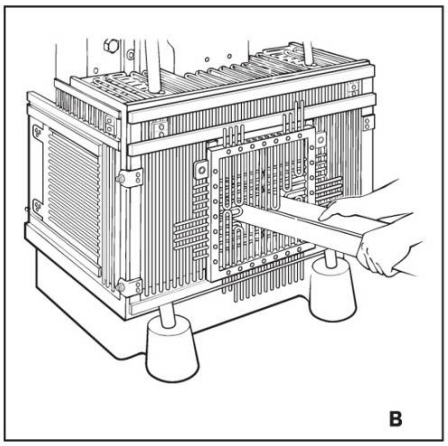
Single rotating parts, such as shafts or couplings, present a risk of snagging or entanglement. Two or more parts rotating together, such as feed rolls and V-belt and pulley drives, create nip points (see Figures 1.1 and 1.2). Parts that slide or reciprocate, such as dies in punch presses, create shearing or crushing hazards. Parts that can rupture or fragment, such as an abrasive wheel, may cause impact injuries.

Classification of Guards

Barrier guards







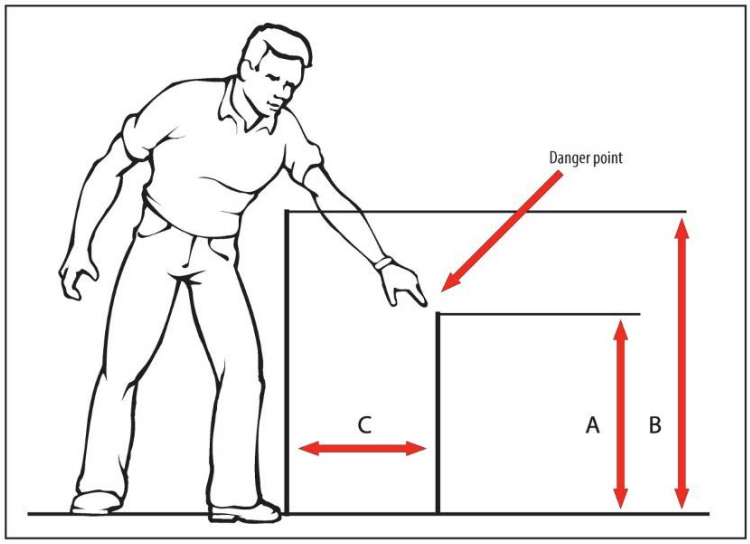


Figure 3.6. Factors to consider in designing a protective barrier: **A** = height of the danger zone, **B** = height of the protective barrier, **C** = horizontal distance to the danger zone.

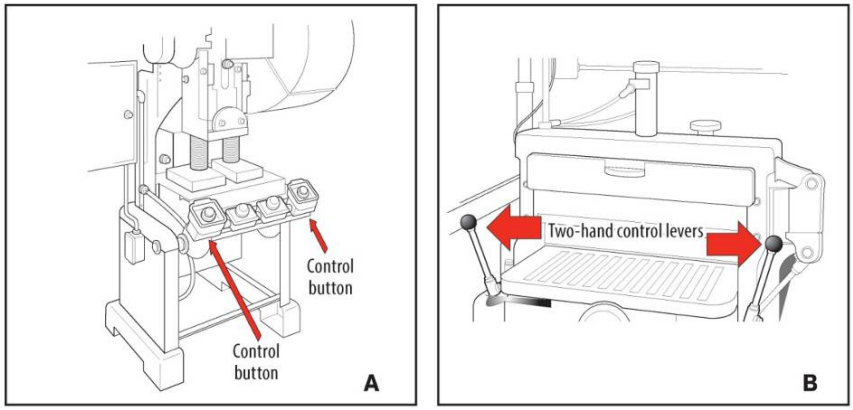


Figure 3.7. Two-hand controls. (A) Two-hand controls – power press. The press will not cycle unless both run buttons are activated using both hands within a certain time period of each other. (B) Two-hand control levers – paper guillotine shear. The shear will not cycle unless both levers are activated, which requires the use of both hands within a certain time period of each other.

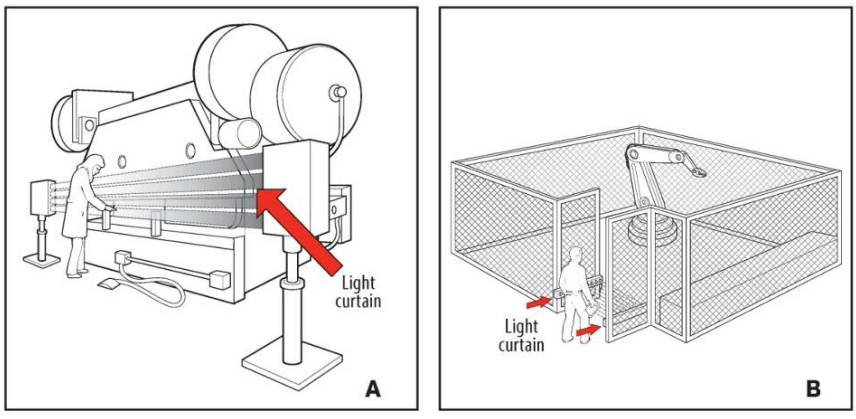


Figure 3.8. Light curtain or similar photoelectric sensing device. (A) Light curtain – brake press. The press is operated in the normal manner using the foot control. It will stop if hands enter the light beam-protected zone. (B) Light curtain – access to robotic cell. The robot is deactivated if a person enters the doorway protected by a light curtain safeguarding device.

The main purpose of a risk assessment is to decide which machine should be given priority, and which parts of the machine should be safeguarded first.

Machine Risk Assessment Survey				
Company Name	**Date of Survey**	**Survey done by:** 1. 2. 3.		
Machine Name	**Machine Function**			
Identify and describe *every* hazardous machine motion or harmful condition to which the worker's body parts are exposed (e.g., rotating shafts, in-running nip points, shearing parts, reciprocating parts, punching action, impact hazards, flying debris, abrasive surfaces, electrical hazards, hot/toxic fluids, vapours, emissions, radiation). Be as descriptive and detailed as possible.	**Describe the worst injury that would reasonably occur due to each hazard.** Use the following descriptions as a guide: • **Fatal** • **Major** (normally irreversible: permanent spinal damage, loss of sight, amputation/crushing, respiratory damage) • **Serious** (normally reversible: loss of consciousness, burns, fractures) • **Minor** (bruising, cuts, light abrasions)	**Estimated severity of injury:** Minor = 1 Serious = 5 Major = 7 Fatal = 10	**Estimated likelihood of injury** (see Note 1): Unlikely = 1 Possible = 5 Probable = 7 Certain = 10	**Estimated level of risk** (see Note 2): Estimated severity × estimated likelihood
1.				
2.				
3.				
4.				

Note: Gathering this information may require repeated observations, especially when determining what the worker does when normal production flow is interrupted.

Recommended safeguarding to eliminate or reduce the risk to an acceptable level	
1.	3.
2.	4.

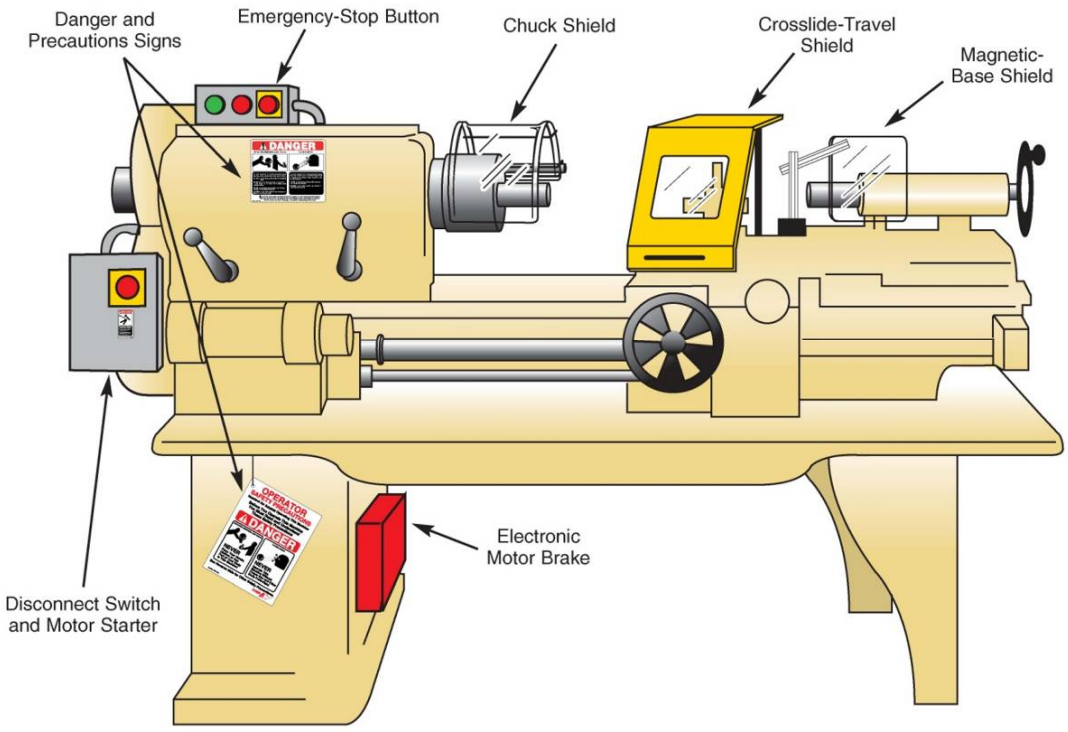
Note 1. The following factors may be useful when estimating the likelihood of injury:

- Machine cycle speed
- Hand feeding with foot control
- Operator training and experience
- Boredom factor (repetition)
- History of jams and misfeeds resulting in frequent access to danger areas of the machine
- Previous injuries on this machine or machines of this type

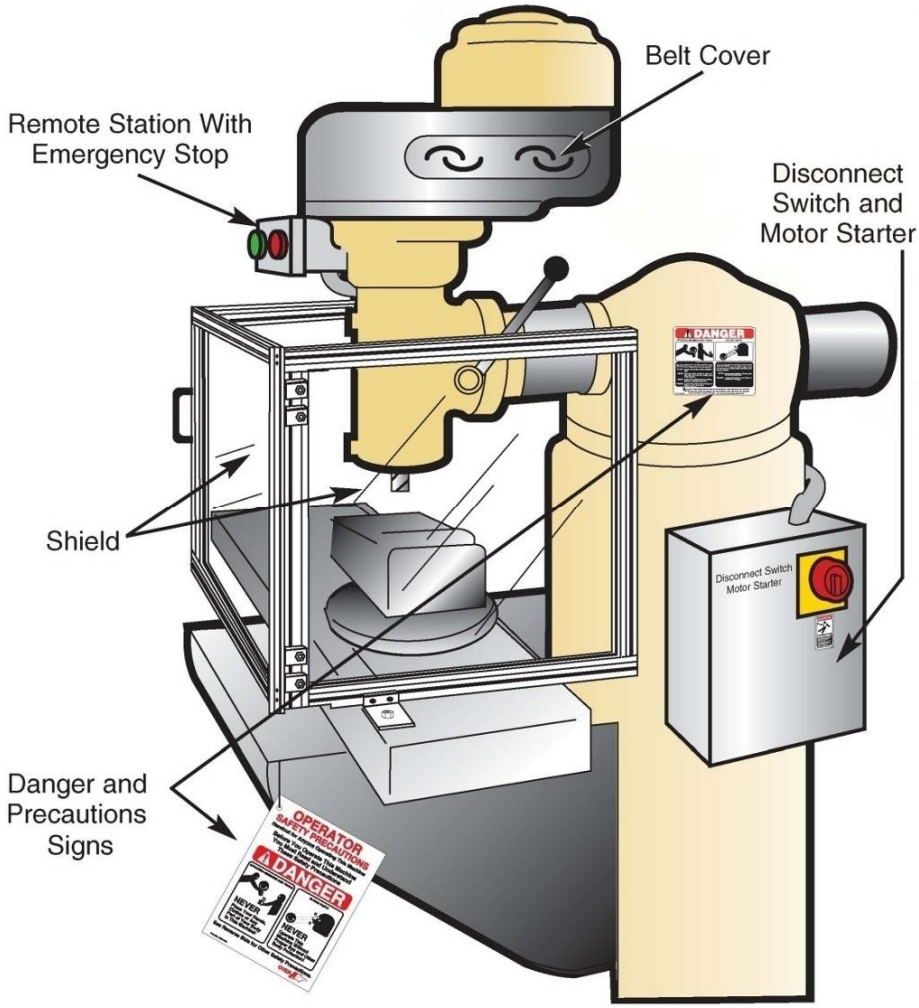
Note 2. Use the estimated level of risk to set the priority for implementing safeguarding measures. The higher the estimated level of risk, the more urgent it is to implement safeguarding solutions.

Note 3. Always follow the hierarchy of safeguarding controls regardless of the perceived level of risk.

SAFEGUARDED LATHE



SAFEGUARDED MILL



Checklist for Machine Guarding

Answers to the following questions should help the interested reader to determine the safeguarding needs of his or her own workplace, by drawing attention to hazardous conditions or practices requiring correction.

Yes No

Requirements for All Safeguards

1. Do the safeguards provided meet the minimum legal requirements? □□
2. Do the safeguards prevent workers' hands, arms and other body parts from making contact with dangerous moving parts? □□
3. Are the safeguards firmly secured and not easily removable? □□
4. Do the safeguards ensure that no objects will fall into the moving parts? □□
5. Do the safeguards permit safe, comfortable and relatively easy operation of the machine? □□
6. Can the machine be oiled without removing the safeguard? □□
7. Is there a system for shutting down the machinery before safeguards are removed? □□
8. Can the existing safeguards be improved? □□

Mechanical Hazards

The point of operation:

1. Is there a point-of-operation safeguard provided for the machine? □□
2. Does it keep the operator's hands, fingers and body out of the danger area? □□
3. Is there evidence that the safeguards have been tampered with or removed? □□
4. Could you suggest a more practical, effective safeguard? □□
5. Could changes be made on the machine to eliminate the point-of-operation hazard entirely? □□

Power transmission apparatus:

1. Are there any unguarded gears, sprockets, pulleys or fly-wheels on the apparatus? □□
2. Are there any exposed belts or chain drives? □□
3. Are there any exposed set screws, key ways or collars? □□
4. Are starting and stopping controls within easy reach of the operator? □□
5. If there is more than one operator, are separate controls provided? □□

Other moving parts:

1. Are safeguards provided for all hazardous moving parts of the machine, including auxiliary parts? □□

Non-mechanical Hazards

1. Have appropriate measures been taken to safeguard workers against noise hazards? □□
2. Have special guards, enclosures or personal protective equipment been provided, where necessary, to protect workers from exposure to harmful substances used in machine operation? □□

Electrical Hazards

1. Is the machine installed in accordance with National Fire Protection Association and National Electrical Code requirements? □□
2. Are there loose conduit fittings? □□
3. Is the machine properly grounded? □□
4. Is the power supply correctly fused and protected? □□
5. Do workers occasionally receive minor shocks while operating any of the machines? □□

Training

1. Do operators and maintenance workers have the necessary training in how to use the safeguards and why? □□
2. Have operators and maintenance workers been trained in where the safeguards are located, how they provide protection, and what hazards they protect against? □□
3. Have operators and maintenance workers been trained in how and under what circumstances guards can be removed? □□
4. Have workers been trained in the procedures to follow if they notice guards that are damaged, missing or inadequate? □□

Protective Equipment and Proper Clothing

1. Is protective equipment required? □□
2. If protective equipment is required, is it appropriate for the job, in good condition, kept clean and sanitary, and stored carefully when not in use? □□
3. Is the operator dressed safely for the job (that is, no loose-fitting clothing or jewellery)? □□

Machinery Maintenance and Repair

1. Have maintenance workers received up-to-date instruction on the machinery they service? □□
2. Do maintenance workers lock out the machine from its power sources before beginning repairs? □□
3. Where several maintenance persons work on the same machine, are multiple lockout devices used? □□
4. Do maintenance persons use appropriate and safe equipment in their repair work? □□
5. Is the maintenance equipment itself properly guarded? □□

Other Items to Check

1. Are emergency stop buttons, wires or bars provided? □□
2. Are the emergency stops clearly marked and painted red? □□
3. Are there warning labels or markings to show hazardous areas? □□
4. Are the warning labels or markings appropriately identified by yellow and black, or orange colours? □□

CHAPTER 55: MAINTENANCE OF SCROLL CASES & DRAFT TUBES

AIM:
Maintenance of scroll cases and draft tubes is associated with lot of material handling and lifting & removal of components that need to be refurbished or replaced. EOT cranes are used for the handling thus causing injuries related to material handling activities for the operators & employees working in the area. Huge size and working at height in addition to material handling pose great risk to the employees who need to be protected specially during maintenance activity.

Legal :

THE BUILDING AND OTHER CONSTRUCTION WORKERS' (REGULATION OF EMPLOYMENT AND CONDITIONS OF SERVICE) ACT, 1996 AND RULES, 1998

Chapter VI : GENERAL PROVISIONS
All the rules applicable **(34-54)**
Chapter VII : LIFTING APPLIANCES AND GEARS
All the rules applicable **(55-81)**

Spiral Case:
The function of the spiral case (or scroll case) is to supply water from the penstock to the stay vanes and through its unique shape of continual cross sectional area reduction, maintain a near uniform velocity of water around the stay vanes and wicket gates.

- Welding & gas cutting safe practices should be applied while maintenance activity for scroll cases & draft tubes.
- EOT crane use and safety associated with handling of equipment like lifting, slinging & movement in and around the work area is of concern for the safety of the employees.
- Training to be imparted to the employees for appropriate methods of slinging, safe working
- load calculations, hitching methods, centre of gravity etc for safe lifting methods.
- Slings have to be inspected on regular basis & certified by Competent Person once in a year.
- SWL- Safe Working Load marking – labels should be visible and readable with appropriate colour codes for indication of use.
- Regular inspection should be done for the moving & sliding mechanism of the EOT and maintenance to be carried out regularly.
- In case of use of metal wire ropes &chain slings they have to be checked for defects and replaced immediately if found defective.
- Ensure that Slings are protected at All Sharp Corners on Heavy Items.
- Never allow wire rope slings, or any wire rope, to lie on the groundfor long periods of time or on damp or wet surfaces, rusty steel, ornear corrosive substances.
- Avoid dragging slings out from underneath loads.
- Keep wire rope slings away from flame cutting and electric welding.
- Never make slings from discarded hoist rope.
- Avoid using single-leg wire rope slings with hand spliced eyes.

Observe the following precautions with slings.

- Never use damaged slings. Inspect slings regularly to ensuretheir safety.
- Check wire rope slings for kinking, wear, abrasion,broken wires, worn or cracked fittings, loose seizing and splices,crushing, flattening, and rust or corrosion.
- Pay special attention to the areas around thimbles and otherfittings.
- Slings should be marked with an identification number and theirmaximum capacity on a flat ferrule or permanently attached ring.
- Mark the capacity of the sling for a vertical load or at an angleof 45°.
- Ensure that everyone is aware of how the rating systemworks.
- Hand signal training to be imparted to operators associated with material handling & lifting of components with help of guided cranes.

Draft Tube:

The function of the draft tube is to gradually slow down the high discharge velocity water capturing the kinetic energy from the water, which is usually below atmospheric pressure. In most cases, it has an elbow in order to minimize excavation for the unit. The head recovery

from the draft tube is the difference between the velocity head at the runner discharge and draft tube discharge overall, increasing the head across the turbine. The larger the head differential is across the turbine, the higher the turbine power output. The draft tube should be steel lined from the discharge ring to the point where the water velocity reduces to about 20 ft/s, which is considered below concrete scouring velocity.

Regular mock drill for emergency evacuation should be conducted atleast once in a year and if the maintenance team has to work in smaller areas, mock drill should be conducted regularly before the commencement of maintenance work.

Fire fighting training along with hands on experience on use of fire extinguishers should be imparted to all employees.

Electrical safety to be practiced while maintenance as lot of electrical equipments like hand held portable grinders, welding machines etc. will be used. Operators will have to work in wet conditions; hence operators have to be trained for first aid in case of electric shock.

CHAPTER 56: SAFETY IN USE OF ELECTRICITY

Voltage levels as defined in IE Rule 1956

- "Low" where the voltage does not exceed 250 volts under normal conditions subject, however, to the percentage variation allowed by these rules;
- "Medium" where the voltage does not exceed 650 volts under normal conditions subject, however, to the percentage variation allowed by these rules;
- "High" where the voltage does not exceed 33,000 volts under normal conditions subject, however, to the percentage variation allowed by these rules;
- "Extra high" where the voltage exceeds 33,000 volts under normal conditions subject, however, to the percentage variation allowed by these rules.

