



CHAPTER 1

SAFETY IN EXCAVATION JOBS

1.1 SAFETY IN OPEN EARTH AND ROCK EXCAVATION

1.1.1 **Reference:** IS 3764:1992 Safety Code for Excavation Work

1.1.2 **Scope:**

This covers the requirements for carrying out safely the excavation work such as trenches, test pits, cellars, borrow pits, cutting for rails, canal and road formations and all excavations on which the sides of excavations are not trimmed simultaneously to a stable slope at the Rampur Hydro electric Project, Jhakri, Himachal Pradesh.

1.1.3 **COMMON HAZARDS IN EXCAVATION:**

Following measures should be adopted and effectively carried out for preventing accidents due to the **nature of excavated material** resulting into fall of persons, machinery and materials in excavation jobs;

A) **QUICKSAND**

As quicksand tends to run, close continuous sheathing should be used for holding it whereas only bracing may be used to hold damp sand, as it is more stable and Rocks should be sealed to prevent fragments falling.

B) **EFFECT OF FREEZING AND THAW**

During freezing water expands and rock fragments and boulders frequently loosen. And also during heavy rainfall sidewalls of a trench may become unstable whereas during a thaw sidewalls may crack. Suitable bracing or sealing of the loose material from sides should be provided to prevent any accident occurrence.

C) **VIBRATION FROM NEARBY SOURCES**

Additional bracing precautions should be provided for sites having vibration due to adjacent machinery, vehicles, railroads, blasting and other sources.

D) **SURCHARGE IMPOSED BY ADJACENT BUILDINGS, LUMBER PILES**

Additional bracing should be provided to support sides of trench on account proximity of buildings, piles of materials, construction machinery and other heavy objects.

1.1.4 **RESPONSIBILITIES**

A) **Responsibilities of Site Incharge:**

In all works an **experienced and competent** foreman or supervisor should be placed In-Charge of the work whose authority to enforce the rules, guard against the use of defective safety appliances, rigging, tools and materials, to see that no man is permitted to do work for which he is not qualified and to brief all workmen on the plan of work before it is started with special emphasis on all potential hazards and on the ways to eliminate or guard against them and responsibilities for strict observance of the safety rules have been made clear to him and his subordinates.



He should inspect the sides of excavated site during the course of activities and after every rain, storm and necessary precautions against slides and caving should be provided.

No excavation of earthwork below the level of any foundation of a building or structure should be commenced or, continued unless adequate steps are taken to prevent danger to any person employed, from collapse of the structure or fall of any part thereof.

First aid facilities should be provided at conspicuous places at excavation site under the charge of trained persons – first aiders.

B) Responsibilities of Workers:

All workers should get trained in use of safety devices and appliances provided to them.

Workers who are not aware of hazards peculiar to the work should not proceed to work without being properly instructed and they should obey the instructions of the properly qualified and authorized person under whom they would work.

In case any worker feels that he cannot perform a work safely he should immediately inform the site in charge of his inability to carry on with the work.

All persons entering trench where hazards from falling stones, timber or other materials exist should wear IS approved and certified safety helmets and they should also wear appropriate IS approved and certified safety footwear and safety belt attached to lifeline and life lines should be securely tied to at least two anchorages. Manila lifeline used should be at least 20 mm in diameter.

1.1.5 SHORING

All trenches in soil more than 1.5 m deep and in friable or unstable rock exceeding 2 m in depth should be securely shored by approved quality of Sal wood or material having strength not less than it. Materials used for bracing, shoring etc. should be in good serviceable condition sound and free from large or loose knots. Shoring is comprised of following three members;

A) Sheathing:

The sheathing should be placed against the side of the trench so that length of each piece of sheathing is vertical and is held securely in place against the Wales by ensuring that the sheathing is kept firmly pressed against the wall of the trench.

When the trench is excavated in loose, sandy soil or soft soil or soil that is under hydrostatic pressure, each piece of sheathing should be driven into bottom of the trench so as to be firmly held in place.

B) Wales

The Wales should be parallel to the bottom of the trench. Each wale should be supported on cleats spiked to the sheathing or by posts set on the Wales next below it. Where necessary wedges should be provided between a wale and sheathing it supports so as to provide uniform support to all individual pieces of sheathing.

C) Struts

Struts should be horizontal and at right angles to the Wales or sheathing supported thereby and should be cut to proper length required to fit in tightly between the Wales. It should be ensured that no nails are protruding out of wooden planks to cause any injury.



IS 3764:1992 Code of safety for excavation work may be further referred for the sizes and spacing of members of shoring.