Some important definitions

Live – Electrically charged.
Dead – At or about earth potential and disconnected from any live system provided that apparatus separated from a live conductor by a spark gap shall not be deemed to be dead.

Apparatus – Electrical apparatus and includes all machines, fittings, accessories and appliances in which conductors are used.

Installation – Any composite electrical unit used for the purpose of generating, transforming, transmitting, converting, distributing or utilising energy.

System – An electrical system in which all the conductors and apparatus are electrically connected to a common source of electric supply.

Switchgear – Switches, circuit breakers, cut-outs and other apparatus used for the operation, regulation and control of circuits.

Switchboard – An assembly including the switchgear for the control of electrical circuits, electric connections and the supporting frame.

Earthed / connected with earth – Connected with the general mass of earth in such a manner as to ensure at all times an immediate discharge of energy without danger.

Guarded – Covered, shielded, fenced or otherwise protected by means of suitable casing, barrier, rails or metal screens to remove the possibility of dangerous contact or approach by persons or objects to a point of danger.
Electricity is considered to be a good servant but a bad master. Hence, one should be very careful while working with electrical equipments, apparatus or installations.

Basic Do's & Don'ts

	Do's	**Don'ts**
1.	Determine positively whether a circuit is 'LIVE' or 'DEAD' before starting work. A circuit must be considered 'alive' until checked by means of a voltmeter, an approved short circuiting	Do not attempt to work on any electrical plant, machinery or equipment until you are thoroughly familiar. Do not take chances. If you are not certain of the correct

Do's		Don'ts
	device or other authorized method.	procedure, ask your superior for proper instructions.
2.	Check frames of electrical plant, machinery and equipment to ensure a sound electrical and mechanical connection to earth in order to prevent metalwork becoming electrically charged.	All power circuits are dangerous. Do not work on any LIVE equipment, irrespective of voltage, without taking every precaution to ensure safety i.e. the use of insulating stands, screens, boots, gloves or other suitable means.
3.	Use proper PPEs (Personal Protective Equipment), recommended safety appliances and insulated tools.	Do not work on a low or medium voltage system until you have made certain that all breakers, switches / isolators are open.
4.	Take special care to safeguard against probable backfeed from parallel feeders, interconnectors, bus couplers, bus section switches, temporary connections etc.	Do not start to work on a high voltage circuit or apparatus connected thereto, until a 'permit-to-work' card has been obtained from the authorized and competent staff official in charge of the electric power supply.
5.	Place warning signs on all circuit breakers, switches, isolators etc that might be used to energise the circuit. Bond all de-energised conductors that have been isolated / proved 'dead' together and connect them to a good earth to protect against electrostatic / accidental charging.	Never work unaccompanied on plant, machinery or equipment hazardous / high risk areas. Always take care that someone is close to hand to render assistance in event of accident.
6.	Care should be taken when dealing with electronic equipment. There are applications where earthing is impracticable and complete knowledge of the circuitry / apparatus is essential in order to avoid danger.	Never use an industrial type flash lamp, portable hand lamp or lighting fitting in locations where there is fire & explosion hazard. Only apparatus and circuits that are intrinsically safe should be employed.

Note: All authorised persons should be trained on artificial respiration and be competent to apply the instructions given in the 'Shock Treatment Chart' in case of electrocution of a co-worker.

Precautions to be taken before energizing a system

- Check that no one is in contact with the apparatus or circuit. The system is ready for charging and that all men, materials, temporary shortings and / or earth connections have been removed.
- Persons who were previously working on the apparatus or circuit, should be warned that the power supply will be switched on so as to avoid any misunderstanding and danger.
- Always refer to the log book specially provided for recording the isolating the apparatus and circuits.
- Never reclose or energise any system until you have checked and satisfied yourself that any request for making 'dead' has been correctly cancelled and that no danger is present.

List of Indian Standards on safety in electrical work:

IS No.	**Title**
2551: 1982	Specification for danger notice plates
5216 (Part 1): 1982	Recommendations on safety procedures and practices in electrical work: Part 1 General
5216 (Part 2): 1982	-do- Part 2 Life saving techniques
8923: 1978	Warning symbol for dangerous voltages
SP 31: 1986	Method of treatment of electric shock

CHAPTER 57: SAFETY IN HANDLING ELECTRICAL EQUIPMENT

Guidelines as per IE Rule 36

(1) Before any conductor or apparatus is handled adequate precautions shall be taken, by earthing or other suitable means, to discharge electrically such conductor or apparatus, and any adjacent conductor or apparatus if there is danger therefrom, and to prevent any conductor or apparatus from being accidentally or inadvertently electrically charged when persons are working thereon.

Every person who is working on an electric supply line or apparatus or both shall be provided with tools and devices such as gloves, rubber shoes, safety belts, ladders, earthing devices, helmets, line testers, hand lines and the like for protecting him from mechanical and electrical injury. Such tools and devices shall always be maintained in sound and efficient working conditions:

(2) No person shall work on any live electric supply line or apparatus and no person shall assist such person on such work, unless he is authorised in that behalf, and takes the safety measures approved by the Inspector.

(3) Every telecommunication line on supports carrying a high or extra-high voltage line shall, for the purpose of working thereon, be deemed to be a high voltage line.

1. Earthing of equipment

(Abstract from IS: 3043 code of practice for earthing)

1.1. All medium voltage equipment shall be earthed by two separate and distinct connections with earth.

1.2. In the case of high and extra high voltage the neutral points shall be earthed by not Less than two separate and distinct connections with earth, each having its own electrode at the generating station or substation and may be earthed at any other point provided 'no interference is caused by such earthing.

1.3. If necessary, the neutral may be earthed through suitable impedance.

1.4. In cases where direct earthing may prove harmful rather than provide safety (for example, high frequency and main frequency coreless induction furnaces). Relaxation may be obtained from the competent authority.

1.5. As far as possible, all earth connections shall be visible for inspection and Earthing Electrode Resistance measurement.

1.6. No cut-out, link or switch other than a linked switch arranged to operate simultaneously on the Earthed or earthed neutral conductor and the live conductors shall be inserted on any supply System.

1.7. This however does not include the case of a switch for use in controlling a generator or a transformer or a link for test purposes.

1.8. Grounding is not likely to reduce the total magnitude of over-voltage produced by lighting or switching surges. It can, however, distribute the voltage between phases and reduce the possibility of excessive voltage stress on the phase-to-ground insulation of a particular phase.

1.9. Plate electrodes shall be of the size at least 60 c m X 60 cm, Plates are generally of cut iron not less than 12 mm thick and preferably ribbed. The earth connection should be joined to the plate at not less than two separate points. Plate electrodes, when made of GI or steel, shall be not less than 63 mm in thickness.

1.10. Plate electrodes of Cu shall be not less than 3.15 mm in thickness.

1.11. Plate electrodes shall be buried such that ii. Top edge is at a depth not less than 15m from the surface of the ground. However, the depth at which plates are set should be such as to ensure that the surrounding soil is always damp.
1.12. Pipes may be *of* cast iron of not less than 100mm diameter, 2.5 to 3 m long and 13 mm thick. Such pipes cannot be driven satisfactorily and may, therefore, be more expensive to install than plates for the same effective Area.
1.13. Water pipes shall not be used as consumer earth electrodes.
1.14. Under fault conditions, the earth electrode is raised to a potential with respect to the general mass of the earth that can be calculated from the prospective fault current and the earth resistance of the electrode. The results in the existence of voltage. In the soil around the electrode, that may be injurious to telephone and pilot cables, whose cores are substantially at earth potential, owing to the voltage to which the sheaths of such cables are raised.
1.15. The voltage gradient at the surface of the ground may also constitute a danger to life, especially where cattle are concerned. The former risk arises mainly in connection with large electrode systems as at power stations and substation.
1.16. Earth electrodes other than those used for the earthing of the fence itself, should not be installed
1.17. In proximity to a metal fence to avoid the possibility of the fence becoming live and thus. Dangerous at points remote from the substation.
1.18. The materials used for making connections have to be compatible with the earth rod and the copper earthing conductor so that galvanic corrosion is minimized. In all cases, the connections have to be mechanically strong.
1.19. The cross-sectional area of every protective conductor which does not form part of the supply cable or cable enclosure shall be in any case, not less than
- 2.5 mm^2, if mechanical protection is provided and
- 4 mm^2, if mechanical protection ii not provided.

1.20. Joints of protective conductors shall be accessible for inspection and testing except m compound-filled or encapsulated joints.
1.21. No switching device shall is inserted in the protective conductor, but joints which can be disconnected for test purposes by use of a tool may be provided.
1.22. An auxiliary earth electrode shall be provided electrically independent of all other earthed metal, for example, constructional metalwork, pipes, or metal-sheathed cables. This requirement i. considered to be fulfilled if the auxiliary earth electrode is installed at a specified distance from all other earthed metal (value of distance under consideration).
1.23. The earthing conductor leading to the auxiliary earth electrode shall be isolated to avoid contact with the protective conductor or any of the parts connected thereto or extraneous conductive parts which are, or may be, in contact with them.
1.24. In TN systems, for cables in fixed installations having a cross sectional area not less than 10mm^2 for copper and 16mm^2 for aluminum, a single conductor may serve both as protective conductor and neutral conductor, provided that the part of the installation concerned is not protected by a residual current-operated device.
1.25. However, the minimum cross sectional area of a PEN conductor may be 4mm^2, provided that the cable is of a concentric type conforming to Indian Standards and that duplicate continuity connections exist at all joints and terminations in the run of the concentric conductors.

1.26. When the source of energy is privately owned, there should be no metallic connection with the General public supply unless there has been consultation with the electricity authority concerned.
1.27. It should be emphasized that an installation together with its source of energy may not consist entirely of one particular type of system. In such cases, each part of that installation may be required to be treated separately without detriment to other parts of the same installation.
1.28. RCD's having Minimum Operating Currents Greater Than 30 mA -- These devices are intended to give indirect shock risk protection.
1.29. The neutral points of each separate electricity system which has to be earthed at the power station or substation.
1.30. GI/Copper Plate Size: 500mmX500mmX10mm.
1.31. Wood coal powder and salt are in same quantity.
1.32. Size of GI Strip: 300mmX10mm
1.33. Size of GI Pipe: 2.5" Diameter.
1.34. Minimum 1Ω Resistance should be available at a distance of 15m.
1.35. Earthing resistance of earthing rod is changed from 0.3Ω to 0.8Ω between summer to winter.
1.36. Distance between two earthing pit is 2 X Length of earthing electrode.
1.37. If ground resistance is high in case of plate earthing (if hard rock), then Pipe earthing shall be used.
1.38. Resistance between two earthing pit is negligible.
1.39. Earthing of lightning protection should not be mixed with power system earthing.
1.40. Lightning protection earthing should be 10 time stronger than normal earthing (use copper bus strip instead of wire)
1.41. Jointing of earthing strip shall be overlap of min 50mm and for earthing wire overlapping shall be min 40mm

Plate / Pipe Earthing:
Plate Earthing Electrode

- For copper shall be 600X600X31mm and
- For Hot dip GI shall be 600X600X63mm.

Pipe Earthing Electrode.

Earthing electrode shall consist of a GI pipe (class B of approved make), not less than 40 mm dia. and 3 meters long. CL pipe electrode shall be cut tapered at the bottom and provided with holes of 12 mm dia. drilled at 75 mm interval up to 2.5 meters length from bottom. The electrode shall be buried vertically in the ground as far as practicable below permanent moisture level, but in any case not less than 3 meters below ground level. The electrode shall be in one piece and no joints shall be allowed in the electrode.

Size of Excavation:

- Size of 1 meter diameter and 3 meter length shall be excavated after depth of 3 meter the size of excavation shall be 900X300X900mm depth.
- Plate / Pipe Electrode shall be in vertical position.
- GI/PVC pipe for Watering shall be used of 40mm Diameter, length of 3 meter (contain hole of 12mm Diameter in Zigzag manner starting from 15cm away from bottom to 2 meter height).

- At bottom 150mm layer of Salt and charcoal power shall be installed than Plate shall be installed.
- Min 120kg of charcoal power and 120kg of salt shall be used for each earth pit.
- The plate \ pipe electrode, as far as practicable, shall be buried below permanent moisture level but in no case not less than 2.5 M below finished ground level.

2. Working on bus-bars, transformers, circuit breakers, insulators etc

Operation and Maintenance staff should be familiar with the station layout and operations limits of different equipment such as Circuit Breakers, Transformers, Isolators CTs, PTs, etc. A person should be allowed to operate / maintain or take over the equipment only after he has acquired adequate knowledge of the equipment.

Preconditions:

- Operation / maintenance should be carried out as per Standard Procedures. This will help in achieving safely and maintaining uniformity. In case of any modifications/ change in the layout operating instructions should be reviewed.
- Booklets/ manufacturer's instructions for different equipment should be available and should be referred to before taking out equipment for maintenance.
- It is the responsibility of the supervisor to interpret correctly and explain safety rules and regulations to all the persons concerned and ensure that they thoroughly understand the same.

Working Instructions

- Use HRC fuses only with proper capacity.
- While opening isolator confirm that it is not carrying load current. Similarly isolator should not be closed on load.
- Isolating switches provided for Generators and synchronous condensers and other rotating machines should never be opened when connected to any voltage source even when the machine is carrying no load.
- Underrated circuit breakers should not be used to clear the fault.
- No breaker should be operated beyond stipulated operating duty.
- While working on the breaker, its operating mechanism should be de-energized such as discharging spring, releasing air pressure etc.
- Transformer should be discharged and grounded from all sides (windings). Neutral grounding of the transformer should not be treated as grounding.
- Current transformer secondary should never to be left open circuited.
- After cutting out capacitor bank, it should be allowed to discharge through discharge PT for about 10 minutes. The bank should be grounded with hot stick before commencing the work.
- ASKAREL compound used in capacitor bank as a dielectric is very toxic and harmful. Hence, should be handled with great care.
- Apparatus, frame work and other non-current carrying metal parts associated with power system are to be effectively grounded.
- Lighting arresters shall be grounded independently.
- The areas should be cordoned off indicating location of work on the particular equipment.

- Use of safety tags must be ensured while allowing shut down for maintenance on some part/ equipment.
- Documentation at all levels of work done is necessity for any references and analysis of data/information in future as and when required.

Safety Note:

- No unsafe operation will ever be permitted. Feedback regarding unsafe operation/ condition should be taken into consideration with proper spirit and review should be made to avoid accidents.
- Interlocks should not be by-passed unless it is very essential. Written permissions sould be obtained from Station Incharge. Extra precaution should be taken by all the parties during such cases.
- Equipment are designed for certain operating conditions, it should be operated within prescribed operations limits. Overstressing of the equipment should be for minimum possible time with minimum percentage of overloading. This will avoid damage to the equipment.

Protection System:

Protection system is provided for lines, transformers, reactors, busbars, for fault clearance to minimize damage to the equipment and the system.
Transmission Lines:

400 kV and 220 kV lines are provided with double main protections based on independent principles. Two Stage over voltage protection is provided on 400 kV lines.

132 kV lines are provided with one distance protection and other directional O/C and E/F protection.

Power Transformers:

Following protections are provided for Power Transformers:

- Differential protection
- Restricted Earth Fault Protection
- Directional Back up O/C and E/F Protection on HV &MV sides
- Over fluxing Protection
- Over Load Alarm
- Buchholz, Pressure Relief Device (PRD)
- Alarm & Tripping due to Oil and Winding temperatures

Reactor:

- Following protections are provided for Reactors:
- Differential protection
- Restricted Earth Fault Protection
- Back up Impedance
- Buchholz, PRD
- Alarm & Tripping due to Oil and Winding temperatures_

Bus Bars:

400 kV bus bars are provided with two bus bar protections and 220 kV bus bars are provided with one bus bar protection.
Local Breaker Backup Protection:

The protection is provided to take care of following contingencies:

- Failure of local end breaker
- Fault between CT & CB

In addition to above Disturbance recorders and fault locators on each line and Event Logger for each station is provided to provide information about the fault.

Each Substation is also provided with Global Positioning System (GPS) based time synchronizing equipment and all recorders in the substation are time synchronized. In addition time of all substations are also synchronized through GPS.

Use of new generation relays working on numerical principles that offer benefits like economy, self supervision, support for network based substation control, faster repair swap, reduced spare inventories, etc. may also be considered for further installation, and so also substation automation because of technological innovation in the field.

3. Working on lines during installation of insulators, stringing of conductors, jumpering and fixing of spacers or vibration dampers

A. INSULATORS

The cost of insulators in the construction of a transmission line represent usually less than 5% of the overall cost of the project. Despite the low cost impact of insulators in the total cost of a line, flashover phenomena on the high voltage outdoor ceramic insulators are a serious threat to safe and uninterrupted operation of the transmission system.

Types of Insulators for overhead lines / substation equipment

1. String insulators (Suspension or Tension) - For Flexible ACSR line conductors and flexible ACSR bus-bars in substations. Generally identical 'cup and pin' insulator units are assembled in series. For higher strength, two / four / six parallel assemblies are used per assembly. Corona rings are necessary.
2. Post insulators for rigid aluminium tubular bus-bar and equipment – mounted on galvanised steel structure. One, two or more identical units of porcelain insulators are bolted with metal flanges.
3. Hollow bushing insulators for wall bushings, Transformer / Reactor bushings, SF6 GIS bushings, CTs, Circuit Breaker chambers etc. Hollow porcelain body with internal and external surface glazing and cemented end flanges. One or more units are assembled with bolted flanges with neoprene rubber gaskets between the porcelain surface and metal flange for sealing. Corona rings are necessary.
   String insulators are widely used for EHV AC and HVDC transmission lines. The most important requirements of air insulation and porcelain insulators in EHV-AC and HVDC transmission lines and substations are –
   - Creepage distance along the surface of insulators

- Clearances in air

While the creepage distance requirements are based on level of atmospheric pollution and continuous voltage, the clearances depend on most severe transient overvoltage.
The values of minimum creepage distances for porcelain insulators of AC equipment varies between 16 mm/KV for clean atmosphere to 25 mm/KV for heavily polluted atmosphere. The values of creepage for HVDC insulators are higher as the continuous application of DC voltage accelerates the tracking process. Creepage of the order of 45-70 mm/KV are used for outdoor insulators in HVDC system.

The degree of pollution in different areas depending on pollution level can be estimated as per the following table.

Area	**Pollution mg/cm^2/month**	**Equivalent salt deposit (NaCl) mg/cm^2**
Clean area	0.01 – 0.10	0.02 – 0.05
Moderately polluted area	0.10 – 0.20	0.05 – 0.08
Industrial area	0.20 – 0.80	0.08 – 0.10
Heavily polluted area	0.80 – 04.0	0.10 – 0.40

As per IS 731, the creepage distance requirements in moderately / Heavily polluted areas are tabulated below. The extreme right column represents recommended values as per IEC 60815 in moderately polluted areas keeping same no. of insulators per string length

Highest System voltage (KV)	**Minimum Creepage distance (mm) requirement**		
	Moderately polluted atmosphere	**Heavily polluted atmosphere**	**Recommended value (20 mm / KV)**
72.5	1100	1700	1450
123	1850	2800	2460
145	2250	3400	2900
245	3800	5600	4900
420	6480	9660	8400

Assembly data

Nominal system voltage (KV)	**Number of units on the string**		**Minimum failing load**	
	Suspension string	**Tension string**	**Suspension string (Kg)**	**Tension string (Kg)**
132	9-10	9-10	7000	11500
220	13-16	13-16	7000	12500
375	15-19	15-19	9000	16500
400	23-25	23-25	11500	16500

B. LINE CONDUCTOR

The design of EHV AC and HVDC overhead transmission line conductors is based on the following considerations.

1. Bundled conductors are essential for eliminating corona losses. The corona effect takes place above critical surface tension of 25 KV / cm. By bundling, the surface stress is reduced to about 18 KV/cm by enlarging the radius (of the bundle) thus eliminating corona.
2. The sub-conductors in the bundle are stranded ACSR or AAAC. Vibrations, wear, fatigue, corrosion are the major problems to be guarded against
3. Size of conductors (cross section area) is decided by resistance, I^2R losses, mechanical strength and sag span calculations.
4. Conductor fittings include – Spacers between sub-conductors of the bundle, mid span conductor joint, anchor clamp with jumper connection and vibration dampers.
5. The earth conductor located above the phase conductors provides lightning protection. In some cases fibre-optic cable is placed axially in the earthed ACSR conductor.