For deep and wide-open cut excavations where it is not possible to provide safe stable slopes for excavated pit, steel sheet piling may be provided for side protection in form of retaining wall to contain the materials adjacent to the excavation. IS 2314:1986 Code of Practice for Steel sheet piling should be further referred for the sizes and spacing of sheet piling.

1.1.6 LOOSE SIDE MATERIAL AND MINIMUM BERM

All loose stones, projecting clumps of earth and unstable material that may come down on workers in trench should be removed and the excavated sides should be adequately braced and trench suitably guarded. On steep slopes workmen should not be permitted to work one above the other.

Stockpiles of these materials should not be located in the immediate vicinity of overhead power lines and materials should not be piled against walls as it may endanger the walls.

Excavated material should not be stacked within 1/3 rd of depth of the pit or 1m whichever is more, away from the edge of any excavation and should be stored and retained so as to prevent it from falling or sliding back into the excavation and to prevent excessive pressure upon the sides of the excavation.

1.1.7 MEANS OF ACCESS

In all trenches 1.5m or more in depth, ladders extending from the floor of trench excavation to at least 1m above top of excavation shall be provided and so located as to provide means to exit without more than 15m of lateral travel.

1.1.8 PROVISION OF LIGHT AND WARNING SIGNALS

Excavation areas shall be adequately lighted for night work.

During hours of darkness all public sidewalks shall be adequately illuminated and warning lights about the excavation shall be provided to ensure safety of pedestrians and vehicular traffic.

At all approaches and exists of the sites of excavation; danger and warning signal shall be placed. To emphasize the danger, a flagman with a red flag shall also be posted to warn the public or approaching trucks and to direct trucks in and out of the site of excavation.

Every accessible part of an excavation pit or opening in the ground into which a person is liable to fall vertically from a height of 2m or more, suitable barrier about one meter high shall be provided.

1.1.9 INSPECTION & EXAMINATION:

(a) No person shall work in any excavation, shaft, and earthwork or tunnel unless all timbering and plant used therein are inspected by a competent person before work is started and also after explosives have been used in or near the excavation, shaft, earthwork or tunnel.

(b) When open excavations with steep side slopes are carried out by means of blasting, after every blasting operation, the side slopes of excavations shall be carefully examined by a



competent person to prevent rock falls. Work inside the excavations shall not commence until all loose rock on the sides is first removed. All workers engaged in such excavation shall use hard hats.

(c) No material or load shall be placed or stacked near the edge of any excavation, shaft, pits or opening in the ground which may endanger persons working below.

(d) Adequate measures shall be taken to prevent workers and spectators from approaching the dangerous areas. Visitors shall not be allowed on the scene of excavations unless a supervisor accompanies them.

1.2 SAFETY IN TUNNEL AND SHAFT EXCAVATION:

1.2.1 Reference: IS 4756:1978 Safety Code for Tunneling Work

1.2.2 Scope:

It lays down the safety requirements for tunneling and underground excavations in rocks and soft strata at Rampur Hydro Electric Project, Jhakri, Himachal Pradesh.

The works involved in tunneling is of a specialized and hazardous in nature. Cramped working space in the heading, wet and slippery flooring, artificial lighting – all too often inadequate, difficult ventilation, obnoxious gases, unseen weakness in the rock, handling of explosives, leading and hauling muck, etc. might contribute to accidents. In order to avoid hazards, it is necessary to follow all possible safety precautions of the use of machinery, electrical installations and labour in tunnels, during the construction period.

1.2.3

SAFETY RESPONSIBILITIES OF PERSONNEL:

1. All operations inside the tunnel or shaft shall be carried out under the immediate charge of a competent engineer incharge. The engineer incharge shall also be responsible for the safety arrangement of the work. In larger jobs these responsibilities and function in respect of safety arrangements may be delegated to an independent qualified and competent safety officer working under the overall control of the engineer incharge. Periodically meetings shall be conducted to review the effectiveness of safety measures.

2. Workmen shall be thoroughly instructed in safety rules and shall be required to follow them at all times. They shall be required to report immediately any unsafe conditions observed.

3. The engineer incharge appointed to look after the tunneling 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.

4. Where the geological data collected so warrants advance probe holes by percussion or core drilling, as required, shall be drilled ahead of the tunnel faces to locate any gas, flowing mass of rock, aquiferous strata, geological disturbances, etc. In case presence of gases like methane is detected, further tunneling 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.



5. If the geological data collected and information from other sources indicate presence or likelihood of gases like methane, advice of DGMS shall be sought about supervising personnel to be entertained and additional safety precautions necessary.
6. The occurrence of any accident, involving personal injury or of any dangerous incident, such as serious break-down of or damage to any apparatus / equipment shall be reported to the supervisory staff / officers and adequate precautionary measures shall be taken by the engineer-in-charge to prevent recurrence. An accurate record of such accidents shall be properly maintained. Probable reasons of accidents shall be investigated and precautionary measures taken to avoid further recurrence.
7. Accidents occurring during the fortnight shall be discussed in the safety meetings and adequate publicity shall be given to the causes of these accidents and their preventive measures.