Bundled conductors and their GMRs (Geometric Mean Radius)

Rated voltage of EHV AC Line (KV)	**400**	**750**	**1000**	**1200**
Sub-conductors in bundle	2	4	6	8
Sub-conductor Radius r cm	1.59	1.78	2.3	2.3
Bundle Radius R cm	22.5	34.65	55	60
Sub-conductor spacing B cm	45	45	55	45.87
GMR of bundled conductor cm	8.4	21.73	43	51

C. SPACERS:

The sub-conductors of the bundled conductor are held in position by means of the spacers at regular interval of about 60 m. The sub-conductors experience unequal wind forces, electromagnetic forces and oscillations. The functional requirement of spacers are –

- To hold sub-conductors in desired configuration
- To prevent mechanical clashing, twisting or touching of conductors.
- To prevent circulating current through the spacers
- Corona free construction
- To permit axial movement of sub-conductors
- To permit pitch or yaw movement of sub-conductors at spacer clamps
- Enhance service life.

The resistance of a spacer between sub-conductors should be above 1 Mega-ohm. This is achieved by synthetic rubber bushes.
If the spacers are of conducting type, the contact resistance between conductor and the spacer clamp should be less than i milliohm so that the joint does not get heated up due to circulating currents.

D. VIBRATION & VIBRATION DAMPERS:

The overhead conductors face various types of vibrations due to reasons like wind pressure / direction of flow, corona effect, snowfall etc. it may be of different frequencies some of which may cause resonance resulting in high amplitude of vibration and failure of conductors due to mechanical failure or flashover.

Factors affecting vibration of conductors are –

- Conductor span / tension
- Bundle configuration
- Spacer configuration and spacing
- Type / configuration of conductors
- Supporting clamps and assembly
- Vibration dampers and their location
- Wind velocity vis-a-vis terrain of overhead line / tower height
- Trees near the towers
- Other electrical / electromagnetic phenomena

Significance of vibrations –

- The sub-conductors in a bundle tend to come closer and touch each other.
- The clearance between phases is reduced
- Vibration cause failure of strands and ultimately failure of conductors

The mechanical design of conductors, hardwares, towers, spacers etc depend on permissible vibration level.

Vibration Dampers:

The vibrations of conductors are damped by fitting vibration dampers on the conductors. Dampers cause reduction in amplitude in Aeolian vibrations. The Aeolian vibration of conductors are less with the conductors fitted with vibration dampers. A damper provides concentrated mass at a single point on the conductor and absorbs energy in the wave of vibration.

For small conductors used in distribution line, simple dampers are provided in the form of wires twisted around the line conductor over a length of about 5 m of either side of insulator support.

For conductors of EHV AC / HVDC lines, Stock Bridge dampers are used. They consist of two hollow weights on either side of the central clamp. The two weights are joined together by flexible steel / aluminium cable with a clamp. The clamp is fitted on the line conductor at a distance of 2-5 m from the insulator support on each side.
There are two dampers per insulator support and two per insulator span. The damper weight is about 5-15 Kg, overall length 30-65 cm, Dia. of hollow weights 3-5 cm. Spacers used with bundled conductors provide additional damping effect.

4. HV / EHV static capacitor banks

AC Power Systems are required to feed active Loads (watt) as well as reactive load (VAr). Majority of loads connected to a typical Power System are Inductive in nature. Hence it is essential for a Power system to meet demand of active (MW) & reactive Power (inductive) at all times by means of generated active & reactive power.

Capacitors are very beneficial in power grids. By producing reactive power, they compensate for the reactive power consumption of electrical motors, transformers, etc.

Capacitor bank: an assembly at one location of capacitors and all necessary accessories, such as switching equipment, protective equipment, control, etc., required for complete operating installation

TYPES OF CAPACITOR BANKS

- Externally fused capacitor banks
- Internally fused capacitor banks
- Fuseless capacitor banks

Externally Fused Capacitor Banks

These are units with fuses connected externally to the capacitor units. The fuses are intended to disconnect the faulted capacitor unit in a bank, preventing rupture of the capacitor case. The remaining units can continue in service without interruption.

Internally Fused Capacitor Banks

In this design, the entire capacitor is constructed with several series–parallel combinations. Usually, the current limiting fuses are used inside the capacitor bank. These fuses are designed to isolate the failed capacitor unit, allowing the continued service of the remaining units.

Fuseless Capacitor Banks

In a fuseless capacitor bank, a number of individual capacitor units are connected in series, and the group of units is referred to as a string. If one of the internal series groups of a capacitor unit fails due to a short circuit, the resulting increase in current through the capacitor unit is small.

All Capacitors shall be capable of continuous operation within the following limits

INSTALLATION TESTS OR FIELD TESTS

When the capacitor banks are installed in the desired location, certain tests are performed to ensure that the units are connected to the specifications. The following tests are performed before energization of the capacitor banks.

Capacitance Measurement

A capacitance meter is used to measure the effective capacitance of the bank to determine the accuracy of the connection. The voltage used for this type of test is only a fraction of the rated voltage. A 10% increase in the capacitance indicates a partially failed capacitor unit.

Low Voltage Energization Test

In this test method, the capacitive reactance is measured by applying a low voltage to the capacitor bank. The applied voltage for this type of test will be of the order of 120V.

High Voltage Insulation Strength Tests

Extreme caution needs to be taken in performing these tests because these are high voltage tests and the capacitor is an energy storing device. The capacitors should be protected from tank rupture by an appropriate fuse.

MAINTENANCE
Capacitor banks require very little maintenance because they are static equipment. However, regular inspection of the capacitor units should include a check of ventilation, fuses, ambient temperature, phase voltages, line currents, and cleaning of the surfaces for removal of dust.

Clearance and Grounding
After a capacitor bank is de-energized, there will be residual charges in the units. Therefore, wait at least 5 min before approaching it to allow sufficient time for the internal discharge resistors in each capacitor unit to dissipate the stored energy.
However, the grounding leads should be applied to all three phases to short out and ground the capacitor bank. Even after grounding, it is recommended that individual capacitor units be shorted and grounded before personnel come into contact with them to ensure that no stored energy is present.

Leaking from Capacitor Units
Another mode of failure in the capacitor bank is leaking due to the failure of the cans. When handling the leaking fluid, avoid contact with the skin and take measures to prevent entry into sensitive areas such as eyes.

Periodic Inspection, Measurement, and Maintenance
The substation and distribution capacitor banks should be inspected and electrical measurements be made periodically. The frequency of the inspection should be determined by local conditions such as environmental factors and type of controller used to switch the capacitors on and off.

Visual Inspections
Visual inspection of the capacitor bank must be conducted for blown capacitor fuses, capacitor unit leaks, bulged cases, discolored cases, and ruptured cases. During such inspection, check the ground for spilled dielectric fluid, dirty insulating surface on the bushings, signs of overheated electrical joints, open switches, and tripped protective devices.
An infrared camera is very useful for inspecting the substation equipment for overheated joints and surfaces, and records can be maintained for future reference.

Physical Inspection and Measurements
Physical inspection and measurements should include loose connections, overheated lead wires, and faulty fuse tubes. Fuses should be inspected for evidence of overheating or other such damage.
The protection devices should be inspected for proper settings including the position of the current transformer and the potential transformer. The capacitance of the bank should be measured and compared with the previous measurements.

5. Opening or splicing de-energized conductors or over-head ground wires

Before separating and / or splicing a conductor or OGW (while under a clearance), at ground level take the following precautions:

1. Bond all conductors together, including OGWs when applicable and bond them to ground as near to the worksite as practicable.

2. Install a ground on the damaged conductor or OGW at each structure from which it is to be lowered. Continuous grounding must be in place until the conductor or OGW is reinstalled.
3. Install a ground rod and bond it to the metallic work platform if in use. Also install ground cables from the ground rod (using a hot stick) to each side of where the conductor or OGW is to be cut or spliced.

NOTE: *If an insulated work platform is used, it must be kept clean and dry.*

4. Bond any other conductive objects in the work area to the same ground rod if a worker could bridge between them and the conductor or OGW being worked.
5. The use of insulated or bonded conductive work platforms should be considered and they should be accessed quickly to minimize the possibility of getting affected by hazardous step, touch, and transferred touch voltages.
6. Bond equipment used to pull and hold tension on the conductor or OGW to a structure ground or a temporary ground rod.

NOTE: *All workers should stay on the equipment or at least 10 feet away from it. When necessary to access or get off the equipment, it should be done quickly.*

Precautions to be taken before separating / splicing a conductor or OGW at an in-span location above ground level from an insulated or un-insulated aerial device

1. Short all conductors together including OGW when applicable and bond them to grounds as near the worksite as practicable.
2. Persons on the ground should stay at least 10 feet away from the vehicle, ground rods, down, guys, etc, during this operation to reduce exposure to hazardous step, touch and transferred touch voltages.
3. Install a jumper or bond (and /or section of conductor) rated for the maximum continuous current to maintain the continuity of the conductor or OGW before cutting. Use a hot stick when installing a jumper to restore continuity to a severed conductor or OGW.
4. Ground switches may be used in conjunction with personal protective grounds. They must not be used as or in place of personal protective grounds.

6. Storage batteries;

1. Verify the type of battery being handled (NICAD, Lead Acid, etc.). Storage batteries emit hydrogen and oxygen gas, especially during the last phase of high rate of charging. If contained in a room, these gases can create an explosive atmosphere.
   a. Lead Acid batteries contain sulfuric acid; a highly corrosive acid.
   b. NICAD Batteries contain Cadmium, Cadmium hydroxide, Nickel, Nickel Hydroxide and Potassium Hydroxide in varying proportions. Cadmium and Nickel are listed as carcinogens. Avoid contact with the liquids contained inside NICAD batteries.
   c. Nickel Metal Hydride Batteries contain Nickel and small amounts of Manganese, Potassium Hydroxide, Lanthanum and Neodymium. Nickel is a listed carcinogen. The liquids contained in these batteries are irritating to the skin. Avoid Contact. Consult the MSDS for more information.
2. Keep the battery location well ventilated / ensure good exhaust system to prevent formation of explosive gases..
3. Do not adjust connections etc while charging or in the first hour after charging
4. Never use a naked light to examine the interior of a battery.
5. Do not smoke or use an open flame.

6. Do not use brushes or devices which can short out a battery cell.
7. Ensure and verify there is a Full Body Shower and Eye Wash system in good working condition near the battery bank.
8. When working with or around electrolytes, ensure there is a solution of baking soda and water available to neutralize any spilt acid.
9. When adding electrolyte solution, always pour acid into water. The reverse can cause an explosion.
10. Wear acid proof gloves, sleeves, apron, and goggles when opening battery caps.
11. Use tools with insulated handles / surfaces

7. Testing of High Voltage / Extra High Voltage equipment

A. Testing, operation & maintenance of HV/EHV systems & apparatus

As per IE Rule 65

(1) Before approval is accorded by the Inspector under rule 63, the manufacturer's test certificates shall, if required, be produced for all the routine tests as required under the relevant Indian Standard.

(2) No new HV or EHV apparatus, cable or supply line shall be commissioned unless such apparatus, cable or supply line are subjected to site tests as per relevant code of practice of the Bureau of Indian Standards.

(3) No HV of EHV apparatus, cable or supply line which has been kept disconnected, for a period of 6 months or more, from the system for alterations or repair shall be connected to the system until such apparatus, cable or supply line are subjected to the relevant tests as per code of practice of Bureau of Indian Standards

(4) Notwithstanding the provisions of sub-rules (1) to (3) (both inclusive) the Inspector may require certain additional tests to be carried out before charging the installations or subsequently.

(5) All apparatus, cables and supply lines shall be maintained in healthy conditions and tests shall be carried out periodically as per the relevant codes of practice of the Bureau of Indian Standards.

(6) Records of all tests, trappings, maintenance works and repairs of all equipments, cables and supply lines shall be duly kept in such a way that these records can be compared with earlier ones.

(7) It shall be the responsibility of the owner of all HV and EHV installations to maintain and operate the installations in a condition free from danger and as recommended by the manufacturer and/or by the relevant codes of practice of the Bureau of Indian Standards and / or by the Inspector.

B. PROTECTIONS

As per IE Rule 64A (2), All systems and circuits shall be so protected as to automatically disconnect the supply under abnormal conditions. The following protection shall be provided, namely -

1. Over current protection to disconnect the supply automatically if the rated current of the equipment, cable or supply line is exceeded for a time which the equipment, cable or supply line is not designed to withstand;

2. Earth-fault/earth leakage protection to disconnect the supply automatically if the earth fault current exceeds the limit of current for keeping the contact potential within the reasonable values;
3. Gas pressure type protection to given alarm and tripping shall be provided on all transformers of ratings 1000 KVA and above;
4. Transformers of capacity 10 MVA and above shall be protected against incipient faults by differential protection; and
5. All generators with rating of 100 KVA and above shall be protected against earth fault/leakage. All generators of rating 1000 KVA and above shall be protected against faults within the generator winding using restricted earth fault protection or differential protection or by both.

8. SF6 gas filled equipment;

Ground SF6 equipment as per manufacture's recommendations. The procedures for handling non-faulted SF6 are well covered in manufacturer's instruction books.

These procedures normally consist of removing the SF6 from the circuit breaker, filtering and storing it in a gas cart as a liquid, and transferring it back to the circuit breaker after the circuit breaker maintenance has been performed.

1. Operating / working persons must be familiar with the handling of Sulphur Hexafluoride- SF_6 Gas.
2. Gas handling e.g. filling, evocation has to be carried out only by qualified personnel.
3. Use dust protection mask, gas proof protective glasses and protective clothes.

a) Physical Properties

- SF6 is one of the heaviest known gases with a density about five times the density of air under similar conditions.
- SF6 shows little change in vapor pressure over a wide temperature range and It is a soft gas in that it is more compressible dynamically than air.
- The heat transfer coefficient of SF6 is greater than air and its cooling characteristics by convection are about 1.6 times air.

b) Dielectric Strength

SF6 has very high dielectric strength - about three times that of air at one atmosphere pressure for a given electrode spacing. The dielectric strength increases with increasing pressure; and at three atmospheres, the dielectric strength is roughly equivalent to transformer oil.

The heaters for SF6 in circuit breakers are required to keep the gas from liquefying because, as the gas liquifies, the pressure drops, lowering the dielectric strength.

The exact dielectric strength, as compared to air, varies with electrical configuration, electrode spacing, and electrode configuration.

c) Arc Quenching

SF6 is approximately 100 times more effective than air in quenching spurious arcing. SF6 also has a high thermal heat capacity that can absorb the energy of the arc without much of

a temperature rise.

d) Electrical Arc Breakdown

Because of the arc-quenching ability of SF6, corona and arcing in SF6 does not occur until way past the voltage level of onset of corona and arcing in air. SF6 will slowly decompose when exposed to continuous corona.

e) Risks involved with SF6

Toxicity - SF6 is odorless, colorless, tasteless, and nontoxic in its pure state. It can, however, exclude oxygen and cause suffocation. If the normal oxygen content of air is reduced from 21 percent to less than 13 percent, suffocation can occur without warning.

Recommendation:

1. Equipment tanks should be purged out after opening.

CHAPTER 58: COMMON TO ALL ELECTRICAL PLANTS AND ELECTRIC LINES

A. Safety in sub-station, switchyard and switchboards:

- **These areas should be accessible only to authorized persons** and notice to be displayed for entry restrictions. Also **Danger boards, as per IS 2551, to be affixed** as per IE Rule 35. Shock Treatment chart to be displayed and authorized persons should be trained in First Aid, Artificial Respiration and CPR.
- No person shall work within minimum working distance from the exposed live mains and apparatus. The minimum working distance depends upon the actual voltages. Exposed live equipment in the vicinity shall be guarded off so that the persons are working on the released equipment in service. The guarding shall be done in such a way that it does not hinder the movement of the maintenance personnel. If necessary a person for observing safety could be posted.
- All barriers, shutters etc. of high voltage equipments must always be kept locked except when required for carrying out work under a permit to work (Safety Tagging) wherever possible. Keys controlling locks, except those in the possession of specified officials, shall be kept in safer place in control room or zonal office. The controlling / movement of keys shall only be retained by authorized persons / site in-charges.

1. **Safe working clearance -** minimum clearance to be maintained in air between the live part of the equipment on one hand and earth or other piece of equipment or conductor on which it is necessary to carry out the work, on the other.

a. Although Chapter X of IE Rule deals with 'Additional precautions to be adopted in Mines and Oil Fields, **Rule 114 (3) for Isolation and fixing of transformer, switchgear etc** is applicable in other installations as well **–** Adequate working space and means of access, clear of obstruction and free from danger, shall so far as circumstances permit, be provided for all apparatuses that have to be worked or attended to and all handles intended to be operated shall be conveniently placed for that purpose.

b. As per **IE Rule 64 (2) (a)**, the following provisions shall be observed where energy at high or extra-high voltage is supplied, converted, transformed or used: -

(i) Clearances as per Indian Standard Code shall be provided for electrical apparatus so that sufficient space is available for easy operation and maintenance without any hazard to the operating and maintenance personnel working near the equipment and for ensuring adequate ventilation.

(ii) The following minimum clearances shall be maintained for bare conductors or live parts of any apparatus in out-door substations, excluding overhead lines, of HV and EHV installations: -

Highest system voltage	Safe working distance (meters)
12 KV	2.6
36 KV	2.8
72.5 KV	3.1
145 KV	3.7
245 KV	4.3
420 KV	6.4
800 KV	10.3

Highest System Voltage is defined as the highest rms phase to phase voltage which occurs under normal operating conditions at any time and at any point of system.
The above values are valid for altitude not exceeding 1000 meters (m). A correction factor of 1.25% per 100 m is to be applied for clearance at altitude more than 1000m and upto 3000m.

c. IE **Rule 51(1)(c) for Provisions applicable to MV, HV or EHV installations -** Every switchboard shall comply with the following provisions:

(i) A clear space of not less than 1 metre in width shall be provided in front of the switchboard

(ii) If there are any attachments or bare connections at the back of the switchboard, the space, if any, behind the switchboard shall be either less than 20 cms or more than 75 cms in width, measured from the farthest outstanding part of any attachment or conductor

(iii) If the space behind the switchboard exceeds 75 cms in width, there shall be a passage-way from either end of the switchboard clear to a height of 1.8 m.

d. Safe clearance for overhead lines

1. Clearance above ground of the lowest conductor (IE Rule 77)

a. No conductor of an overhead line, including service lines, erectec across a street shall at any point thereof be at a height less than –

- For Low and Medium voltage lines 5.8 m
- For High voltage lines 6.1 m

b. No conductor of an overhead line, including service lines, erected along any street shall at any point thereof be at a height less than –

- For Low and Medium voltage lines 5.5 m
- For High voltage lines 5.8 m

c. No conductor of an overhead line, including service lines, erected elsewhere than along or across any street shall at any point thereof be at a height less than –

- For Low, Medium and High voltage lines up to and including 11 KV, if bare 4.6 m
- For Low, Medium and High voltage lines up to and including 11 KV, if insulated 4.0 m
- For HV line above 11 KV 5.2 m

d. For EHV lines, the clearance above ground shall not be less than 5.2 m plus 0.3 m for every 33 KV or part thereof by which the voltage of the line exceeds 33 KV

Provided that the minimum clearance along or across any street shall not be less than 6.1m.

2. Minimum Clearances (in meters) between lines crossing each other (IE Rule – 87)

Sl..	Nom System Voltage	11-66KV	110-132KV	220KV	400KV	800KV
1.	LV, MV	2.44	3.05	4.58	5.49	7.94
2.	11-66KV	2.44	3.05	4.58	5.49	7.94
3.	110-132KV	3.05	3.05	4.58	5.49	7.94
4.	220KV	4.58	4.58	4.58	5.49	7.94

5.	400KV	5.49	5.49	5.49	5.49	7.94
6.	800KV	7.94	7.94	7.94	7.94	7.94

Provided that no guardings are required when an Extra High Voltage (EHV) line crosses over another EHV, High Voltage (HV), Medium or Low Voltage (MV or LV) line or a road or a tram subject to the condition that adequate clearances are provided between the lowest conductor of the EHV line and the topmost conductor of the overhead line crossing underneath the EHV line and the clearances as stipulated in Rule 77 from the topmost surface of the road is maintained.

3. IE RULE – 80: Clearance From building from EHV Lines.

(2) Where a High or Extra High Voltage overhead line passes above or adjacent to any building or part of a building, it shall have, on the basis of maximum sag, a vertical clearance above the highest part of the building immediately under such line, not less than –

a) For HV lines up to and including 33 KV 3.7 m
b) For EHV lines 3.7 m plus 0.3 m for every additional 33 KV or part thereof

(3) The horizontal clearance between the nearest conductor and any part of such building shall, on the basis of maximum deflection due to wind pressure, be not less than –

a) For HV lines up to and includign11KV 1.2 m
b) For HV lines above 11KV and up to and including 33KV 2.0 m
c) For Extra HV lines 2.0 m plus 0.3 m for every additional 33KV or part thereof

[For the purpose of this rule, expression 'building' shall be deemed to include any structure, whether permanent or temporary]

2. **Guarding of live apparatus**

Although Chapter X of IE Rule deals with 'Additional precautions to be adopted in Mines and Oil Fields, **Rule 120 (d) for switchgears & terminals** is applicable in other installations as well As per Rule 120 (d), all live parts shall be so protected or enclosed as to prevent persons accidentally coming into contact with them and to prevent danger from arcs, short circuits, fire, water, gas or oil. Following fundamental rules have to be followed.

- Barricade / fence the entire area and prevent unauthorised entry
- The entry doors of Switchyard, Transformer yard, Substations, Control Rooms, MCCs and other regulating panels, Cable Cellars etc be prominently marked for 'Unauthorised Entry Prohibited' and they should preferably be locked.
- Panel doors to remain closed with interlock to prevent opening while the system / circuit is ON.
- Panels / cubicles to be clearly marked for its nomenclature, both at front & backside.
- No one is allowed to open the front or backside of a panel without written clearance / Permit.

Besides static equipment, guidelines have been given vide **Sec.21 of Factories Act 1948** for rotating machines, wherein it has been stated that –

Every part of an electric generator, a motor or rotary converter; every part of transmission machinery and every dangerous part of any other machinery shall be securely fenced by safe guards of substantial construction which shall be constantly maintained and kept in position while the parts of machinery they are fencing are in motion or in use.

In this connection IP Standards (International Protection Code) may also be referred. It

denotes classification of degrees of protection provided by housing for electrical equipment with rated voltage not exceeding 72.5 KV.

They specify the following –
1. Protection of persons
2. Protection of elec equipment against penetration of solid matter, including dust
3. Protection of electrical equipment against the harmful effects of water

IP code consists of the letters "IP" and two digits. 1st digit (1-6) denotes protection against infiltration of impurities

1. 50.0 mm and above
2. 12.5 mm and above
3. 2.5 mm and above
4. 1.0 mm and above
5. *Protection against dust
6. Dust proof

*Ingress of dust not totally eliminated. But, dust may not penetrate the enclosure to an extent that may affect functioning of the device or safety.

2nd digit (1-9) stands for protection against water

1. Vertical dripping of water
2. Dripping with $\pm 15^0$ tilted enclosure
3. Water spray at $\pm 60^0$ inclination
4. Water splash from any direction
5. Water jet (any direction)
6. -do- High power
7. Intermittent submersion in water
8. Continuous submersion in water
9. High pressure water and steam jet cleaning

3. **Operation on live apparatus**

The operation of power station requires that its staff is trained and well versed with all necessary technical as well as basic trouble shooting knowledge. As a brief description to bring out some details of operating a SHP, the following checks are to be made before starting of machine:-

- Shut down clearance
- Water restriction, if any
- Permission for ALDC
- Permission from nearest grid substation
- Proper working of

– Communication system
– AC Power
– DC Power
– Firefighting system
– Cooling water system
– Drainage & dewatering system

– H.S. lubrication system
– L.P. & H.P. compressed air system
– Protection system

Check List for Starting of Machine
The staff responsible for the operation should be well conversant with technical details and importance of following:-

- Intake gates bye pass gates & forebay
- Inlet valves
- Turbine
- Generator
- Generator Transformers
- Switchyard
- Synchronizing with grid
- Closure of machine
- Emergency closing of machine
- Importance of log sheets

4. **General provisions relating to maintenance**

NO MAINTENANCE ACTIVITY CAN BE STARTED UNLESS A WRITTEN WORK PERMIT / LINE CLEARANCE HAS BEEN ISSUED BY AN AUTHORISED PERSON IN THE ORGANISATION AND LOCK OUT TAG OUT (LOTO) PROVISIONS COMPLIED WITH.

Safe Clearance Provisions.
Safe Clearance provides LOTO directions for the safe blocking, tagging, and grounding of electrical switching and controlling devices to clear lines and equipment for the safe accomplishment of work in the de-energized condition.

Preparation Responsibility. A LOTO procedure will be developed by certified individuals authorized to do so.

Standardization/Strength. LOTO devices shall be standardized within each facility based on at least one of the following ways: colour, shape, or size. They shall be securely fixed to prevent displacement / unauthorised removal

Tag Recognition. In the process of LOTO tags defining the hazard and the control measure to be used must be filled in, including the names of the individual responsible for the tag and the functional manager. The tags must warn against hazardous conditions if the machine or equipment is energized and shall include a legend such as the following:

DO NOT START / DO NOT OPEN / DO NOT CLOSE / DO NOT ENERGIZE /
DO NOT OPERATE

The Maintenance Planning is an important part in Maintenance Management System. The Central Electricity Authority has recommended in their regulation 2010 the Maintenance planning (vide article 5, 6) as well as Maintenance Management System (Article 24-32). These recommendations shall be followed as guidelines to decide the maintenance strategies at different units / power stations of NHPC.

CEA Regulation 2010.

5. Maintenance Planning.-

(1) The Regional Power Committees shall, before the commencement of the financial year, prepare an annual maintenance plan for the generating stations and the inter-State transmission system in their respective regions keeping in view the demand pattern and maintenance schedule of the generating units and diversity in demand of the States.

(2) The Regional Power Committees shall co-ordinate the annual maintenance plan for Inter-Regional transmission system.

(3) The Regional Power Committees shall review and revise the coordinated generation and transmission system maintenance plan in their monthly operating Committee meetings.

(4) The State Load Despatch Centre shall in consultation with the concerned transmission licensee, coordinate the annual maintenance plan of Intra-State transmission system taking into account the annual maintenance plan of generating units and inter-state transmission system decided by the Regional Power Committee.

(5) The State Load Despatch Centre shall also review and coordinate the maintenance plan of intra-state transmission system for the next month, taking into account the monthly maintenance plan of generating units and inter-state transmission system prepared by the Regional Power Committee for the next month.

(6) The generating company or transmission licensee shall, before actual shut down, obtain the approval of the Appropriate Load Despatch Centre.

6. Coordination in Operations.-

(1) No Entity shall introduce or take out the element of the grid without the concurrence of the Appropriate Load Despatch Centre except in case of imminent risk of safety of plant and personnel in which case it must intimate Appropriate Load Despatch Centre giving reasons therefore.

(2) The Appropriate Load Despatch Centre shall inform all affected parties of the outage.

Maintenance Management System

24. Maintenance schedules.-

(1) Entities shall identify critical equipment and as far as possible, practice condition based maintenance for such equipment in place of traditional time based maintenance.

(2) In case of time based maintenance, the periodicity of maintenance of lines shall be fixed based on whether they are passing through normal area or polluted area or coastal area and the transmission lines and sub-stations in polluted or coastal areas shall be maintained more frequently.

(3) The maintenance of lines passing through and sub-stations located in such areas should be completed once before onset of winter so as to minimise tripping under conditions of fog or due to salt deposit on insulator discs in coastal areas and once before onset of summer.

(4) Maintenance and cleaning of various equipment fittings, accessories, primary instruments and sensors shall be carried out when they are de-energised during the shut-down of main equipment so as to minimise shutdown time.

(5) Where defects are observed through condition monitoring or during patrolling and inspection, the maintenance work on various items of equipment may be advanced depending on the condition of the equipment.

25. Use of diagnostic techniques for condition monitoring of equipment.-
The diagnostic methods of maintenance shall be preferred over traditional time based maintenance. For purpose of this regulation, devices or methods specified in the Schedule shall be used. A list of recommended Condition Monitoring tools given at the end of this chapter.

26. Thermo – vision scanning.-
The Thermo-vision scanning for hot spots on all overhead lines and sub-station equipment at voltage level of 220 kV and above shall be carried out at least once a year and necessary remedial measures shall be taken where hot spots are detected.

27. Failure analysis.-
(1) All failures of equipment and tower collapse shall be analysed by the Entity to avoid recurrence and a copy of the report shall be submitted to the Regional Power Committee and the Authority.
(2) The Authority may appoint a group of experts for investigation and analysis and the representatives of manufacturers may be invited to participate in such analysis.
(3) All relevant data which may help the group of experts in analysing the failures shall be furnished by the respective Entities.
(4) The recommendations of the group of experts shall be submitted to the Authority and the recommendations accepted by the Authority shall be implemented and circulated to all within the organisation and to other concerned organisations to prevent recurrence of similar failures.

28. Inventory control and spare part management.-
(1) The required spare parts shall be kept in stock, to ensure speedy the maintenance of the equipment.
(2) Computerised materials management system shall be developed by the Entities to optimise inventory.

29. Maintenance Audit.-
(1) An internal committee may be established by the Entities to verify whether actual maintenance works are carried out at site in compliance of the procedures and the policy of the transmission company.
(2) The observations of the Committee shall be put up to the management of the Entity for perusal and taking corrective action, if any.

30. Residual life assessment.- The residual life assessment shall be carried out for all major equipments including transformers, reactors, breakers, as envisaged by the relevant standards specified by the Bureau of Indian Standards, manufacturer's instruction or industry best practices and suitable remedial action for breach of the same shall be taken by the management of the Entity.

31. Disaster management.-

(1) The maintenance staff shall be trained in disaster management and a detailed procedure for the same shall be developed by the Entity and displayed prominently.

(2) This detailed procedure shall be reviewed periodically and also based on mock exercises carried out by the Entity.

(3) The maintenance staff shall be trained in emergency restoration procedures for managing major failures and breakdowns.

(4) The equipment including vehicles, diesel generating sets and fire fighting equipment and Emergency Restoration System for transmission lines shall be kept available at sub-station or at appropriate location for disaster management.

32. Maintenance records.- The records of all maintenance carried out for each equipment shall be kept in the table and formats in electronic form and hard copy and the next due date for maintenance of each item of work shall be clearly marked in such tables and formats.

The Devises and Methods for Condition Based Monitoring of Equipment

1. Hot line puncture detection of insulators
2. Vibration measurement of the line
3. Pollution measurement of the equipment
4. Dissolved Gas Analysis of Transformer oil
5. Frequency response analysis of transformers/reactors
6. Tan d and capacitance measurement
7. Circuit breaker operational analyzer
8. Dynamic contact resistance measurements of breakers
9. Third harmonic resistive current measurements of surge arresters
10. Recovery voltage measurements of transformers/reactors
11. Vibration measurements of the reactors
12. Steady state and Dynamic testing of protective relays
13. Signature Analysis
14. Partial Discharge measurement for transformers/Gas insulated Switchgear
15. Static resistance meter for circuit breakers, isolators, bus bar joint, earth switches etc.
16. Ground tester for measurement of resistivity of soil and ground resistance
17. Battery impedance test equipment
18. Insulator tester
19. SF6 gas leakage detector and dew point
20. Power quality Analyzer
21. Fibre optic cable testing devices

5. **Working in areas containing exposed live conductors;**

1. Working space around electrical enclosures or equipment shall be adequate for conducting all anticipated maintenance and operations safety, including sufficient space to ensure safety of personnel working during emergency conditions and workers rescuing injured personnel.
2. Isolated the system / equipment from all other points from which it is possible for the system / equipment to become alive (e.g. voltage and auxiliary transformers, common neutral earthling equipment).
3. Locking of all enclosures leading into live section from the work area to avoid wrong or unauthorized accesses to live parts.

4. Locking, tagging of circuit breaker, isolators, control handles and safety devices wherever such arrangements exist.
5. The section de-energized for working should be that section required for execution of the work and should be defined by use of barriers, screens, danger notices, etc. in order to maintain specified clearances.
6. For bare conductors or live parts of any apparatus in outdoor substations, excluding overhead lines of HV & EHV installations, the following minimum safety working clearance must be maintained. Ref Safe Working Clearance at A (1) i.e. Safety in Substationss, Switchyards and Switch-Boards.
7. A distance of 300mm (12") shall also be maintained form that portion of the insulators supporting exposed High Voltage conductors which is outside the appropriate safety distance from the conductors.
8. Maintain the clearances specified above while carrying materials, tools, etc.
9. Authorized person should monitor movement and erection.

6. Demarcation of work areas

The Work area shall be clearly defined and, where necessary, protected physically to prevent danger to persons in the work area from system hazards of adjacent plant and / or apparatus.
It is essential that persons are alerted to avoid entering any other area where there is danger from the system. The working area shall be so defined that persons approaching it can recognise it is a safe working area.
The major work areas shall include –

1. **Power House** including Generators, Generator Transformers (GTs), Station Transformers (STs), Unit Transformers (UTs) and associated switchgears etc
2. **Switchyard / substations** include Transmission Towers, Overhead conductors, Breakers, Isolators, CTs, PTs, Surge suppressors etc
3. **Other utilities** e.g. Pump Houses, Lighting / Emergency lighting, battery banks, Air conditioning, Fire Protection systems, Earthing system, DG sets etc.
   Each major areas shall be further divided into sub areas and qualified competent persons shall be authorised for operation and maintenance of plant & equipment in specified areas.
   Each work area shall be clearly identified and relevant statutory provisions shall be complied with e.g.

- Danger Boards to be displayed at entry point as well as on each installation
- Entry Restriction to be displayed at the entrance. Gates to be closed, wherever unmanned.
- List of authorised persons shall be displayed at work site
- Type of Hazards / Risks to be assessed and displayed for general awareness
- Shock Treatment Charts to be displayed with list of trained persons inside substations
- Safety instructions, Do’s & Don’ts to be displayed at work site which will also highlight the requirement of Safe Work Practices and PPEs
- Common safety appliances (Rubber mat / hand-gloves, Discharge rod etc) shall be available at work place
- Emergency telephone nos. to be displayed etc etc.

7. **Working on remotely controlled / automatically controlled equipment**

Control Concept:

The committee for updating the best practicers in Transmission lines in the country recommends that –

All EHV Circuit Breakers are controlled and synchronized from switchyard Control Room. All Isolators have remote operation control from Control Room as well as local operation control. The Earth Switches can be operated locally only. Isolators and associated earth switches are provided with electrical as well as constructional mechanical interlocks.

Danger

Danger may occur to persons working on or testing plant and apparatus which has automatic or remote control, if the same control has not been isolated.

Procedure

- Precautions shall be taken to achieve safety from the system by isolating the automatic / remote control as well as local control feature .
- Such facilities (features) shall be properly isolated and locked till the work is completed.
- If it is required to restore the automatic / remote control feature for the purpose of testing, a special permit shall be issued for restoration of power for testing.
- Such test procedures shall be approved before issuing special permit.
- Only an authorized person or a competent person under personal supervision of an authorized person shall work on or make any adjustment to the controlling features of plant and apparatus under operating condition. Before commencing such work consultation must take place between the authorized person, controlling authority and Safety.

8. **Working on equipment operated by or containing compressed air**

Any equipment when operated by compressed air or containing compressed air resembles to a pressure vessel and hence all precautionary measures relevant to pressure vessels shall be ensured while working on such equipment.

However, for routine Inspection & Maintenance, the following points shall be checked and recorded.

1. Check air pressure in the chamber (ensure the Pressure Gauge is calibrated)
2. Ensure compressors are in good condition (check noise, vibration, temperature etc)
3. The standby compressor also to be tested for its healthiness

Vide CEA Regulation 2010 on Technical standards for electrical plants and electric lines

– Compressed air system comprising of instrument air and service air shall be provided to cater to the requirement for operation of various pneumatically operated drives and general purpose cleaning and maintenance services.
– Air dryers shall be provided for instrument air to achieve desired dryness.
– At least one no. Compressor shall be provided as stand-by.

Regarding High Pressure and Low Pressure compressed air, the regulation also maintains that

– High Pressure (HP) compressed air system shall be provided to meet the requirement of turbine governing system and MIV. The pressure of HP air compressor shall be 1.1

times the governor working pressure. However, the HP compressed air system shall not be required in case high pressure N2 system has been provided for governing system and MIV

– Low Pressure (LP) compressed air system shall be provided to meet the requirement of inflatable rubber seal of shaft glands, operation of pneumatic tools, cleaning, generator braking and jacking, boosting pressure in the fire protection hydro-pneumatic tank, pneumatic detection line for the operation of deluge valve provided for the generator transformer etc.

– A separate compressed air system, wherever required, shall be provided to supply the compressed air for depressing the water level in the draft tube below the runner to run the machine in synchronous condenser operation mode.

For maintenance work, system depressurisation must be ensured and locked at source. Only authorised persons or competent persons under personal supervision of an authorised person can take up such maintenance work against work permit.

9. **Working on circuit breakers, transformers, isolators, surge arresters, instrument transformers, storage tanks etc**

Equipment Parameters:

The Committee for updating the best practices in Transmission lines in the country, after examination of various Indian and International standards, standardization committee reports and engineering studies, recommended the following parameters.

- Only SF6 Circuit Breakers may be used at EHV levels. At 400 kV level the circuit breakers are to be provided with
- closing resistors, if used for switching the line longer than 200 kM.
- The Instrument transformers may be live or dead tank oil insulated type. In future novelle sensors may also be used.
- The isolators may be generally Horizontal center break type, however double break isolators may also be used
- depending on layout requirement. The Isolators are to be provided with motor operated operating mechanism.
- The surge arresters to be used are only of metal oxide gapless type.
- Shunt reactors to be used are of oil insulated, iron or air core type with ONAN cooling.
- Inter-connecting transformers should be provided with On Load Tap Changer and with ONAN/ONAF/OFAF cooling.
- The transformer may be single phase or three phase depending upon the considerations of transportation constraints or size of the transformers. In case of single phase transformer arrangement, one single phase transformer should also be procured as spare and kept connected to the system. The switching arrangement of this transformer should be so designed that it can be connected to any of the phases, whenever required.
- All equipment are to conform to the type test and routine tested as per relevant standards.

10. **Handling failed SF6 circuit breaker**

Toxic decomposition products are formed when SF6 gas is subjected to an electric arc. The decomposition products are metal fluorides and form a white or tan powder. Toxic gases are also formed which have the characteristic smell of rotten eggs.

Therefore, Faulted SF6 gas can cause nausea and minor irritation of the eyes and upper respiratory tract. Normally, faulted SF6 gas is so foul smelling no one can stand exposure long enough at a concentration high enough to cause permanent damage.
Solid arc products are toxic and are a white or off-white, ashlike powder. Contact with the skin may cause an irritation or possible painful fluoride burn.
Normal circuit breaker operation produces small quantities of arc products during current interruption which normally recombine to SF6. Arc products which do not recombine, or which combine with any oxygen or moisture present, are normally removed by the molecular sieve filter material within the circuit breaker.

Recommendation:

1. Equipment tanks should be purged out after opening.
2. Do not breathe the vapors remaining in a circuit breaker where arcing or corona discharges have occurred in the gas.
3. Evacuate the faulted SF6 gas from the circuit breaker / other equipment and flush with fresh air before working on the circuit breaker.
4. If solid arc products come in contact with the skin, wash immediately with a large amount of water.
5. All materials used in the cleanup operation for large quantities of SF6 arc products shall be placed in a drum and disposed of as hazardous waste.
6. Use special clothing and safety appliances as detailed below.

Coveralls – Coveralls must be worn when removing solid arc products. Coveralls are not required after all solid arc products are cleaned up. Disposable coveralls are recommended for use when removing solid arc products; however, regular coveralls can be worn if disposable ones are not available, provided they are washed at the end of each day.

Hoods – Hoods must be worn when removing solid arc products from inside a faulted dead-tank circuit breaker.

Gloves – Gloves must be worn when solid arc products are hah-died. Inexpensive, disposable gloves are recommended. Non-disposable gloves must be washed in water and allowed to drip-dry after use.

Boots – Slip-on boots, non-disposable or plastic disposable, must be worn by employees who enter eternally faulted dead-tank circuit breakers. Slip-on boots are not required after the removal of solid arc products and vacuuming. Nondisposable boots must be washed in water and dried after use.

Safety Glasses – Safety glasses are recommended when handling solid arc products if a full face respirator is not worn.

Respirator – A cartridge, dust-type respirator is required when entering an internally faulted dead-tank circuit breaker. The respirator will remove solid arc products from air breathed, but it does not supply oxygen so it must only be used when there is sufficient oxygen to support life. The filter and cartridge should be changed when an odor is sensed through the respirator.

The use of respirators is optional for work on circuit breakers whose in terrupter units are

not large enough for a man to enter and the units are well ventilated.

Air-line-type respirators should be used when the cartridge type is ineffective due to providing too short a work time before the cartridge becomes contaminated and an odor is sensed.

When an air-line respirator is used, a minimum of two working respirators must be available on the job before any employee is allowed to enter the circuit breaker tank.

11. **Working on or near LV, MV, HV or EHV equipment**

As per **IE Rule 3 (1),** competent persons to be authorised strictly for any / all of the following purposes.