1.2.4 MEDICAL AND OTHER FACILITIES

- a) First-Aid Arrangements: Arrangements for rendering prompt and adequate first-aid to the injured persons shall be maintained at every work site under the guidance of a medical officer-in-charge of the project. Depending upon the magnitude of the work the availability of an ambulance at a very short notice (at telephone call) shall be ensured.
- b) First-aid arrangement commensurate with the degree of hazard and with the number of workers employed shall be maintained in a readily accessible place throughout the whole of the working hours. At least one experienced first-aid attendant with his distinguishing badge shall be available on each shift to take care of injured persons. Arrangements shall be made available for calling the medical officer, when such a need may arise. It is recommended that engineer incharge or foreman who is normally present at each working face in each shift be given adequate training on first-aid methods to avoid employment of a separate attendant.
- c) Stretchers and other equipment necessary to remove injured persons shall be provided at every shift and portal.
- d) Where there are more than 50 persons working in a shift, effective artificial respiration arrangements shall be provided, with trained men capable of providing artificial respiration.

1.2.5 MISCELLANEOUS:

- a) Only the materials required for work in progress shall be kept inside the tunnel. All other materials shall be as even as possible and without any obstacles to enable the workers to get out of the tunnel quickly in case there is any collapse or any other mishap inside the tunnel.
- b) All storage handling and use of flammable liquids shall be under the supervision of qualified persons. Flammable liquids shall not be stored inside the tunnel.
- c) All sources of ignition shall be prohibited in areas where flammable liquids are stored, handled and processed. Suitable warning and "NO SMOKING" signs shall be posted in all such places. Receptacles containing flammable liquids shall be stacked in such a manner as to permit free passage of air between them.
- d) All combustible materials like rubbish shall be continuously removed from such area where flammable liquids are stored, handled and processed. All spills of flammable



liquids shall be cleared up immediately. Containers of flammable liquid shall be tightly capped.

- e) Fire extinguishers and fire-buckets appropriate to the hazard should be conveniently located and identified.
- f) Telephone system – A telephone system shall be provided to ensure a positive and quick method of communication between all control locations inside tunnel and portal of the tunnels when longer than 500 m and for shafts when longer than 50 mtrs.
- g) Warning signals – Irrespective of length and bends in the tunnel, arrangements shall be made for transmitting of warning signals by any one of the following means:
 1. By electrically operated bells, operated by battery / dry cells with the bell placed outside the tunnel and the position of the switch shifting with the progress of the tunneling work. The position of the operating switch although temporary shall be so chosen as to ensure proper accessibility and easy identification.
 2. By the use of two field (magnet type) telephone.
 3. Any other suitable arrangement like walkie talkie
 4. Up to 100m length of the tunnel only one of the systems mentioned above shall be provided whereas in tunnels of length more than 100 m at least two systems shall be installed; the wires running along opposite sides of the tunnel, if practicable.
 5. Red and green lights of adequate size and brightness shall be provided at suitable intervals on straight lengths and curves, cross over points, etc. to regulate the construction traffic.
 6. In all the cases as above the system(s) shall be subject to daily checks regarding proper serviceability. The checks shall be carried out every day immediately prior to the commencement of the tunneling work under the supervision of a responsible person.

1.2.6 ELECTRICAL INSTALLATIONS AND LIGHTING

- a. The entire electrical installation shall be carried out according to the existing Indian Electricity Rules as modified from time to time.
- b. General Provisions: All parts of the electrical installations shall:
 - have all conductors and contact areas of adequate current carrying capacity and characteristics for the work they may be called upon to do and all joints in conductors shall be properly soldered or otherwise efficiently made;
 - be so constructed, installed and maintained as to prevent danger of fire, external exposition and electric shock;
 - be of adequate mechanical strength to withstand working conditions underground;
 - 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 contact with the same.
 - Usage of Earth leakage circuit breakers shall be encouraged for distribution of power supply from the panels.
 - A passageway not less than 60 cm wide shall be maintained in front of switchboards.
 - Rubber mats shall be provided in front and in back of the switch boards. No one shall be permitted at the back of switchboards when the current is on.