- Handling of electrical supply lines and apparatus
- Working in panels where energy is supplied, converted, transformed or used at Medium, High or Extra High Voltage (i.e. above 250V)
- All operations in connection with High and Extra High Voltage (i.e. above 650 V)
- Working on / adjacent to any live line or apparatus

1. Contractual workers / supervisors shall obtain competency certificates from State Electrical Inspectorate
2. Company staff shall be authorised based on their qualification and experience, as competent for specific important tasks. Such tasks may include among others

- Applying / Issuing / Receiving Permit for electrical work
- Working on

• HV/ EHV equip & Installations
• Motors / Generators above 650 volts
• Drive Control systems
• MCC panels etc

- Testing of protection relays / other tests & measurements
- Running Inspection / Condition Monitoring / lubrication / etc

3. List of authorised persons shall be signed by both the authoriser and authorisees. Such lists shall be displayed in the office of the authorizer and related workplaces
4. The list should be reviewed once in a year or so to ensure

- Coverage of all areas
- Replacement of persons in case of Separation / Transfer / Promotion / Change in responsibility etc

Many electrical hazards and work practices are the same regardless of the voltage involved. However, due to the nature of high voltage work, there are many hazards and work practices that are specifically related to high voltage. The following should be checked:

1. First of all a permit to work is obtained before any person is allowed access to carry out any work on any High or Extra High voltage system
2. Before grounds are installed, the de-energized line or equipment shall be tested for voltage. Appropriate tests for the nominal voltage involved (audio or visual) should be used. They shall be tested immediately before and after use to verify that they are in good working condition.
3. Employees attaching and removing grounds shall comply with the following:

• Grounding equipment should be visually inspected and all mechanical connections checked for tightness before each use.

- The surface to which the ground is to be attached should be clean before the grounding clamps installed / or a self-cleaning clamp shall be used.
- No ground shall be removed until all personnel are clear of the temporary grounded lines or equipment. When the grounding set is removed it shall disconnected from the line or equipment end first with an approved hot-line tool and moved to a point clear of energized conductors before the ground end is disconnected.
- All electrical systems /equipment should be considered as live unless it is confirmed to be dead after using approved indicators to verify that the system / equipment is not live.
- Only authorized person to climb structures or equipment which bring them under reduced clearance to live parts.
- New electrical system / equipment should not be placed in service without the approval of the manager in charge and until the same has been thoroughly examined and tested by him.
- When testing, switching or doing other work in a particular locations of the working zone is likely to effect the operation is any other locations, the authorized person should inform all the concerned before the work is started and after the work is completed.
- Danger notice - barriers and screens should be fixed and moved only under the supervision of the authorized Person.
- The authorized person should supervise the work and should remain present at the point of work till the job is over.
- All specific guidelines from the safety point of view applicable to installation and maintenance work of the specific / equipment as given in the respective manuals should also be followed.

12. **Procedure for adding or removing equipment to or from the HV / EHV system.**
There may be three occasions when we need to remove an equipment from system or add on to such system.

- As a preparatory of maintenance activity. Safe isolation and normalisation procedure, is a normal day-to-day activity for handing over an equipment for maintenance and putting it back into service after maintenance
- During load balancing. This happens at the user / load end (and not at generating end) during any abnormality at generating end.
- For islanding in case of grid failure and re-synchronising with grid
- The text below will refer to safe isolation / normalisation procedure

Sequence of isolation / normalisation steps

A. Isolation / De-energizing

1. Notify all concerned persons as to the hazard source, its control, and its possible stored energy
2. Shut down the system by isolation of energy sources. System is rendered non-operative.(**Ref. A1 below**)
3. Secure all energy source shutdowns by lockout / tagout of controls.
4. Release all stored energy and verify such release.
5. Verify by testing there is no voltage.
6. Provide temporary grounding (**Ref. A2 below**)

B. Re-energizing

1. Inspect the work area for an operationally intact system and remove nonessential items.
2. Notify all affected workers that the system is to be re-energized and warn them to stand clear.
3. Remove temporary grounding (**Ref B.1 below**)
4. Remove the lockout / tagout devices.
5. Visually determine that all affected workers are clear of the circuit.
6. Proceed with restoring service.

A1. Hazardous Energy Elimination: Eliminate any source of hazardous energy affecting the work by controlling electrical / nonelectrical energy hazards

1. **Electrical systems / equipment**

a. Isolating by control operation:
- Open switching devices; lockout if possible
- Pull plugs or fuses
- Block interlock feedbacks

b. Stored or other energy release:
- Disconnect and discharge capacitors, choke coils, and surge arresters.
- Discharge static electricity.
- Temporarily short to ground induced voltage from adjacent lines, static charges, accidental connections, and incorrect disconnections.
- Provide shielding for possible contact with energized parts

c. Verify by testing there is no voltage on de-energized system / equipment.

2. **Nonelectric energy hazards**

a. Check for chemical, electromagnetic, mechanical, pneumatic, thermal, and ultraviolet energy.

b. Isolate by blocking valve operations or other control operations for the above systems.

c. Discharge trapped energy by releasing pressure or by draining / purging lines and verify lack of rotation or dangerous temperatures.

A2. De-energized Line Grounding

1. **Grounding Provision.** Grounding is used to limit dangerous potentials. Permanent grounding is provided as a part of any electrical system to meet safety and design requirements. A ground system consists of a grounding connection, a grounding conductor, a grounding electrode, and the earth (soil) that surrounds the electrode or some conductive body which serves instead of the earth (a ship hull/aircraft frame). A jumper connects conductors so that continuity is maintained. Bonding is the joining of metallic parts to form a conductive path. Temporary grounds are used so that work may be safely done on parts of the system that are temporarily isolated and cleared (de-energized).

2. **Why Temporary Grounds Are Necessary.** Energized lines over 50 volts which have been opened and checked as showing no voltage must be considered as hot if they have not been grounded. Potential differences can occur on de-energized lines from any of the factors. Hence, temporary grounding is essential for safety.

Causes of hazardous induced potential differences

a. Potential differences caused by various line effects (such as induced voltages from adjacent energized lines and electrostatic build-up from wind action).
b. Lightning strikes anywhere in the circuit.
c. Fault-current feed-over from adjacent energized lines.
d. Connection to an energized source through switching equipment, either by equipment malfunction or human error.
e. Accidental contact of the de-energized line with adjacent energized lines.
f. Residual charge from power-factor correction capacitors or surge arresters.

3. **Equipotential (Single Point) Grounding.** Whenever possible install temporary grounding to provide an equipotential zone at the work site. An equipotential zone provides a zero ground potential gradient across a worker's body, thus preventing a harmful electrical current through the worker.

4. **Placement of Grounds.** Grounds will be installed as close as possible to the work.

B1. Temporary grounding connection / removal procedures

1. Select a ground electrode using either an established ground at the structure or a temporarily driven ground rod. The selection should minimize impedance and not introduce a hazardous potential difference.
2. Test the de-energized line/equipment for voltage by an approved tester, verified immediately before and after use as to its good working condition
3. Visually inspect ground equipment. Check mechanical connections for tightness. Clean clamp jaws and conductor surfaces. Clean not earlier than 5 minutes before connection using a wire brush attached to a hot-line tool. Use of self-cleaning equipment is also acceptable.
4. The ground end clamp of each grounding cable should always be the first connection made and the last to be removed. Hot sticks will be used if the grounded system and worker are at different potentials.
5. The conductor-end clamps of each grounding cable will always be connected last and removed first by hot sticks. Apply to the nearest conductor first and proceed outward and/or upward until all phases have been connected. Remove in reverse order. The practice of holding the cable near the base of the hot stick to lighten the load on the head of the stick is strictly prohibited. Instead, a co-worker should assist in installing heavy cables by holding the cable with another hot stick, or by using a "shepherd hook" with a pulley and a nonconductive rope to hoist the grounding cable into position.

B2. Stringing/removing conductor ground locations

1. Ground all stringing equipment such as reel stands, pullers, tensioners, and other devices.
2. Provide a safety barrier around the equipment.
3. Install a running ground between pulling and tensioning equipment and their adjacent structures.
4. Ground stringing blocks at first and last structures, and at least every 2 miles (3.2 kilometers) in between.

5. Ground stringing blocks at each structure on both sides of an energized circuit being crossed. If the design of the circuit interrupting devices protecting the lines so permits, the automated reclosing feature of those devices shall be made inoperative.

B3. Conductor ground location after pulling

1. Ground at each structure next to intermediate deadends of the stringing operation.
2. Ground at each structure where and while work (including clipping-in) is being performed on or near the conductor.
3. Remove grounds as the last phase of finished aerial installation.

CHAPTER 59: ADDITIONAL REQUIREMENTS APPLICABLE FOR ELECTRIC LINES

Safety measures in over head lines

Accidental contact with live overhead power lines kills people and causes many serious injuries every year. People are also harmed when a person or object gets too close to a line and a flashover occurs. Work involving high vehicles or long equipment is particularly high risk, such as; In Construction – Lorry mounted cranes (such as Hiabs), Mobile Elevated Work Platforms (MEWP's), scaffold poles, tipper vehicles, cranes, ladders;

IE Rule 91 for Safety and protective devices.

(1) Every overhead line (not being suspended from a dead bearer wire and not being covered with insulating material and not being a trolley-wire) erected over any part of a street or other public place or in any factory or mineor on any consumer's premises shall be protected with a device approved by the inspector for rendering the line electrically harmless in case it breaks.

(2) An Inspector may by notice in writing require the owner of any such overhead line wherever it may be erected to protect it in the manner specified in sub-rule(I).

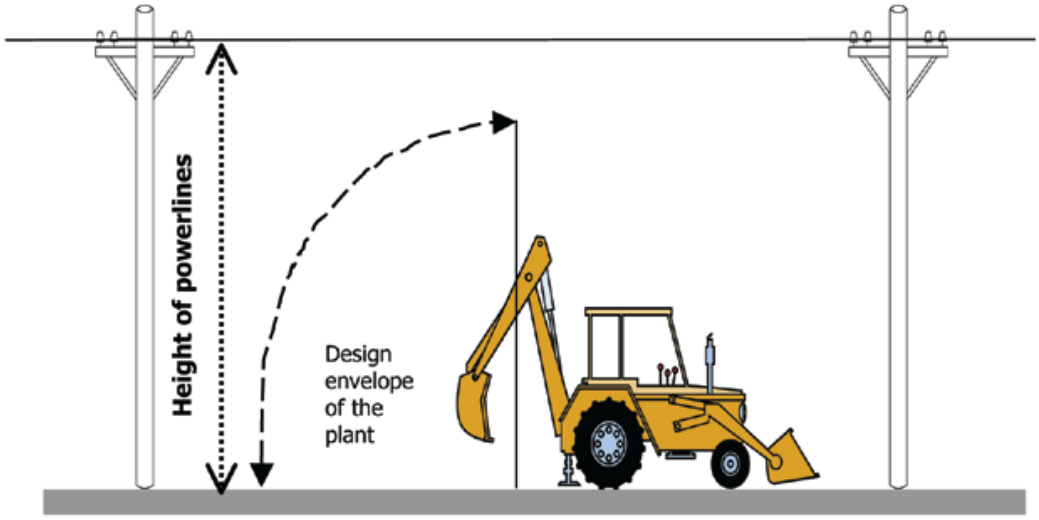
(3) The owner of every high and extra-high voltage overhead line shall make adequate arrangements to the satisfaction of the Inspector to prevent unauthorised persons from ascending any of the supports of such overhead lines which can be easily climbed upon without the help of a ladder or special appliances. Rails, reinforced cement concrete poles and pre-stressed cement concrete poles without steps, tubular poles, wooden supports without steps, I-sections and channels shall be deemed as supports which cannot be easily climbed upon for the purpose of this rule.

Working on overhead lines

- The first and foremost condition is that – no work is allowed to be carried out at or near an overhead transmission line by any person other than an authorized person or by competent persons under the supervision of an authorized person / supervisor.
- Secondly, no such work it to be started without a line clearance / Permit-to-work issued by an authorized person.
- Before starting any work under overhead line, a Site-specific Risk Assessment exercise is to be carried out, taking into account the maximum potential height that can be reached by the plant or equipment that will be used. If the equipment is capable of reaching a height of more than 4 metres, then further safety control measures will need to be put in place.
- Check points before start of work:

– Nature of work and ways of dealing with changes as the work proceeds
– The possible hazards and risks associated with the work
– Consultation with the network operator
– Communication and interaction between workers at the site
– Training, qualifications and competency of workers
– Checking the operation of plant & equipment, including control devices
– Proximity of persons, cranes, mobile plant, material and tools to OH lines
– Proximity of persons to cranes and mobile plant
– Specific instructions for employees
– Workplace access and egress
– Emergency procedures, including first aid, evacuation and rescue; and
– Environmental factors (Do not work in cloudy, rainy or stormy weather)

- Also Height Barriers should be used in conjunction with ground-level barriers to restrict the locations where machinery or other plant and equipment can cross safely under an overhead line.



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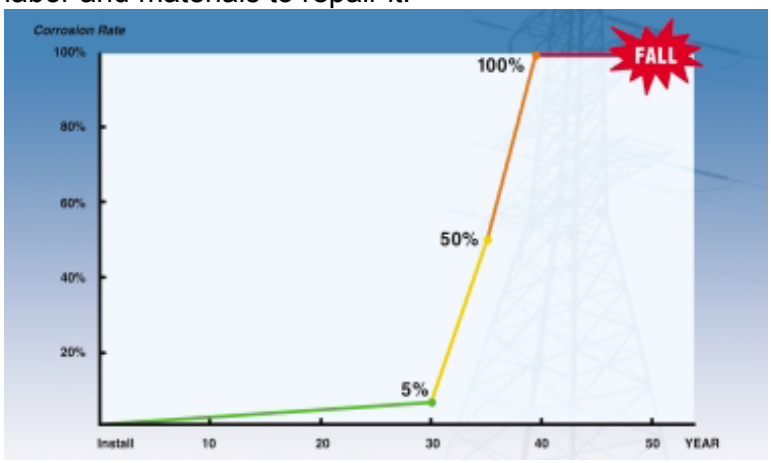
Do not attempt to directly measure the height of overhead power lines. Do not use conductive metallic objects or metal tape for measuring the height of overhead power lines.

1. Inspections and maintenance of steel towers and structures;

The main concern of galvanised towers is corrosion. It takes long time for corrosion to put its mark on a galvanised tower / pole, depending on the climatic condition and pollution level.

While galvanized steel in rural or desert settings may remain rust-free for up to 50 years, coatings in salty coastal air or heavy industrial environments may only do so for 15 years or less.

Unfortunately, once the corrosion of a galvanized transmission tower/pole does begin, it advances exponentially. As the chart below indicates, a tower/pole with less than 5 percent rust at age 30 can oxidize to the point of failure within ten years. More critically, as the corrosion of the tower/pole accelerates, so too can the cost of time, labor and materials to repair it.



Here are the four phases of transmission tower corrosion:
Phase 1: Coffee stain rust (cosmetic, not structural)

- 5% rust
- On edges and bolts
- About 1 mils to 2 mils of galvanization remains

Phase 2: Abrasive rust

- On bolts, edges and horizontal flat areas
- Rust falls off on touch

Phase 3: Extensive abrasive rust and **Phase 4:** The tower falls

Tower Inspections
The reputed tower manufacturers recommend that a structural inspection be done annually and/or after any severe weather. Standard checklist for inspection of towers is given below.

Tower Inspection checklist.

- Visual inspection from the ground prior to climbing. Address any safety concerns or hazards prior to proceeding
- Visual inspection of guy anchors without digging (for guyed towesr)
- Tension readings from guy wires (for guyed towers)
- Measurement of tower plumb / base flange heights to verify that tower is plumb and not settling
- Visual inspection of lighting system for proper function
- Verify operation of photo cell switch, if any
- Check 10% of hardware for tightness
- Check weep holes if applicable
- Visual inspection of safety climb if applicable
- Visual inspection of antennas and transmission lines
- Visual inspection of overall tower condition noting any potential problems
- Visual inspection of paint condition
- Visual inspection of overall site condition

Note:

- Only authorised persons are allowed to carry out tower inspection and subsequent maintenance, painting etc.
- During 'climbing inspection' look out for defects like – bent / broken / missing member, loose bolts, broken / chipped insulators, poor condition of the ground wire at the attachment point, rust on the wire or signs of corrosion etc.
  After inspection, depending on their physical condition, the towers can be categorised in 03 groups -

1. Protected structure - those having sufficient galvanized or maintenance coating protecting the steel. This allows them to be placed in the later years of maintenance cycle.
2. Stained structures – those which are still being protected by a thin layer of galvanized coating on the steel surface. This is the stage just before corrosion of the steel begins. The thin layer of galvanized coating will have a light brown color and will be smooth to the touch. Maintenance of these structures normally requires minimal surface

preparation and one coat of standard coating material.

3. Corroded structures, however, have lost all of their protective galvanized and/or maintenance coating. The steel surface is also rusting, thus losing structural integrity. The surface will be rough and/or pitted, and rust particles normally will come off when rubbed. Maintenance of structures in this condition require more extensive surface preparation and a surface tolerant primer prior to finish coat. As a result, it is far more costly to maintain corroded structures than those in the stained condition. In fact, the cost could be double of the stained structures.

   In maintenance painting schedule, the priority1 are the stained structures, priority 2 the corroded structures and protected structures come as Priority 3 i.e.at the end of the schedule. From a coating perspective, This proactive approach reduces maintenance costs by not allowing stained structures to reach the more costly corroded condition.

2. Norms for patrolling of lines

Article 23 of CEA Regulation 2010 (Grid Standard)

Inspection and Patrolling.- (1) All essential parameters, which indicate the healthiness of the equipment in a sub-station, shall be inspected by the shift engineer once in each shift and periodically by the officer-in-charge.

(2) Overhead lines shall be patrolled at periodicity decided by the transmission licensee and different patrolling schedules shall be implemented by the transmission licensees for normal terrain, vulnerable terrain and most vulnerable terrain.

(3) The patrolling schedules for ground inspection of live lines and tower top inspection of de-energised lines shall be separately issued by the licensees.

(4) The important lines shall be inspected by senior engineers after patrolling by junior staff and maintenance works such as tree cutting and replacement of damaged insulators shall be carried out immediately after patrolling, wherever required.

As per IS 5613,

All overhead lines should be patrolled periodically at intervals not exceeding 3 months from the ground when the line is live.

As per US code (CFR 192.705),

(a) Each operator shall have a patrol program to observe surface conditions on and adjacent to the transmission line right-of-way for indications of leaks, construction activity, and other factors affecting safety and operation.

(b) The frequency of patrols is determined by the size of the line, the operating pressures, the class location, terrain, weather, and other relevant factors, but intervals between patrols may not be longer than prescribed in the following table:

	Max. Interval between patrols	
Class location of line	**Highway / Rail-road crossings**	**Other places**
1,2	7½ months; but at least twice each calendar year	15 months; but at least once each calendar year.
3	4½ months; but at least four times each calendar year	7½ months; but at least twice each calendar year.
4	4½ months; but at least four times each calendar year	

(c) Methods of patrolling include walking, driving, flying or other appropriate means

of traversing the right-of-way.

3. Classification of terrain of electric lines i.e. normal terrain and vulnerable terrain

Terrains are generally classified based on pollution level in the area. The design of insulators changes depending on the level of pollution. The creepage distance has to increase with increased level of pollution.

As per IEC 60815, considerable increase in creepage distance is required to counter the increase in pollution levels from lower severity to higher severity level.

While the Indian Standard for insulators (IS 731) defines only two levels of pollution (Medium and Heavy) IEC 60815 defines four levels (light, medium, heavy and very heavy).

Pollution level	**Minimum Nominal Specific creepage Distance (mm / kV of phase to phase value of highest system voltage)**
Light	16
Medium	20
Heavy	25
Very Heavy	31

For critical locations coming in areas with higher pollution level, utilities can specify antifog type insulators with higher creepage distance or polymer insulators depending on the level of pollution and as per the recommendations of the RegionalPower Committee (RPC)

For arresting tripping of transmission lines during heavy fog condition, the RPC recommends –

The entire line length shall be classified as stretches of light, medium, heavy and very heavy pollution as per the following ESDD values.

Pollution Level	****ESDD (mg/sq.cm)**
Light	0.03 – 0.06
Medium	0.06 – 0.2
Heavy	0.2 – 0.6
Very Heavy	More than 0.6

** Equivalent Salt Deposit Density

Till data are created by ESDD measurements, pollution level stretches / terrains shall be determined on the following basis.

Pollution Level	**Basis**
Light	All line stretches not covered by medium heavy and very heavy pollution
Medium	Line stretches within 5 to 10 km radius from polluting sources like industrial pollution, brick kiln / sugar cane crushers/dying industry /bio mass power plant or similar installation having smoke emission and chimney height of 20-30 meters or salt laden barren land or kuchha road in agricultural land with heavy traffic or locations within a band of + 2 kms (as per distance to fault locator or visual inspection) where at least 3 flashovers has been observed in one

	single foggy day with normal creepage distance porcelain/ toughened glass discs.
Heavy	Line stretches within 2 to 5 km radius from polluting sources as defined for medium pollution and from coal /lignite based thermal power plants or dry ash disposal area or locations within a band of + 2 kms where at least 3 flashovers has been observed in one single foggy day with high creepage distance porcelain/ toughened discs.
Very Heavy	Line stretches near sea or within 2 km radius from polluting sources like coal /lignite based thermal power plants or dry ash disposal area or locations within a band of + 2 kms where more than 3 flashovers has been observed in one single foggy day with high creepage distance porcelain/ toughened discs.

4. Tower top patrolling – Ref article 3 at Part IV.

5. Thermo vision scanning –

It is one of the diagnostic tools for condition monitoring. The Thermo-vision scanning for hot spots on all overhead lines and sub-station equipment at voltage level of 220 kV and above shall be carried out at least once a year and necessary remedial measures shall be taken where hot spots are detected.

6. Punctured insulator detection

As per the recommendations of the Regional Power Committee (RPC) inquiry committee constituted by CEA on the grid incident in the northern region in January 2007 -

- Detection of punctured insulators needs to be carried out using hotline puncture detectors and change of punctured insulators so identified shall be replaced during scheduled maintenance. For medium, heavy and very heavily polluted stretches the replacement should be effected before onset of winters i.e October every year.
- For change of insulator strings, as far as possible hot line techniques may be followed and necessary hotline tools & gadgets and trained manpower be employed.

On-line tools shall include thermo-vision camera for detection of hot spots and live line punctured insulator detector.

7. Off-line fault location, signature analysis

For condition assessment / fault location of conductors, clamps, connectors, insulators etc, provision for off-line diagnostic tools are available. Off-line tools include insulation resistance measuring instrument and contact resistance measuring instrument.

While On-line measuring depends mostly on Protection Relays, EHV AC Transmission line Analyzer is a state of the art offline portable kit, capable of detecting accurately any fault on EHV Transmission lines and also helps in venturing beyond, into innovative line signature analysis study, useful in predictive maintenance of Transmission lines.

Thus Off-line Fault Locators can be used during patrolling of lines and detects potential faults which can be brought back to normalcy through timely maintenance. This will result in long trouble free operation of overhead transmission lines.

Maintenance schedule of Electric lines

Maintenance crews posted at locations within wireless / telephone link so that during emergency at any part of the line can be attended within the shortest possible time.
A small store house containing spare parts such as insulators, cable length, clamps located intermediate to maintenance posts. There should be routine inspection for stock checking.
A light truck with two way communication facility and equipped with necessary tools, tackles and materials for urgent repair work of the line.
Battery operated spotlights.

The maintenance of transmission line is in flowing steps:

1. Routine patrolling and inspection
2. Cleaning insulators periodically where necessary
3. Tightening of clamps and fixtures periodically
4. Replacement of cracked insulators
5. Clearing of trees, bushes etc
6. Inspection of earthing
7. Checking of towers for corrosion and remedial actions

- A Wireless power-line sensor hangs from an overhead power line and sends measurements to a data collection system. Because the sensor does not touch anything but a single live conductor, no high-voltage isolation devices are needed. The sensor is installed simply by clamping it around a conductor. The sensor powers itself from energy scavenged from electrical or magnetic fields surrounding the conductor being measured.[1]
- Overhead power line monitoring helps distribution system operators provide reliable service at optimized cost
- The primary purpose of a powerline sensor is to measure current, however, they can monitor other operating paramers such as:
  - Conductor temperature
  - Ambiant temperature
  - Inclination or the amount of line sagging
  - Wind movement
  - Electric fields

8. Safety in washing of live insulators and testing of insulators on live lines

As per the recommendations of the Regional Power Committee (RPC) inquiry committee constituted by CEA on the grid incident in the northern region in January 2007 -

- Cleaning of insulators may be completed by 15th November every year for all affected stretches. For very heavy pollution stretches the cleaning may be completed by 15th Dec so that pollution deposits shall be minimum during foggy days.
- Cleaning of insulators in the polluted areas with non washable contamination, shall be effected as per the procedures indicated in IEEE guidelines
- For cleaning of insulators in polluted areas with washable contamination, the present practice of manual cleaning of insulators may be progressively replaced with high pressure
- water jet live line washing wherever approach of truck mounted or telescopic boom washers are feasible. Else the practice of replacing polluted insulator string with cleaned insulator string may be adopted.

- The polluted insulator string removed from the line shall be washed/ cleaned at ground level and reused for replacing polluted insulator strings at subsequent locations.
- Helicopter live line washing needs to be resorted to in the areas where approach of truck mounted washers / telescopic boom washers is not feasible or where due to high pollution and its faster accumulation, speed of operation so demands. While practicing helicopter washing the safety considerations as per the IEEE guidelines (Refer Appendix) needs to be ensured. On an average, the helicopter needs to be utilized for approx. 5 hours per day or for effecting cleaning of approx. 10 circuit-km stretch of line.
- High pressure water jet cleaning shall not be practiced on polymer insulators.
- No detergent or soap water be used for cleaning of line insulators under energized conditions. If used for cleaning during un-energized conditions, this should be followed by a low-pressure flood rinse with clean water to remove any residue.
- Solvents may be used only after manufacturer approval, provided all cleaning residue are removed by the final clean water rinse.
- For selection of insulator strings, the committee has suggested that -
- Present practice of using porcelain insulator string units of 292 to 350 mm creepage distance may be continued to be employed in light pollution areas. In areas exposed to heavy fog and medium pollution level antifog insulators discs of creepage distance of 430 mm or higher (corresponding to creepage distance of 22 mm /kV for 400kV lines with 23 discs) or
- Porcelain long rod insulators offering equal creepage distance may be employed with insulator profile as per IEC 60815. In areas exposed to heavy fog and heavy & very heavy pollution levels composite long rod (polymer) insulators with silicon impregnated (SIR) weather sheds having creepage distance of 25mm/kV & 31mm/kV respectively may be employed.
- In respect of lines in operation, insulator strings shall be progressively replaced as per 3 above depending upon pollution levels.
- The quality of insulator cleaning whether by wet cloth or by pressurized water jet is dependant on adoption of correct methodology by the operator and better supervision (more so where it is outsourced). The operators /supervisors may be provided training in cleaning / replacement of insulator strings on de-energised line as well as live line working.

Hot line maintenance;

Under normal condition, all maintenance work will be carried out in de-energised condition only. However, during emergency situations to avoid / minimize human injury / loss of property, work may have to be carried out in energized condition (partly / fully) i.e. Hot Line Maintenance. However, such work will strictly be carried out by competent persons / designated key person in DMERP (Disaster Management & Emergency Response Plan) and as per approved standard procedures for pre-work and actual job execution.
In case of planned work in energized condition, a step by step protocol will be prepared including activity break-ups, sequence of execution, job responsibility and duration. One senior officer of the company from executing agency will be made responsible for safe execution of the entire work as per plan.

Besides authorised operation and maintenance managers, the protocol will be signed by all others who may be affected directly or indirectly. The protocol will be approved by Unit Head. Two principles for safe live line maintenance. The person is insulated from ground or grounded parts by means of special platforms, special tools, gloves, shoes etc thereby the contact current through body to eartrh is eliminated.

The person is provided with shielding metallic cage which is connected to the live part but is insulated from earth; thereby the electric field stress across the person is eliminated.

Conditions for Hot Line Maintenance –

- Do not start work until the following conditions are completed
  - Obtain Hot Line maintenance approval
  - Determine existing condition and complete the Job Hazard Analysis
  - Determine voltage rating of circuit to be worked on, distances to other energised lines and location of work
  - Prepare a written work procedure / protocol
  - Review work and safety precautions with the working group
  - Evaluate
- Safe working distance based on line voltage
- If aerial lift / Sky lift (platform and cage which can be raised / lowered, rotated / held in position from ground control) equipment can be used
- Personnel qualification / competency required. At least two workers, fully qualified for the voltage range (including other conductors within reach), must be available.
- If special equipment, tools or hazard protections are needed
  - Inspect tools and equipment before work starts
- Insulating mats of good quality and conforming to relevant standards
- Insulating ladder usually made of laminated epoxy resin bonded wood section or Fibre-glass resin insulated section.
- Insulated tongs and other insulated tolls for repair
- Leather protectors over rubber gloves
- Insulating guard equipment and insulating tools as per standards, preferably of FRP (Fiberglass Reinforced Plastic)
- Approved gloves and rubber insulating sleeves with hot-line tools. (Use of hot-line tools without gloves to detect tool deterioration is discouraged).
- Complete instructions and regulations detailing correct use and maintenance of such tools/equipment should be available and reviewed as a part of the work procedures.

Energised Work (Hot Work) precautions –

1. Check that circuit automatic reclosing devices have been made inoperative while work is being performed.
2. All items of a voltage class lower than required for the work should not be available to the workers at the work site.
3. Exercise special care when working in the proximity of equipment such as fuses, surge arresters, and similar equipment, or where conductor checks indicate burns or other defects in conductors, tie wires, and insulators. Procedures may require that some equipment be bypassed for the duration of the work.
4. Comply with adverse weather and number of qualified worker requirements.

9. Safety in working in underground systems.

Electrical work in underground system is a high risk activity.

Underground structures such as manholes, poorly ventilated vaults, tunnels etc should be treated as confines space and the risk increases manifold when some electrical work is taken up. There are many examples when a small negligence while working in confined space led to catastrophe, specially involving welding cutting job.

Worker Protection (Human Safety)

Hence, electrical work in underground calls for both Electrical as well as Confined Space Permit. Such activities require -

- Testing / monitoring of inside air quality
- Ensure adequate ventilation
- Respiratory protection and other PPEs and
- Training

Existing Utility Protection (during excavation) -

Locate and mark existing utilities in work areas where excavations are to be made. Digging restrictions may apply. Coordinate with the appropriate maintenance group or the fire department for unexpected hazards.

Precautions before entering a manhole -

1. Secure the work area.
2. Use the probes of an atmospheric tester to check air. First check for moisture on the end of the probe. If none found, test for air.
3. If air is acceptable, remove manhole cover.
4. Inspect the structure interior for the presence of water, oil, gasoline, or other contaminants which must be removed before work can proceed. Then check the structure by lowering the probe as far as possible .
5. If air is acceptable, set up the lifting A-frame on the manhole.
6. Enter (and leave) the structure by means of a ladder or climbing device for structures more than 4 feet (1.2 meters) deep. Never climb in or out by stepping on cables or their supports.
7. Test the air at each corner of the structure and at each of the duct entrances.
8. Provide additional ventilation as necessary. Continuous monitoring of air quality should be performed for work taking longer than 15 minutes. Whenever the cover has been replaced, repeat air testing.
9. Lower tools using a handline. Use the A-frame for heavy tools and parts, or when a manhole rescue must be made.

Precaution when working on underground structures –

1. Use only flashlights or facility approved lighting units for illumination. In hazardous locations (heat, spark, and impact resistant)..
2. Never have open flames inside the structure and avoid spark producing connections/ disconnections.
3. Move energized cables only when specifically approved. Never change energized cable bends.
4. Splicing and terminating of cable must be done by qualified cable splicers / terminators.

5. Equipment for heating cable splicing materials will be operated only by workers trained in such use.

Precautions during cable work in underground structures

1. Identify cables to be worked on and examine them for any damage.
2. Protect the work space by covering all live parts and cables with temporary insulation.
3. De-energize a cable and test for no voltage after waiting long enough for the dissipation of any static or capacitive charges. This period will be at least 5 minutes for capacitors with internal discharge resistors and at least twice the duration of an applied voltage test (“Hi-Pot”).
4. Ground the de-energized cable downstream from all sources of electric power and on both sides of the work location as hazardous potential differences may occur on de-energized (but not grounded) cables.
5. Proceed with cable work (such as cutting, resplicing, other reconnections, and fireproofing) in accordance with standard work procedures.

ANNEXURE II

FIRE PROTECTION & FIRE FIGHTING

It is necessary to install necessary hydrant points fire extinguishers at different locations of the power station as per recommendations of district fire officer.
Periodic drill of use of different types of fire extinguishers is must so that staff on duty in the power plant could operate these in case of emergencies.
First aid boxes as per recommendation of Factory Rules must be kept in the PS and these should be inspected periodically by station in-charge. Timely recoupment of consumed items must be ensured by shift in-charge.
Shift in-charge should also ensure timely refilling of fire extinguishers installed in the Power house. He must periodically check working of hydrant points.
Smoking inside power station should be prohibited. Throwing match sticks and other burning stuff may sometime create fire in the power station.
Additional fire extinguishers must be kept during maintenance specially when activities like, welding, brazing etc. are going on. Fire Retardant cloth must be used to cover electrical parts during such maintenance activities.
In power stations normally following types of fire extinguishers are used:

- Soda acid type
- Dry chemical type foam type (chemical foam)
- CO_2 cylinders
- Fire hydrants

IE Rule 43

(1) Fire buckets filled with clean dry sand and ready for immediate use for extinguishing fire, in addition to fire extinguishers suitable for electrical fires, shall be conspicuously marked and kept in all Generating stations, enclosed substations and switch stations in convenient situations.
The fire extinguishers shall be tested for satisfactory operation at least once a year and record of such tests shall be maintained.

(2) First Aid Boxes or Cupboards conspicuously marked and equipped with such contents as the state Govt may specify, shall be provided and maintained in all generating station, enclosed substation and enclosed switch station so as to be readily accessible during all working hours.
All such boxes and cupboards shall, except for in the case of unattended substations and switch stations, be kept in charge of responsible persons who are trained in First Aid treatment and one of such persons shall be available during working hours.

(3) Two or more Gas Masks shall be provided...in every generating station with capacity 5 MW and above and enclosed substation with transformation capacity of 5 MVA and above for use in the event of fire or smoke.
Where more than one generator of 5 MW and above is installed, each generator shall be provided with at least two separate Gas Masks...

ANNEXURE III

TRAINING

The Central Electricity recommends as follows (Ref Regulation 2010)

33. Training.-

(1) Every person involved in operation and maintenance of transmission lines shall be trained at the induction level and at least once in a year.

(2) The shift staff shall be trained to make them thorough in carrying out operations at each sub-station and every person concerned with real time operation shall be trained.

(3) Every grid operator shall undergo training in real time digital simulator and a refresher course at least once in two years.

(4) The maintenance personnel of every entity shall also be trained in preventive and breakdown maintenance of various equipment and the personnel shall be trained in various detailed maintenance procedures.

Guidelines under IE Rule 3.2-A (Annexure XIV):

The owner of every generating station of capacity 100 MW and above shall arrange for training of personnel, engaged in the operation and maintenance of his generating station, in the manner specified below –

(1) (a) The training may be arranged in his own institute or any other institute established for this purpose, Any institute, where such training is arranged shall have been recognised by the Central Electricity Authority

(2) There shall be separate training course for the persons to be engaged in operation and maintenance of thermal power station and hydropower stations together with associated substations

(3) Refresher courses shall be arranged periodically for the persons who have already undergone training under para (2) above and those who have already sufficient experience in the operation & maintenance of a generating station and are engaged in its operation and maintenance under cl.(b) of sub-rule 2A of Rule 3 to familiarise with modern practices of operation and maintenance

IE Rule 3.2A

- No person shall be authorised to operate or undertake maintenance of any part or whole of generating station of capacity 100 MW and above together with the associated substation unless he is qualified and has successfully undergone the type of training specified in Annexure XIV.
- The appropriate government may, on the recommendations of the owner of such generating station, relax the conditions stipulated in Cl.(a) of this sub-rule for any engineer and such other persons who have already sufficient experience in operation & maintenance of a generating station.
- The owner of a generating station, in consultation with the Central Electricity Authority, may alter the duration and manner of training in respect of those persons who have been already engaged in the operation and maintenance of a generating station or a substation.

1. Duration and content of training.

(3). The duration of the training course for the operating and supervisory staff to work in hydro-power stations shall not be less than nine months. This shall include 124 hours of lectures as specified in **Appendix V** to this annexure. The procedure for familiarisation,

visits and in-plant training shall be similar to that which has been specified in respect of thermal power stations as given below.

[After the lecture course is completed, the trainees should be taken on visits to a few modern power stations and factories manufacturing turnines, generators, switchgear, instrumentation and auxiliary equipments. The remaining period will be spent on in-plant training where the candidates will be given an opportunity to operate or maintain the machineries by themselves under close supervisions of regular operating staff as well as the training supervisors. Arrangements shall be made for familiarising the trainees with the operation of power stations, through simulator facilities]

Annexure IV

Syllabus for operation and maintenance staff who will be engaged in the operation and maintenance of Hydro electric generating station.

Particulars	Hours
Concept of modern hydro-station: Type of station, its role in power system, base load, peak load operation, plant layout, capacity, underground power station, hydraulic and electrical design features, inter-connection with other stations	3
Hydraulic system; Reservoirs – Type of reservoirs, storage capacity, operation of reservoirs, intake tower, surge tank, tunnels, forebays & pen-stocks, protection against water hammer and negative pressure in pen-stocks, provision for draining pen-stocks.	3
Type of Valves: Butterfly valve, spherical valve, needle valve – their operation and control	3
Water turbines: Types of turbines, their characteristics, ratings, specifications, constructional details	2
Generating system: Control circuit for generating, types of governors, pendulum (hydraulic, electronic)	3
Generator: Type and rating, cooling and ventilation system, bearing cooling arrangements, lubrication system, construction and characteristics of generators, split phase double layer winding, synchronising, loading, grounding of generator neutral.	3
Excitation system, types of exciters, voltage control, automatic voltage control, amplifying control, magnetic amplifier	5
Generator Protection: Earth Fault (Rotor and Stator), Negative Phase sequence, Differential protection, back up protection, Reverse Power protection, Under voltage protection, constructional details of the relays used, methods of setting and their testing	10
Hydraulic and electrical protective devices, load frequency control	3
Starting, shutting down and operating procedure	3
Power transformer connections, parallel operation, three single phase unit versus three phase unit, regulation, temperature control, tap changing, grounding	5
Transformer protection: Buchholz Relay, over current, differential and earth fault protection, types of relays used, their construction, testing and settings	5
Transformers commissioning: Dielectric strength of oil, insulation resistance, tap changer, filtration of oil, pre-commissioning testing	3
Cooling system for transformers	2
Circuit breakers, isolator diconnectors, bus-bar arrangements, charging and synchronising with the grid, disconnection for repairs, maintenance of switchgear contacts	4
Maintenance of equipments in the outdoor switchyard, current transformers, potential transformers, lightning arrestors, erection, operation and maintenance	4
Cable: High voltage oil filled cables, types of cables used, rating of cables, layout, testing	4
Principles of electronic controls and transistorised circuits	3
Pneumatic and electric transmitters and receivers, servomotors	3
Control Board- layout, indicating and recording instruments for monitoring and supervision, remote control of various equipments, signaling and interlocking, automatic reclosure of breakers on outgoing lines and enunciation system	3

Interlocking sequential control circuits, details of components used	4
Calibration and testing of various types of instruments, indicating, recording and analysers	4
Study of communication/system	1
House turbine set-its functions and use	1
Station transformers, alternating current, auxiliary supply, essential auxiliaries, auxiliaries in emergency, study of single line diagrams	3
Station Direct Current system-storage battery, rectifiers, motor generator set etc. their control and operation, standby source of station power, automatic change over to standby source of supply	3
Records- (hourly, daily, monthly, annually) of operations	2
Flow diagram and single line diagram for hydraulic and electrical system in the station	5
Air conditioning and ventilation plant, compressors	2
Operation under emergency conditions	2
General plant maintenance procedures	3
Cranes, hoists-characteristics and controls	2
Statutory Electricity Acts and Rules, permit procedure	2
Fire fighting	6
General safety precautions, first-aid	6
Personnel management, duties and responsibilities, labour laws & labour welfare	4
Total Hours	**124**