- In no case, space in front or back of a switchboard shall be allowed to be used as a change room, locker or storage room.
 - All electric wires carrying voltage 440 and above installed underground shall be in the form of insulated, lead covered cables, armored effectively against abrasion and effectively grounded.
 - Identification – Electrical equipments in use shall bear the essential details of voltage, amperage and circuit diagrams, etc.
- c. Ventilation – All places where electrical apparatus is installed shall be adequately ventilated in order to ensure proper cooling of the apparatus and dilution of flammable gases.
- d. Lighting: Adequate lighting shall 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 shall 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 shall be provided for efficient and safe working. The lighting in general in any area inside the tunnel or outside an approach road, etc. shall not be less than 10 lux.
- e. Emergency lights (battery operated) shall be installed at the working faces and at intervals along the tunnel to help escape of workmen in case of accidents. All supervisors and gang-mates shall be provided with cap lamps or hand torches. It shall be ensured that at least one cap lamp or hand torch is provided for every batch of 10 people.
- f. Any obstruction, such as drill carriages, other jumbos and drilling and mucking zones in the tunnel shall be well lighted.
- g. 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 shall, therefore, be properly grounded. The switches shall be located on a high ground and these shall be properly grounded.
- h. Use of Hand Lamps Underground – Hand lamps shall be:
- Equipped with strong cover of glass or other transparent material, dust and waterproof,
 - Equipped with a strong and guard over the cover and,
 - The exterior of all lamp sockets shall be non-metallic.
- i. All electrical apparatus including portable tools shall be connected only to an electrical supply system, which shall have proper earthing and grounding.
- j. The following notice shall be kept exhibited at suitable places:
- A notice on the board of 45 x 30 cm prohibiting unauthorized persons from entering electrical equipment rooms.
 - A notice on the board of 45 x 30 cm prohibiting unauthorized persons from handling or interfering with electrical apparatus.
 - A notice on the board of 60 x 90 cm containing directions as to the rescue of persons in contact with live conductors and the restoration of persons suffering from electrical shocks.
 - A notice specify the person to be notified in case of electrical accident or dangerous occurrence, and indicating how to communicate with him.
 - Suitable warnings shall be placed at all places where contact with or proximity to electric equipment can cause danger.



- k. Telephone lines shall be laid on the opposite of the electric side in the tunnel. No blasting line shall preferably be laid within 3m of the light and power line; its distance from a telephone line being immaterial so long as insulation can be ensured.
- l. Voltage for lighting in a tunnel should be 125V between phases as specified for underground lighting in terms of Rule 118 (c) of Indian Electricity Rules, 1956.
- m. Adequate number of persons, including all supervisors and electricians shall be adequately trained in the manual application of artificial respiration to persons suffering from electric shock and in particular should be aware of the necessity for immediate and continued application. A board of instructions for artificial respiration shall be hung at a conspicuous place.

1.2.7 PROTECTION AGAINST FIRE

- a. As far as practicable, combustible material shall not be used in the construction of any room or recess containing electrical apparatus.
- b. No flammable material shall be stored in rooms, recesses or compartments containing electrical apparatus other than telephone, lighting apparatus and damp-proof apparatus.
- c. Adequate fire extinguishing equipment suitable for use on live parts shall be kept ready for immediate use in or near any room, recess or compartment containing such parts as will be readily accessible safely for use in case of emergency. These equipments shall be tested at least once in a month.
- d. On the occurrence of a fire caused by any electrical apparatus or a fire liable to affect any electrical;
 - the supply of electricity should be cut off from such apparatus or installation as soon as practicable, and
 - The fire shall be attached as soon as possible and reported to the nearest available supervisor.
 - All waste and combustible rubbish shall be removed at least daily from the tunnel.

1.2.8 UNDERGROUND EXCAVATION

- a. Drilling Equipment:
 1. All drilling equipment shall be kept in good working order. Safe handling and proper lifting methods shall be used.
 2. Only wet drilling shall be permitted
 3. Jumbos or other drill platforms shall be carefully designed, built and maintained to provide safe working conditions. The jumbo should be provided with a suitable railing around the top deck.
- b. Drilling operations – The drilling operations shall be carried out as specified in this document.
- c. Drilling shall not be resumed after blasts have been fired until a through examination has been made by blasting foremen (head blaster) to make sure that there are no misfired charges which the drill may strike.
- d. All holes shall be of slightly greater diameter than the diameter of cartridges of explosives used.
- e. A drill, pick or bore shall not be inserted in butts of old holes even if examination fails to disclose explosives; separate holes shall be so drilled as to be nowhere less than 30 cm clear distance away from the previous hole.



- f. Charging of drilled holes and drilling shall not be carried out simultaneously in the same area by using non-electric detonation.
- g. The air supply manifolds and the lines of supply to each drill shall be examined according to the numbers of drilling equipment.

1.2.9 UNDERGROUND TRANSPORTATION AND STORAGE:

- a. Explosives and detonators shall be placed in separate insulated carriers, whether carried by persons or conveyed mechanically and an attendant shall ride with the explosives being conveyed mechanically on slopes in shafts or in underground work areas. For carrying explosives mechanically, prior permission of Chief Inspector of Explosives shall be obtained.
- b. Insulated containers, used for carrying explosives or detonators shall be constructed of finished wood (not less than 5 cm thick) or plastic (not less than 6mm thick) or pressed fiber (not less than 10 mm thick). There shall be no metal parts not even nails, screws, bolts, etc. and it shall be waterproof and provided with lid. The container shall be provided canvas handle or a strap. For use of plastics in the container for carrying explosives, prior permission of Chief Inspector of explosives shall be obtained.
- c. Explosives and detonators shall be transported in separate insulated containers, and in separate compartment where rope or locomotive haulage is used. Cars shall not have metal parts exposed on the inside. They shall have an open space of 45 cm between explosive and detonator compartments and nothing shall ever be carried in that space. The car body and compartments shall be made of plank not less than 5 cm thick. Doors for the explosive and detonator shall open on opposite sides of the car and kept locked except when loading or unloading. Explosives or detonators may be transported in ordinary cars, if they are placed in separate insulated carriers or compartments or containers.
- d. Cars used for transportation of explosives shall not be loaded beyond their rated capacity and explosives shall be so secured to prevent shifting of load or dislodgment from car in transit.
- e. All cars transporting explosives shall be marked or placarded on both sides and ends with word 'Explosives' and provided with two red flags and during night by two red lights. Cars transporting explosives shall be equipped with at least two fire extinguishers.
- f. Explosives and detonators shall be brought to the working places in separate, tight, well-insulated containers, and kept in the containers until removed for placement in drill holes. If drill holes are not ready, they shall be stored in locked box type magazines located at a safe distance of at least 170m from the working space.
- g. Wooden explosive cases shall be opened only with wooden mallets and wedges. Metal tools shall not be used. Scooping out or breakage of cartridges and spilling of their contents shall be avoided.
- h. No person other than a shot firer shall carry any priming cartridges into a shaft, in which the sinking is in progress. No such cartridge shall be so carried except in a thick felt bag or other container sufficient to protect it from shock.

1.2.10 LOADING AND BLASTING

- a. Electric firing shall be done by an approved method. A departure from this may be permitted only with the specific approval of the engineer-in-charge.



- b. All drilling equipment and personal not engaged on loading shall be removed from the site before loading of holes start. Loading of around shall be completed by the crew starting the work of loading. Firing of round shall be the responsibility of the blasting foremen (head blaster).
- c. Just before loading is started each hole shall be blown out with a high- pressure air jet to remove loose cuttings and water.
- d. In the process of charging or stemming a hole, iron or steel, tool, scrapper or tamping rod shall not be used for tamping the charge. Stemming and tamping of the charge may also be accomplished by the use of air jet.
- e. No material other than clay sticks 25 mm dia and 10 cm long shall be used for blinding and sealing the holes after charging the same.
- f. Before use each and every electric detonator shall be tested for a positive test with the help of an ohm-meter. Before shot firing, the circuit shall be tested for insulation and for continuity.
- g. Before a shot is fired in an underground working place due warning shall be given to persons within 330 m in all directions and every entrance to the place where a shot is about to be fired shall be guarded so as to prevent any person, not having received warning from placing himself in dangerous proximity to the shot.
- h. For loading purposes the employees shall be equipped with permissible battery lamps.
- i. Only such explosives as produce less than 4530 ml of poisonous gas (carbon monoxide and hydrogen sulphide) per 3x20 cm cartridge shall be used for underground blasting work.
- j. Approved electrical detonators of known characteristics shall be used for blasting.
- k. As far as possible, blasting shall be carried out using suitable exploder with 25 percent capacity. Electric power from the main shall be used only when it is absolutely necessary.
- l. In case electric power is used for blasting, a separate safety switch shall be used and the safety switch shall be kept in closed locked box, the key of which shall be kept with the blaster. A fuse shall be provided to be replaced every time a blasting is done.
- m. In case the exploder is used the revolving handle of the exploder shall be in the custody of the blasting foreman to prevent anybody else firing the shot when the blasting foreman and other persons are inside.
- n. Stray currents may cause fatalities while loading and utmost care shall be taken in removing all faults from electrical circuits.
- o. Electric power, light and other circuits in the vicinity within 70m of the loading points shall be switched off after charging the explosive and before the blasting operation starts. Power supply is to be switched on only after the blasted area has been properly inspected by the blasting foreman for misfires.
- p. All tracks, air lines and vent pipes shall be kept properly grounded.
- q. The heading shall be properly lighted with the electric flood lights before and after blasting.
- r. Only one cartridge shall be inserted at a time and gently pressed with tampering rod.