ANNEXURE V

List of important documents available for reference

1. Disposal policy for IT hardware, Version 1.0, Date of issue 05.10.2010. issued by IT & C Department, Corporate office, Faridabad.
2. IMS (Integrated Management System) Document – A very detail document containing various activities, their Aspect – impact / Hazard Identification & Risk Assessment (HIRA), Operation Control Procedures (OCPs), Work Instructions (WIs) etc. The document contains the following guidelines / schemes.
    1. IMSP/1/LR Legislative Register
    2. IMSP/1/AR Environmental Aspect Register
    3. IMSP/1/HIRA Hazard Identification & Risk Assessment
    4. IMSP/1/EP Emergency Plan
    5. IMSP/OCP-01 Operation & Maintenance of DG Set
    6. IMSP/OCP-02 Disposal of Batteries
    7. IMSP/OCP-03 Disposal of Used Oil
    8. IMSP/OCP-04 Conservation of Energy
    9. IMSP/OCP-05 Prevention of Oil Spillage & Leakage
    10. IMSP/OCP-06 Waste Disposal
    11. IMSP/OCP-07 Maintenance of Oil Catcher
    12. IMSP/OCP-08 Painting and Carpentry
    13. IMSP/OCP-09 Prevention of Fire
    14. IMSP/OCP-10 Reduction of Paper Consumption
    15. IMSP/OCP-11 Prevention of Leakage of Freon (R-22)
    16. IMSP/OCP-12 Conservation of Water
    17. IMSP/OCP-13 Canteen
    18. IMSP/OCP-14 OHS Guidelines for Suppliers
    19. IMSP/OCP-15 Integrate OHS Considerations at Planning Stage
    20. IMSP/OCP-16 Maintain Drinking Water Quality
    21. IMSP/WI-01 Health & Safety in Creche
    22. IMSP/WI-02 Good House Keeping
    23. IMSP/WI-03 Safety During Electrical Work
    24. IMSP/WI-04 Physical Exercises in Work Place
    25. IMSP/WI-05 Work Instruction to Reduce Noise at Work Place
    26. IMSP/WI-06 Work Instruction During Gas Cutting & Welding Operations
    27. IMSP/WI-07 Work Instruction for Work Place Safety
    28. IMSP/WI-08 Work Instruction for Handling Lift in Case of Emergency

ANNEXURE VI

IMS Documents on Maintenance available with Teesta V Power Station
Doc. No. TSV/IMS/PHM/F-05 for Annual Maintenance

Sl.	Description	Page
1.	Generator and Generator Transformer Protection U#1	12 of 65
2.	Excitation system U#1	6 of 65
3.	Unit Control Board and Governor panel U#1	11 of 65
4.	Unit Auxiliary Protection U#1	13 of 65
5.	Unit Control Board and Governor panel U#2	26 of 65
6.	400 KV XLPE cable protection U#1 at Control Room	15 of 65
7.	Supervisory Equipment in Control Room	50 of 65
8.	Control Panels(Unit Common, Station Service,EPS	51 of 65
9.	Control Panels (Auxiliary, PHC, DAM)	52 of 65
10.	PLCC,RTU & PA System	61 of 65

Doc No. TSV/IMS/PHM/F-03 for Daily Maintenance

Sl.	Description	Page
1.	EOT Crane and Elevator System	09 of 48
2.	400KV Bus Bar Protection	15 of 48
3.	400KV BUS COUPLER PROTECTION	16 of 48
4.	400KV Line Protection System	14 of 48
5.	400KV XLPE CABLE PROTECTION AT Control Room	13 of 48
6.	400KV XLPE CABLE PROTECTION AT Control Room	12 of 48

Note:
The above list of documents were furnished by NHPC (Teesta V). Our comments -

1. *List is not complete. Many pages are missing. This needs to be checked and complete / relevant list be incorporated in the final manual for reference*
2. *These documents were prepared in the year 2008 – 09 and have not been reviewed since then. Should be reviewed before inclusion in the manual.*

NHPC Teesta-V Integrated ANNUAL MAINTENANCE REPORT	Power Management	LIMITED Station System	Doc. No. : TSV/IMS/PHM/F-05 Rev. No. : 00 Page No.: 12 of 65 Eff. Date : 01.08.2009

Name of System/Equipment: Generator & Generator Transformer Protection for U #1			Date :	
ACTIVITY	**STATUS (OK / NOK)**	**OBSERVATION / FAULT (IF ANY)**	**ACTION TAKEN**	**REMARKS**
GENERATOR PROTECTION SYSTEM				
CT Circuit Checking				
PT Circuit Checking				
Meggering of CT Circuit				
Meggering of PT Circuit				
Check operation of all relays, contactors,				
Clean all electrical circuit thoroughly.				
Tightening of all the terminals				
Visual Check of the Cubicle Grounding				
Checking of Alarms in Control room				
Checking the tripping Circuit				
Checking of Generator Temperature relay				
Secondary Injection of Shaft current relay				
87s Differential Relay for Phase wise interturn				As per annexure-common-4& 5
Secondary injection of Thermal Overload relay				
Secondary Injection of Beckwith M-3425 Generator Protection Relay for the following protection element				As per annexure-common-4& 5
87G. Phase differential Current Function				As per annexure-common-4& 5

50. Instantaneous Over current Function				
51. Inverse time Overcurrent Function				
21G.Phase distance Function				
32. Directional Power Function				
40.Loss of field Function				
46.Negative Phase sequence current Function				
78. Out of Step Function				
60-1,60-2. VT Fuse loss detection Function				
64G1. 100% stator ground Function				
64G2. 95% stator Ground Function				
81. Frequencey Function				
59D. Over Voltage Function				
27. Under Voltage Function				
24. Volts per Hertz Function				
50/27 .Inadvertent Energizing Function				
GENERATOR TRANSFORMER PROTECTION SYSTEM				
CT Circuit Checking				
Meggaring of CT Circuit				
Check operation of all relays, contactors,				
Clean all electrical circuit thoroughly.				
Tightening of all the terminals				
Visual Check of the Cubicle Grounding				
Checking of Alarms in Control room				
Checking the tripping Circuit				
Secondary Injection of Beckwith M-3311 Generator Protection Relay for the following protection element				
87GT. Phase differential Current Function				
64R. Ground differential Function				
51N. Inverse time Neutral residual Overcurrent				

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Name of System/Equipment:	U#1 EXCITATION SYSTEM		Date :	
ACTIVITY	**STATUS (OK / NOK)**	**OBSERVATION / FAULT (IF ANY)**	**ACTION TAKEN**	**REMARKS**
Check foundation bolts of exciter fan				
Inspect the rectifiers for Vibrations				
Check Rectifier Protections				
Replace Fan motor bearing if required				
Inspect field circuit breaker contacts, arc chutes etc.				
Inspect AC/DC field flashing Breaker				
Checking of DC field flashing				
Checking of AC field flashing				
Inspect wiring for wear and burns or melted wire insulation.				
Inspect printed wiring board plugs, wiring and connectors for wear and burnts and also ensure correct seating.				
Regulator backup battery Change Over				
Check operation of all relays, contactors, breakers; inspect contacts, check operation of all firing, alarm and protection circuits.				
Secondary injection of MICOM P121 O/C relay and Scheme Checking				As per annexure-common-4& 5
Secondary injection of Rotor earth fault MX3IPG2A relay and Scheme Checking				As per annexure-common-4& 5
Checking the Digital Input				

Checking of Alarms in Control room				
Clean all electrical circuit thoroughly.				
Check & clean thyristor bridges				
Visually check inlet air filters and, if dirty replace/clean it.				
Visual Check of the Cubicle Grounding				
Check tightness of all connections and bolted joints.				
Check cables connecting slip rings and field winding				
Checking the wave form of firing pulse to thyristor Bridge				

NHPC LIMITED Teesta-V Power Station Integrated Management System ANNUAL MAINTENANCE REPORT	Doc. No. : TSV/IMS/PHM/F-05 Rev. No. : 00 Page No.: 11 of 65 Eff. Date : 01.08.2009

Name of System/Equipment: UNIT CONTROL BOARD & GOVERNER PANEL	Date :
U # 1 (UCB)	

ACTIVITY	STATUS (OK / NOK)	OBSERVATION / FAULT (IF ANY)	ACTION TAKEN	REMARKS
Cleaning of panel				
Cleaning of CPU ,I/O & associate modules				
Checking of panel earthing				
Tightening of all terminal box				
Checking of loose connection/damage of cable in between various control modules				
Checking of main AC & DC power supply				
Checking of voltage of power supply for control unit				
Checking of voltage of power supply for CPU unit				
Checking of voltage of Power Supply of interfacing modules				
Checking of tags in relays/control modules/transducer etc in the control panels				
Checking of digital I/P,O/P & Analog I/P modules signal				
Checking of trip signals (86-1 & 86-2) & its interface with HMI				
Checking of all SOE signals & its interface with HMI				
Checking of performance of battery used in				

CPU				
Checking of damaged insulation in the control cable/wire in the control panels.				
Checking of control operation in manual, Auto & CR mode.				
Functionality checking of Push bottom switch in control panel.				
Checking of RTD & DTT.				
U # 1 (GOV)				
Cleaning of panel.				
Cleaning of CPU ,I/O & associate modules.				
Checking of panel earthing.				
Tightening of all terminal box.				
Checking of any loose connection/damage of cable inbetween various control modules.				
Checking of main AC & DC power supply.				
Checking of voltage of power supply for control unit.				
Checking of voltage of power supply for CPU unit.				
Checking of voltage of Power Supply of interfacing modules.				
Checking of tags in relays/control modules/transducer etc in the control panels.				
Checking of performance of battery used in CPU.				
Functionality checking of Push bottom switch in control panel.				
Checking of digital I/P,O/P & Analog I/P,O/P modules signal.				
Checking of trip signals (86-2) & its interface with HMI.				
Checking of control operation in manual and auto mode.				

NHPC Teesta-V Integrated ANNUAL MAINTENANCE REPORT	Power Management	LIMITED Station System	Doc. No.: TSV/IMS/PHM/F-05 Rev. No. : 00 Page No.: 26 of 65 Eff. Date : 01.08.2009

Name of System/Equipment: PANEL U # 2 (UCB)	UNIT CONTROL BOARD & GOVERNER		Date :
ACTIVITY	**STATUS (OK / NOK)**	**OBSERVATION / FAULT (IF ANY)**	**ACTION TAKEN**
Cleaning of panel.			
Cleaning of CPU ,I/O & associate modules.			
Checking of panel earthing.			
Tightening of all terminal box.			
Checking of loose connection/damage of cable inbetween various control modules.			
Checking of main AC & DC power supply.			
Checking of voltage of power supply for control unit.			
Checking of voltage of power supply for CPU unit.			
Checking of voltage of Power Supply of interfacing modules.			
Checking of tags in relays/control modules/transducer etc in the control panels.			
Checking of digital I/P,O/P & Analog I/P modules signal.			
Checking of trip signals (86-1 & 86-2) & its interface with HMI.			
Checking of all SOE signals & its interface with HMI.			
Checking of performance of battery used in CPU.			
Checking of damaged insulation in the control cable/wire in the control panels.			

Checking of control operation in manual,Auto & CR mode.			
Functionality checking of Push bottom switch in control panel.			
Checking of RTD & DTT.			
U # 2 (GOV)			
Cleaning of panel.			
Cleaning of CPU ,I/O & associate modules.			
Checking of panel earthing.			
Tightening of all terminal box.			
Checking of any loose connection/damage of cable inbetween various control modules.			
Checking of main AC & DC power supply.			
Checking of voltage of power supply for control unit.			
Checking of voltage of power supply for CPU unit.			
Checking of voltage of Power Supply of interfacing modules.			
Checking of tags in relays/control modules/transducer etc in the control panels.			
Checking of performance of battery used in CPU.			
Functionality checking of Push bottom switch in control panel.			
Checking of digital I/P,O/P & Analog I/P,O/P modules signal.			
Checking of trip signals (86-2) & its interface with HMI.			
Checking of control operation in manual and auto mode.			

ANNEXURE XI

NHPC Teesta-V Integrated ANNUAL MAINTENANCE REPORT	Power Management	LIMITED Station System	Doc. No. : TSV/IMS/PHM/F-05 Rev. No. : 00 Page No.: 13 of 65 Eff. Date : 01.08.2009	
Name of System/Equipment:	**Unit Auxiliary Protection U #1**		**Date :**	
ACTIVITY	**STATUS (OK / NOK)**	**OBSERVATION / FAULT (IF ANY)**	**ACTION TAKEN**	**REMARKS**
CT Circuit Checking				
PT Circuit Checking				
Meggering of CT Circuit				
Meggering of PT Circuit				
Check operation of all relays, contactors,				
Clean all electrical circuit thoroughly.				
Tightening of all the terminals				
Visual Check of the Cubicle Grounding				
Checking of Alarms in Control room				
Checking the tripping Circuit				
Secondary Injection of O/C Relay				As per annexure-common-4& 5
Secondary Injection of Under Voltage Relay				As per annexure-common-4& 5
Secondary injection of Restricted Earth Fault Relay				As per annexure-common-4& 5

Name of System/Equipment: 400KV XLPE CABLE PROTECTION OF U# I at Control Room

Date:

ACTIVITY	MAIN				BACKUP		
	STATUS (OK / NOK)	OBSERVATION/ FAULT(IF ANY)	ACTION TAKEN	REMARKS	STATUS (OK / NOK)	OBSERVATION/ FAULT(IF ANY)	ACTION TAKEN
XLPE Cable PROTECTION SYSTEM							
CT Circuit Checking							
Meggering of CT Circuit							
Check operation of all relays, contactors,							
Clean all electrical circuit thoroughly.							
Tightening of all the terminals							
Visual Check of the Cubicle Grounding							
Checking of Alarms in Control room							
Checking the tripping Circuit							
Secondary Injection of Diffrential Protection Relay Make- Toshiba Model- GRL 100				As per annexure-common-4& 5			

	Secondary Injection of Overcurrent Protection Relay Make- Toshiba Model- GRD 110.				As per annexure-common-4& 5			
	Binary Input Checking							
	Binary Output Checking							
	Tripping Scheme Checking							

ANNEXURE XIII

NHPC Teesta-V Integrated ANNUAL MAINTENANCE REPORT	Power Management	LIMITED Station System	Doc. No. : TSV/IMS/PHM/F-05 Rev. No. : 00 Page No.: 50 of 65 Eff. Date : 01.08.2009

Name of System/Equipment:	Supervisory Equipment in Control Room		Date :
ACTIVITY	**STATUS (OK / NOK)**	**OBSERVATION / FAULT (IF ANY)**	**ACTION TAKEN**
Cleaning of panel of work station 1,2 &3.			
Cleaning of panel of Large display unit, Engineering Station, Zoom server & printers.			
Checking status of panel earthing of workstation 1,2 & 3.			
Checking status of panel earthing of Large display unit, Engineering station & Zoom server.			
Tightening of terminal box workstation 1, 2 & 3.			
Tightening of terminal box Large display unit, Engineering station, Zoom server & printers.			
Checking of main AC & DC power supply of Work station 1,2 & 3 .			
Checking of main AC & DC power supply of Large display unit, Engineering Station, Zoom server & printers.			
Checking damage of tags in relays/control modules/transducer etc in the workstation 1,2 & 3.			
Checking damage of tags in relays/control modules/ transducer etc in the Large display unit, Engineering station & Zoom server.			
Checking of LAN cable of workstation 1,2,3, Engineering station, & printers.			

NHPC LIMITED Teesta-V Power Station Integrated Management System ANNUAL MAINTENANCE REPORT	Doc. No. : TSV/IMS/PHM/F-05 Rev. No. : 00 Page No.: 51 of 65 Eff. Date : 01.08.2009

Name of System/Equipment:Control Panels(Unit Common,Station Service,EPS)			Date :
ACTIVITY	**STATUS (OK / NOK)**	**OBSERVATION / FAULT (IF ANY)**	**ACTION TAKEN**
Unit Common			
Cleaning of panel.			
Cleaning of CPU ,I/O & associate modules.			
Checking of panel earthing.			
Tightening of all terminal box.			
Checking of main AC & DC power supply.			
Checking of voltage of power supply for control unit.			
Checking of voltage in RECEPT point.			
Checking of voltage of power supply for CPU unit.			
Checking of voltage of Power Supply of interfacing modules.			
Checking damage of tags in relays/control modules/transducer etc in the panels.			
Station Service			
Cleaning of panel.			
Cleaning of CPU, I/O & associate modules.			

Checking of panel earthing.			
Tightening of all terminal box.			
Checking of main AC & DC power supply.			
Checking of voltage of power supply for control unit.			
Checking of voltage in RECEPT point.			
Checking of voltage of power supply for CPU unit.			
Checking of voltage of Power Supply of interfacing modules.			
Checking damage of tags in relays/control modules/transducer etc in the panels.			
Electric Power Supply			
Cleaning of panel.			
Cleaning of CPU ,I/O & associate modules.			
Checking of panel earthing.			
Tightening of all terminal box.			
Checking of main AC & DC power supply.			
Checking of voltage of power supply for control unit.			
Checking of voltage in RECEPT point.			
Checking of voltage of power supply for CPU unit.			
Checking of voltage of Power Supply of interfacing modules.			
Checking damage of tags in relays/control modules/transducer etc in the panels.			

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Name of System/Equipment: Control Panels (Auxillary,PHC,DAM)			Date :
ACTIVITY	**STATUS (OK / NOK)**	**OBSERVATION / FAULT (IF ANY)**	**ACTION TAKEN**
Unit Common Auxiliary			
Cleaning of panel.			
Checking of panel earthing.			
Tightening of all terminal box.			
Checking of main AC & DC power supply.			
Checking of voltage in RECEPT point.			
Checking damage of tags in relays/ control modules/transducer etc in the panels.			
Pothead Yard			
Cleaning of panel.			
Cleaning of CPU ,I/O & associate modules.			
Checking of panel earthing.			
Tightening of all terminal box.			
Checking of main AC & DC power supply.			
Checking of voltage of power supply for control unit.			
Checking of voltage in RECEPT point.			
Checking of voltage of power supply for CPU unit.			

Checking of voltage of Power Supply of interfacing modules.			
Checking damage of tags in relays/control modules/transducer etc in the panels.			
Dam Control			
Cleaning of panel.			
Cleaning of CPU ,I/O & associate modules.			
Checking of panel earthing.			
Tightening of all terminal box.			
Checking of main AC & DC power supply.			
Checking of voltage of power supply for control unit.			
Checking of voltage in RECEPT point.			
Checking of voltage of power supply for CPU unit.			
Checking of voltage of Power Supply of interfacing modules.			
Checking damage of tags in relays/control modules/transducer etc in the panels.			
Optical Fiber Panel			
Cleaning of panel.			
Clening of media converter,hub/switch & asociate modules.			
Checking of panel earthing.			
Tightening of all terminal box.			
Checking of main AC power supply.			

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Name of System/Equipment:	**PLCC,RTU & PA System**		**Date :**
ACTIVITY	**STATUS (OK / NOK)**	**OBSERVATION / FAULT (IF ANY)**	**ACTION TAKEN**
LINE 1 (MAKE : ABB)			
Cleaning of panel.			
Cleaning of Electronics card associate with the PLCC panels.			
Checking of panel earthing.			
Tightening of all terminal box.			
Checking of main AC & DC power supply.			
Checking of voltage in RECEPT point.			
Visual inspection of tags/ferrules of all the modules.			
LINE 2 (MAKE : BPL)			
Cleaning of panel.			
Cleaning of Electronics card associate with the PLCC panels.			
Checking of panel earthing.			
Tightening of all terminal box.			
Checking of main AC & DC power supply.			

Checking of voltage in RECEPT point.			
Visual inspection of tags/ferrules of all the modules.			
RTU			
Cleaning of panel.			
Checking of panel earthing.			
Tightening of all terminal box.			
Checking of main AC & DC power supply.			
Checking of voltage in RECEPT point.			
Visual inspection of tags/ferrules of all the modules.			
PA SYSTEM			
Cleaning of panel.			
Cleaning of associate modules.			
Checking of panel earthing.			
Tightening of all terminal box.			
Checking of main AC power supply.			
Checking of voltage in RECEPT point.			
Visual inspection of tags/ferrules of all the modules.			

ANNEXURE XVII

NHPC Teesta-V Integrated Power Management System LIMITED DAILY MAINTENANCE REPORT	Doc. No. : TSV/IMS/PHM/F-03 Rev. No. : 00 Page No.: 09 of 48 Eff. Date : 01.08.2009

Name of System/Equipment: EOT Crane and Elevator System			Date :
ACTIVITY	**STATUS (OK / NOK)**	**OBSERVATION / FAULT (IF ANY)**	**ACTION TAKEN**
EOT Crane			
Visual Inspection of all Panel.			
Check any abnormality on the Panel.			
Visual Check the hoist rope.			
Examine the operations of crane.			
Check any abnormal sound due to structural deformities in the crane during operations.			
Examine the sound of bearing during idle running & under Load			
Examine the noise of coupling during starting & stopping.			
Check operation of hoist limit switch.			
Check all the motors, if heatingup.			
Elevator			
Visual Inspection of all Panel.			
Check any abnormality on the Panel.			
Check the Cleanliness inside the CAR.			