1.2.11 INSPECTION :

- a. Immediately after a blast has been fired, the firing line shall be disconnected from the blasting machine or other source of power.



- b. When at least 5 minutes have passed after the blast was fired, a careful inspection of the face shall be made by the blaster to determine if all charges have been exploded. Electric blasting misfires shall not be examined for at least 15 minutes after failure to explode. Other persons shall not be allowed to return to the area of blast until an 'ALL CLEAR' signal is given by the blasting foreman.
- c. All wires shall be carefully traced and search made for any exploded cartridge by the man-in-charge of the blasting operation.
- d. Sufficient time shall be given for the fumes to clear before permitting the labour to work for mucking operations.
- e. Loose pieces of rock and other debris shall be scaled down from the sides of the face of excavation and the area made safe before proceeding with the work.
- f. Misfires: Misfired holes shall be dealt with by the blaster preferably by the same person who had done the charging operations.
- g. If broken wires, faulty connections, or short-circuits are determined as the cause of a misfire, the proper repairs shall be made, the firing line reconnected and the charge fired. This shall be done, however, only after a careful inspection has been made of burdens remaining in such holes and no hole shall be fired when the burden has been dangerously weakened by other shots.
- h. The charge of explosives from a misfired hole shall not be drilled, bored or picked out.

1.2.12 SHAFT EXCAVATION:

- a. Head Frame -The head frame (including hoists, cables, etc) shall preferably of steel structure and properly designed with sufficient head room and strong enough for possible overload and impact due sudden drops.
- b. Hoisting Equipment- It shall be thoroughly inspected at least once week and maintained in first class condition. Suitable standby power supply arrangement or alternate means of working the hoist mechanically (see IS: 807, Code of practice for design, manufacture erection and testing of cranes & hoists) shall be provided. A limit switch and a non-failing automatic brake shall be provided on the ho to control speed.
- c. There shall be a fencing round the shaft opening at least 90 cm high and it shall comprise two rail guards and also a toe board, 15 cm high to prevent material from falling in. The gate, provided there, shall be closed except when used for entering or leaving the shaft or emptying the buckets. The gate should preferably be automatic.
- d. Access Through Shafts - Persons shall not be lowered or raised bucket used for mucking.
- e. A special cage or a bucket shall be used for lowering or raising personnel during the sinking of a shaft. For emergency use strong ladder made out of wire rope shall be provided on one side of the shaft. After the shaft is sunk, a suitable arrangement for the workmen shall be made in the shaft for access to the shaft and the tunnel.
- f. Signals - Reliable means of communications, such as bells or whistles shall be maintained at all times between the bottom of the shaft a the surface and telephone used, whenever possible.
- g. Any code of signals used shall be kept conspicuously exhibited near workplace or entrance.

1.2.13 WATER HANDLING

The methods given below shall be followed:



- a. A study of boring data and geological formations shall be made have an indication of locations, where water can be expected.
- b. Water inflow may be reduced or even entirely stopped by grouting off the wet seams. A wet area covering more than a single seam shall scale off by installing a suitable section of concrete lining.
- c. 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.
- d. The number of pumps provided at site shall be 50 percent more than the requirements calculated on the basis of the estimated pumping needs or at least one whichever is more.
- e. In case of steeply inclined tunnels steps shall be provided for quick exit in case of failure or haulage.
- f. Gutters and sumps shall be kept clean. Suitable arrangement shall be made to indicate the position of sumps in case tunnel invert is flooded.

1.2.14 MACHINERY AND MECHANICAL EQUIPMENT

- a. The signalman shall be instructed in his duties and positioned so as to have a clear view of the rear of the truck, the operator and the operation.
- b. All equipment having a drop type skip plan shall be provided with guards on both sides and open end of the skip pan area, to prevent persons from walking under the skip while it is an elevated position.
- c. Platforms, foot-walks, steps, guardrails, hand holds and toe-boards shall be provided on machinery and equipment as necessary, to ensure safe footing and access ways.