Check operation of all the push Buttons inside the CAR.			
Check operation of CAR Call Push buttons.			
Check operation of CAR position indicator/ Direction Indicator.			
Check operation of Alarm Button.			
Check operation of Press & Speak Button.			
Check whether fan is working or not.			
Check the cleaniness of Door Sills, clean it by vaccum cleaner if required.			
Check the leveling of landing door & CAR Door.			

ANNEXURE XVIII

NHPC Teesta-V Integrated DAILY MAINTENANCE REPORT	Power Management	LIMITED Station System	Doc. No. : TSV/IMS/PHM/F-03 Rev. No. : 00 Page No.: 15 of 48 Eff. Date : 01.08.2009

Name of System/Equipment:	400KV Bus Bar Protection		Date :
ACTIVITY	**STATUS (OK / NOK)**	**OBSERVATION / FAULT (IF ANY)**	**ACTION TAKEN**
High Impedance Busbar Protection			
Visual Inspection of Panel.			
Check any abnormality on the Protection Panel.			
Check the DC Power supply Indication.			
Check the AC Power supply Indication.			
Check the relay status .			
Low Impedance Busbar Protection			
Visual Inspection of Panel.			
Check any abnormality on the Protection Panel.			
Check the DC Power supply Indication.			
Check the AC Power supply Indication.			
Check the relay status .			
Check the Protection-In-Service Switch in ON condition.			

ANNEXURE XIX

NHPC LIMITED Teesta-V Power Station Integrated Management System DAILY MAINTENANCE REPORT	Doc. No. : TSV/IMS/PHM/F-03 Rev. No. : 00 Page No.: 16 of 48 Eff. Date : 01.08.2009
Name of System/Equipment: 400KV BUS COUPLER PROTECTION	Date :

ACTIVITY	STATUS (OK / NOK)	OBSERVATION / FAULT (IF ANY)	ACTION TAKEN
Visual Inspection of Panel.			
Check any abnormality on the Protection Panel.			
Check the status of all Protection Relays.			
Check the DC Power supply Indication.			
Check the AC Power supply Indication.			
Check the Status of Circuit Supervision Relay Indication.			
Check the status of Protection Relay.			

NHPC Teesta-V Integrated DAILY MAINTENANCE REPORT	Power Management	LIMITED Station System	Doc. No. :TSV/IMS/PHM/F-03 Rev. No. :00 Page No.:14 of 48 Eff. Date :01.08.2009

Name of System/Equipment:	400KV Line Protection System			Date:		
ACTIVITY	MAIN-I			MAIN-II		
	STATUS (OK / NOK)	OBSERVATION/ FAULT(IF ANY)	ACTION TAKEN	STATUS (OK / NOK)	OBSERVATION/ FAULT(IF ANY)	ACT TAK
Line-1						
Visual Inspection of Panel.						
Check any abnormality on the Panel.						
Check the DC Power supply .						
Check the AC Power supply .						
Check the Status of the Protection relay.						
Check the status of the trip circuit supervision relay.						
Check the S43 Rc (JN) Switch in ON Condition.						
Line-2						
Visual Inspection of Panel.						
Check any abnormality on the Panel.						
Check the DC Power supply .						
Check the AC Power supply .						
Check the Status of the Protection relay.						

Check the status of the trip circuit supervision relay.						
Check the S43 Rc (JN) Switch in ON Condition.						

ANNEXURE XXI

NHPC Teesta-V Integrated DAILY MAINTENANCE REPORT	Power Management	LIMITED Station System	Doc. No. : TSV/IMS/PHM/F-03 Rev. No. : 00 Page No.: 13 of 48 Eff. Date :01.08.2009

Name of System/Equipment:	400KV XLPE CABLE PROTECTION AT Control Room			Date:		
ACTIVITY	Main			Back Up		
	STATUS (OK / NOK)	OBSERVATION/ FAULT(IF ANY)	ACTION TAKEN	STATUS (OK / NOK)	OBSERVATION/ FAULT(IF ANY)	ACTI TAKI
Unit#1						
Visual Inspection of Panel.						
Check any abnormality on the Panel.						
Check the DC Power supply Indication.						
Check the AC Power supply Indication.						
Check the relay Status.						
Unit#2						
Visual Inspection of Panel.						
Check any abnormality on the Panel.						
Check the DC Power supply Indication.						
Check the AC Power supply Indication.						
Check the relay Status.						
Unit#3						
Visual Inspection of Panel.						
Check any abnormality on the Panel.						

Check the DC Power supply Indication.						
Check the AC Power supply Indication.						
Check the relay Status.						

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Name of System/Equipment: 400KV XLPE CABLE PROTECTION AT Control Room				Date:		
ACTIVITY	Main			Back Up		
	STATUS (OK / NOK)	OBSERVATION/ FAULT(IF ANY)	ACTION TAKEN	STATUS (OK / NOK)	OBSERVATION/ FAULT(IF ANY)	ACTION TAKEN
Unit#1						
Visual Inspection of Panel.						
Check any abnormality on the Panel.						
Check the DC Power supply Indication.						
Check the AC Power supply Indication.						
Check the status of circuit supervision relay indication.						
Check the Status for both diffrential & Overcurrent relays..						
Unit#2						
Visual Inspection of Panel.						
Check any abnormality on the Panel.						
Check the DC Power supply Indication.						
Check the AC Power supply Indication.						
Check the status of circuit supervision relay indication.						
Check the Status for both diffrential & Overcurrent relays..						
Unit#3						

Visual Inspection of Panel.						
Check any abnormality on the Panel.						
Check the DC Power supply Indication.						
Check the AC Power supply Indication.						
Check the status of circuit supervision relay indication.						
Check the Status for both diffrential & Overcurrent relays..						

Annexure XXIII

Electrical Maintenance Check Lists

Check list for Transformers

- Cooling water system
- Firefighting system
- Transformer cooling oil pump position
- Buccholz relay
- Oil level in conservator
- Colour of silica gel
- IR of winding and core
- BDV of oil

Check list for Switchyard

- Compressed air in case of ABCB
- SF6 gas pressure in case of SF6 breaker
- Earthing switch position
- Isolator position – close
- Breaker position – off
- Line isolator position

Synchronization – These are the basic procedures for synchronization station generators with grid. However, in almost all new power stations the latest technology controls the entire process through Computers and SCADA without much of manual interference.

(a) Synchronization checks

- Line protection
- PLCC
- Give clearance for line back charging
- Close line isolators
- Close line breakers
- Now circuit is charged upto switchyard from remote end
- Start machine on auto mode

(b) Synchronization

- Close field breaker
- Now m/c will run at rated speed and rated voltage
- Check line voltage & frequency
- Check generator voltage & frequency
- Reduce or increase generator voltage & frequency to match with line voltage & frequency.
- At equal line & generator voltage and frequency close generator breaker.
- Now generator is synchronized with grid.
- Take minimum prescribed load immediately

(c) Checks after synchronizing and taking load

- Unit control board supply is changed to unit Aux. Transformers.

- Transformer “Motor for Cooling Water Supply” started.
- All parameters in control room are matching and correct.
- General check up of machine and other unit auxiliaries at all floors.

Routine Checks – These are for general reference and not for any specific unit neither exclusive for all units. Respective units shall have to prepare their own check lists with the given guidelines and fix frequencies as deemed suitable. Some check lists (OCP / WI) prepared by Teesta V unit are enclosed at Annex.

(i) Turbine & Governor

- Check Temperature of following
  - Thrust bearing
  - Upper guide bearing
  - Lower guide bearing
- Check following in normal working condition
  - Cooling water flow and pressure of all bearings at inlet & outlet
  - Sealing water flow and pressure
  - Stator cooling flow and pressure
  - Grease pump
- Check oil level in housings of all bearings
- Check if, there is vibration or abnormal sound in OPU pumps
- Check grease in the container of centralized grease lubrication system
- Check working of following
  - OPU pump 1 & 2
  - OLU pump
  - Drainage pump & Dewatering pumps
  - Governor compressor
  - General purpose compress
  - Ejector system for top cover drains
  - Cooling water strainers
- Check sealing water pressure & air seal pressure
- Check running and vibration of machine and ensure nothing is abnormal
- Check working of top cover drainage system
- Check water, oil and air flow indicators
- Check physical appearance of various system such as man holes, valves, indicators etc.
- Check G.V. Servomotor stroke & R.B. angle is normal
- Check general house keeping is in order and all panels, mountings on wall are clean and in order.

(ii) Generator, AVR & Excitation System

- Watch running and vibration of machine and ensure nothing is abnormal.
- Check for any sparking from the brush of slip ring.
- Check temperatures of winding & core. Ensure that these are with in limit.
- Check that all instruments and indicators mounted on unit control board, governor panel, AVR & excitation panel are in OK condition.
- Check all indication lamps are glowing.
- Check with test push button that all fault indication lamps are OK.

- Physical check of all sub distribution boards installed in P.S.
- Check all inlet exhaust fans are working.
- Check all batteries are physically in good condition.
- Check battery chargers are in normal working conditions.
- Check for any abnormality, sound, chattering in bus duct, generator barrel, neutral cubicle.
- Check all AC supply boards installed in Power House are okey.
- Check air conditioning plant is working satisfactorily.

(iii) Control room

- Check that all parameters indicated on various panel are matching.
- Check all indicating lamps are glowing. Also check annunciations are OK.
- Check movement of all pointers & reset them.
- Check all instruments mounted on panels are in working order.
- Check all facias & relays are reset.
- Check rear of all panels and mounting on this side for OK condition.
- Check emergency lighting system is OK.
- Check position of circuit breakers for out going lines.
- Check grid voltage & frequency.

(iv) L.T. room

- Check all indication lamps are glowing.
- Have general look on instruments and relays mounted on board.
- Check various switches are in correct position.
- Check whether supply to various distribution boards are OK.

(v) DC Distribution Board, Battery Charger & Battery sets

- Check D.C. voltage is correct.
- Check D.C. supply is healthy by making momentarily float off. This would ensure that batteries are connected with load.
- Check both batteries are on float.
- Check all the switches on DC board are in correct position.
- Check that both chargers are functioning correctly.
- Check all cells of battery bank are healthy. Their sp. Gravity and cell voltage is correct.

(vi) Main Transformers

- See that oil level is OK & there is no leakage from any where.
- Check that oil pressure and water pressure are normal.
- Check that oil temperature and winding temperature are normal.
- Check silica gel colour is normal.
- See that oil and water flow indicators are normal.
- Carry out following checks for healthy condition of Mulsifyre system:
  - Compressor
  - Power
- Oil level in conservator is normal.

(vii) Switchyard

- Have general look at switchyard including bus bars, jumpers etc. Ensure that there is no sparking any where and everything is in order.
- Check compressed air system in case of ABCB, is OK.
- Check SF6 gas pressure in case of SF6 breaker.
- Check position of all breakers, isolators & line isolator and cast a look on all
- CTs, PTs, LAs, Surge counters, wave traps and coupling capacitor and ensure that everything is in order.

(viii) Routine maintenance to be carried out during each shift

- ✓ Cleaning of all panels, instruments and equipment installed in power station.
- ✓ Oiling and greasing of all equipment as per instructions.
- ✓ Topping up of oil in bearings, OPU sump.
- ✓ Replacement of lamps, fuses etc.
- ✓ Cleaning of trash racks.
- ✓ Inspection of forebay, bye pass gates, intake gates.
- ✓ Any other work as assigned.

Work carried out during each shift shall be logged in control room log book.

Detail Checklists for Turbo-Generator

Sl. No.	Description	Freq	Remarks
1.00	**Stator**		
1.01.	Temperature record on log sheet for core and winding, hot and cold air temperature	H	
1.02.	Visual inspection of the overhang parts of the stator winding.	Q	
1.03.	Checking the fixing of winding, condition of winding joints with bus bars etc.	Q	
1.04.	Clean the winding with dry & clean compressed air (2 to 3 kg/cm2).	Q	Cleaning to be done such that the dust does not settle in side machine.
1.05.	Check overhang parts of stator winding, bus-bars, inner periphery of stator core (if possible), parts of stator winding in slots (specially at sector joint) binding & spacers between the winding bars/ bandage rings.	Y	
1.06.	Check looseness of overhang, busbars slot wedges etc.	Y	
1.07.	Check the fixing of stator active iron with the frame body in all possible places. If necessary, tighten the studs of pressing plates.	Y	
1.08.	Check pins & fixing of stator with foundations.	Y	
1.09.	Check D.C. resistance, IR & PI value	Y	Record to be

Sl. No.	Description	Freq	Remarks
			maintained
1.10	Check functioning of RTDs of stator.	Y	-do-
1.11	Blow the winding, active iron and bandage rings etc. with dry & clean compressed air (2 - 3 kg/cm2).	Y	
1.12	After cleaning apply Red-gel coat on the overhang.	Y	
1.13	In case of excessive wetting of stator winding during conditions such as flooding, drying of winding by passing current is not allowed initially as electrolysis of water may take place which is harmful to the winding.	AR	External heating arrangement to be provided till wetness is removed
2.0	**Rotor**		
3.01.	Check rotor winding and insulation details of current carrying leads.	Q	
3.02.	Check the condition of interpolar connections	Q	
3.03.	Check the condition of damper winding	Q	
3.04.	Check the locking of pole wedges.	Y	If required, carry out additional wedging.
3.05.	Check locking of rim wedges	Y	In case the wedges are Loose, contact manufacturer before attempting any rectification.
3.06.	Check the gaps of spider arms, brake track.	Y	
3.07.	Check tightening & proper locking of all fasteners.	Y	
3.08.	Clean rotor from dust by blowing compressed air free from moisture (2 to 3 kg/cm2).	Y	
3.09.	Measure D.C. resistance and IR value of rotor winding.	Y	Keep a record
2.10	Check the pole coils for inter-turn fault.	Y	
3.0	Slip-ring & Brush Rocker		
3.01.	Check sparking	S	
3.02.	Check pitting and grooving of slip-ring	M	In case of excessive grooving rectify by grinding.
3.03.	Check IR value of rotor through slip-rings before & after cleaning slip-rings.	Q	Keep records
3.04.	Clean the Brush rockers, Brushes, Slip-rings and the surrounding areas	M	Care be taken while removing carbon dust from 'V' shaped insulation pieces between slip-rings.
3.05.	Check brush wear and spring tension	M	Use precision spring

Sl. No.	Description	Freq	Remarks
			balance to adjust spring tension.
Note: C/brushes can be used till it is possible to measure/adjust spring tension			
3.06.	Check for absence of oil or its vapour in slipring area.	S	Oil leakages, if any, to be removed.
3.07.	Check distance of brush holder from slip-ring and keep it as specified in the drawing.	M	
3.08.	New brushes to be used after bedding the brushes. The brush should not be too tight / loose inside the holder.	while replacement	
3.09.	Ensure use of same & recommended grade of carbon brushes on one machine.	-do-	
3.10	Check all fasteners of slip-rings, brush rocker & current carrying lead.	Q	
3.11	Check carbon brushes for absence of pittings and severe wear & tear.	M	In case damage is excessive, replace complete set.
3.12	Inter change polarity of slip-rings.	HY	
3.13	Carryout thorough cleaning of slip-ring area. Stop oil leakages in this area.	HY	
3.14	In case the original insulating enamel unit is peeling off remove the balance enamel and apply fresh enamel.	Y	While cleaning avoid using insulating paint removers.
3.15	Check wobbling at slip rings.	At the time of installation/ major overhauling	
4.0	Thrust Bearing		
4.01.	Measurement of temperatures of T.B. Pad & Oil by RTD & TSD and record on log sheet.	H	
4.02.	Check & record reading of oil level relay.	S	
4.03.	Analysis of oil from oil bath.	HY	Record to be kept.
4.04.	Change of oil in T.B. oil bath	When centrifuging doesn't help in improving its quality up to acceptable values.	
4.05.	Check level of oil from the gauge glass. Any increase in level may be due to leakage of water in the oil bath coolers.	S	Unit should be stopped in case of leakage from ooling tube, plugging of cooling tubes upto 10% can be done depending upon bearing temp.
4.06.	Measures insulation resistance of T.B. disc.	Y	
4.07.	Check calibration of the TSD's & RTD's of thrust bearing.	Y	
4.08.	Check the working surface of thrust bearing pads, scrapping, if required, should be carried out with respect to T.B. disc after applying lard (animal fat) on the pads &	Y	

Sl. No.	Description	Freq	Remarks
	giving rotation to the unit. Load sharing on T.B. pads and the verticality of the unit to be checked thereafter.		
4.09.	Check the condition of mirror surface of T.B. Disc. Polishing of the surface can be done to remove minor scratches.	CM	This will require partial dismantling of unit.
4.10	Clean all inner surfaces of oil bath from dust, wash them with Kerosene and dry with clean cloth.	AY	Oil bath to be finally flushed with fresh turbine oil; to be discarded after use.
4.11	Check the condition of weld seam of oil bath & oil pipe lines for leakages visually.	Y	
4.12	Check the condition of insulation of RTD leads	Y	
4.13	Check if excessive foaming is taking place on oil through gauge glass. This is normally due to mixing of water leaking from oil coolers. If oil level is not rising, the oil may need defoment. Oil sample to be checked.	AR	Watch carefully for rise in water level to confirm leakage and attend accordingly.
4.14	Check if any insulating segment over T.B.Disc is displaced.	CM	
4.15	Check (in case of problem) the intactness of spherical surface of thrust bolt.	AR	
4.16	In case of uneven wear of pad, check that the pad eccentricity is correct.	AR	
4.17	Check for proper seating of pads	AR	
4.18	Change rubber seals & woolen felts	AR	

Annexure XXIV

Permit to Work

1. A specimen form is attached, which shall be used as reference to modify the existing PTW format.
2. All electrical jobs, (other than inspection or regular checks) / jobs requiring electrical isolation should be covered by electrical PTW.
3. Safety Dept should also be involved, as additional permitting authority if the job is to be performed in hazardous equipment, location or condition.
4. PTW should be in duplicate / triplicate (3^{rd} copy to Safety Dept) and should have printed serial no.
5. Relevant safety instructions / List of PPEs / safety appliances to be used may be printed on the backside of original copy.
6. There should be a standard procedure regarding authorisation or eligibility to apply / issue / receiving of Permit for different types of work
7. Protocol system shall be followed for work in extremely hazardous areas and involving more than one agencies..

Annexure XXV

References:

1. Report of the committee of experts, constituted by the Central Electricity Authority, Ministry of Power, Govt Of India, to review the insulation requirement of EHV transmission lines of various voltages (Published in November 2008)
2. Report of the committee, constituted by the Government of India, Ministry of Power vide their Office letter No. 11/5/2001-PG dated 9.11.2001, for updating the best practices in Transmission System in the country
3. Guidelines for operation & maintenance of small hydropower station - Alternate Hydro Energy Centre, Indian Institute Of Technology, Roorkee
1. CEA Regulation 2010 (Grid Standard)
2. EHV-AC, HVDC Transmission & Distribution Engineering – S Rao

No.

WORK PERMIT

FOR ELECTRICAL / MECHANICAL WORK REQUIRING ELECTRICAL SHUTDOWN / ISOLATION

Permits to be issued / received by authorised persons only

Permit Issuing / Controlling Dept: **Date:**

Requisition

Name of the equipment: **Location:**

Type of work: Electrical / Mechanical. **Nature of work**: PM / CBM / BDM (Tick whichever applicable)

Description of work: _____

_____

Special instruction, if any: _____

Name of Supervisor: _____ **Desig / Dept** _____

Names of workmen: 1. _____ 2. _____ 3. _____

4. _____ 5. _____ 6. _____

Date / Time Start: **Date / Time Finish:**

Requisitioned By: _____Signed: _____Date: _____Time_____

Issuance:

Safety requirements fulfilled: **Isolation** ☐ **Locked** ☐ **Tagged** ☐ **Earthed** ☐

Special precautions taken

Special instruction, if any: _____

Validity: Till Date _____ **/ Till Time** _____

Shift I/C to sign at the beginning of each shift for validity at the back side with Name, Date & Time

Permit Issued By: _____Signed: _____Date: _____Time_____

Permit Receiving:

I understand the work that is to be carried out and the safety precautions that are necessary to complete the work safely. In case of any abnormal situation / unsafe condition, the work will immediately be stopped and issuing authority informed.

Permit Recvd By: _____Signed: _____Date: _____Time_____

Permit Return:

I declare that the work described above is complete. All work equipment, persons and materials under my control have been removed, safeguards reinstated. The work area returned to a safe status and service.

Permit Returned By: _____Signed: _____Date: _____Time_____

Permit Cancellation:

I declare that the permit is now closed and I have received original copy / copies of the permit back from the responsible person(s). The area has been inspected and is free from risk and all safety devices have been reinstated to their normal operating status.

Permit Cancelled By: _____Signed: _____Date: _____Time_____

Prepared By: D. Mahata, Expert Member,
National Safety Council of India, Mumbai.

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