1.2.15 VENTILATION

- a. 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.
- b. Mechanical ventilation shall be adopted 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.
- c. Purity Requirements: 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 locomotives, dumpers, trucks, shovels, etc, and also to ensure temperatures of not more than 40^o C dry 29^o C wet at the working place.
- d. The concentration of various gases in atmosphere inside the tunnel by volume shall be as follows:
 - Oxygen -not less than 19.5 percent.
 - Carbon monoxide -not more than 0.005 percent
 - Carbon dioxide -not more than 0.5 percent
 - Nitrogen fumes- not more than 0.0005 percent.
 - Methane- not more than 0.5 percent at any place inside the tunnel, for example, in a cavity in the roof, etc
 - Hydrogen sulphide- not more than 0.001 percent
 - Aldehyde- as formaldehyde not more than 0.001 percent
- e. Testing- The tests shall 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 in 7.15.4 are detected to have



crossed the threshold value indicated therein, the workmen shall be withdrawn immediately till the percentage is brought down well below the threshold value by improving the ventilation or by other effective measures.

- f. Records for the tests of gases as also for temperature measurements and ventilation measurements shall be properly maintained.
- g. Dust Control- Adequate steps shall be taken to prevent the liberation, accumulation and the propagation of air-borne dust. Only wet drilling shall be permitted inside the tunnel and other underground works. Besides wet drilling there shall be adequate ventilation for dust control and periodical medical check up of the workers, working in the tunnel shall be done to check up their physical fitness. Such check shall be at least once in three months and the results recorded in the registers provided for the purpose.
- h. The air-borne dust concentration at the working face shall be tested once a month and if the air-borne concentration of total dust exceeds 10 mg Im³ ventilation shall be adequately improved. If required water spraying of the air-bore dust will be resorted to.
- i. Note- It is assumed that the air-borne dust is mainly nuisance dust containing not more than 1 percent free silica and also does not contain other toxic impurities.
- j. Volume of Air Required: Ventilation and exhaust system for tunnel and shaft excavation shall 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 shall provide for size and design of diesel engines to be used as well as for safe hygienic limits for exposure of employees to the multiple toxic and objectionable gases in the tunnel or shaft.
The volume of air required shall depend on the following:
Length of heading,
Size of tunnel,
Type and amount of explosives used,
Frequency of blasting, and
Temperature and humidity
- k. On tunnel work 4.25 m³ of air/min/man is usually considered the minimum requirement. In addition to this 2.00 m³ of air/ min shall 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 shall be provided.

1.2.16 SCALING AND MUCKING

- a. Scaling: After blasting inside a tunnel or a shaft scaling shall not commence unless the roof and walls of the tunnel and sides of the shaft are carefully inspected by a tunnel foreman.
- b. Scaling shall be performed only by the experienced crews under the direct supervision of a competent supervisor.
- c. If the structure of the rock is weak, poor or structurally defective it shall be adequately supported by providing either rock bolts or timber or steel supports with proper lagging and back filling and or by shot creting. Also, if the tunnel excavation is in clay, slit, sand or work layers, the strata shall be supported by well designed members either of wood or steel immediately before further excavation is undertaken. The construction of concrete lining wherever provided for these purposes should follow closely the excavation operations. There should not be a prolonged time interval between the two operations as the risk of accident increases with such delays.



- d. For tunneling 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.
- e. Periodical Inspections: More accidents in tunneling 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.
- f. Careful and frequent inspection of walls and roofs as well as of tunnel supports shall be carried out. Through scaling of loose rocks at all weak spots are the best preventives against the rock falls. Periodic inspection of un-timbered sections of the tunnel from a travelling scaling platform shall be carried out for locating weak spots. Supported sections shall also be inspected regularly to ensure that the weakness of the formation has not spread beyond the supports. Loosened rock shall be supported / removed forthwith. All supports shall be checked occasionally to make sure that there is no member under distress. All scaling platforms shall be equipped with sat ladders.
- g. Mucking -The loading zones shall be well lighted and workmen shall be kept away from the vicinity of the cars being loaded to prevent injury due to rock falling off the car.
- h. Loading of muck into either cars or dumpers shall be done evenly; the muck shall not be piled dangerously high above the sides.
- i. Rolling Stock Track - As far as possible, electric power shall preferably be used. Whenever diesel engines are used, they shall be provided with suitable filters, scrubbers, etc, to remove all carbon monoxide and oxides of nitrogen, etc. Petrol engines shall not be used.
- j. Use of rolling equipment with link couplers shall not be permitted. Rocker or cradle type dump cars shall be provided with a positive type lock to prevent dumping in mucking yards.
- k. The trolley tracks shall be properly laid with points, crossings at junctions and adequately maintained.
- l. At each end of the track suitable blocks or buffers shall be provided.
- m. Dead man switches or other installation necessary shall be provided to check accidents occurring due to runaway muck cars.
- n. Trains shall be operated with care and at a speed under control of the operator at all times. If the locomotive is pushing a string of cars, man shall ride in the front equipped with a whistle and a flash light to warn men along the track and signaling the locomotive operator.
- o. Every locomotive shall have a head light on each end. It shall be equipped with a whistle or horn with a tone of sufficient volume to be heard by men along the track when the air drills are working.
- p. The crew, working tip wagons on trolley tracks shall be given whistle, so that they can announce the movement of tip wagon by blowing the whistles.
- q. A shovel shall never be left unattended with engine running brakes not set. When it is necessary to park it on a sloping ground shall be securely blocked. The operator while leaving the machine shall remove ignition key and keep with him or hand it over to such a responsible person so that the machine cannot be operated by an unauthorized person.
- r. Transport of Material. Cars carrying pipe, rail and timber shall be properly loaded for safe passage through the tunnel. The load shall be kept within the side limits for the car. Loads projecting over the sides are dangerous to men working in the tunnel. If wide loads are transported, a special care shall be ensured in the operation of the train with ample warning to the workmen along the track to ensure a safe journey.



- s. Transport of Employees- No one shall be allowed to ride on front steps of a loco or on a coupling. None other than trainmen shall ride the dump care in going to and from work at change of shift or at any other time. A safe and smooth walkway system shall be provided for pedestrians.

1.2.17 CONCRETING, GROUTING AND GUNITING

- a. Usual safety precautions that are taken for concreting in open shall be applicable for the concreting of tunnels, shafts and other underground works also.
- b. In addition, the following precautions shall be taken where the pump Crete or pneumatic placer is used.
- c. The scaffolding supporting the pipe shall 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 shall then be used.
- d. The pipe line shall be anchored at all curves and near the end. The toggle and flange connections shall be inspected before each placement to ensure tight joints. Air-release valves shall 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.
- e. Pipes and hose used to convey grout shall be of proper size and strength to safely withstand the maximum operating pressures. Pumps shall not be operated at pressures above their rated capacity.
- f. Cleaning of pipeline shall be carefully done.
- g. All workmen in the vicinity of sand blasting or guniting operations shall wear goggles and respirators.
- h. Adequate lighting and ventilation shall be provided for all galleries and shafts where grouting is in progress

1.2.18 PATHWAYS:

In large tunnels the walkways shall be placed to the side of track. In long tunnels, shelter places for workmen shall be provided at suitable intervals during hauling operations.

1.2.19 PUBLIC SAFETY:

Shaft sinking and tunneling fascinate the public. Authorized visitors shall be equipped with safety hats and shall be accompanied by a guide competent to keep the visitors out of dangerous situations.

1.3 COFFER DAMS – CONSTRUCTION AND MAINTENANCE:

1.3.1 GENERAL

- (i) Every coffer dam or caisson and every part thereof shall be of good construction, suitable and sound material and of adequate strength. It shall be properly maintained. Its construction, additions or alterations and dismantling including all work connected therewith shall be supervised by a competent person.
- (ii) A cofferdam or caisson shall, where necessary, be specially secured in position so as to prevent movement in a manner dangerous to persons employed.



- (iii) In any cofferdam or caisson, there shall be adequate means for persons to reach places of safety in the event of an inrush of water.

1.3.2 INSPECTION AND EXAMINATION

- (i) No Person shall be employed in a cofferdam or caisson unless it has been inspected once a day by a competent person and also after explosives have been used in a or near the cofferdam 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 shall be made in the register prescribed for the purpose.

1.3.3 ATTENDANCE AND EQUIPMENT

- (i) No person shall be employed as an under water diver except for shallow depths where skilled divers are employed, unless:
- (a) A sufficient number of competent persons are employed in attendance upon him as to ensure his safety and
- (b) 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 and one complete set of woollen clothing in excess of the number of divers under water at any one time and
- (c) 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.

1.3.4 TESTING AND EXAMINATION OF EQUIPMENT

- (i) All diving equipment shall be initially tested and thoroughly examined by a competent person and thereafter thoroughly examined by him after every three months and record of such tests and examinations entered in a register maintained for the purpose.
- (ii) Air pump, airlines and diving helmets shall be thoroughly examined for any defect every time before they are put to use.

1.3.5 SIGNALING

- (i) In all diving operations, efficient signaling system to enable the diver to be a communication with his attendant shall be maintained.

1.3.6 MEDICAL EXAMINATIONS

- (i) No person shall 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 firm and certified by him as fit for diving.

1.4 DEMOLITION

- 1.4.1 Reference:** IS 4130:1991 – Code of Safety for Demolition of Buildings (2nd Revision)



1.4.2 Scope:

It lays down safety requirements for carrying out safely the demolition / dismantling of all types of buildings at Rampur Hydro Electric Project, Jhakri, Himachal Pradesh.

1.4.3 PLANNING:

- a) A careful study should be made of the structures that are to be demolished.
- b) A definite plan of procedure for the demolition work should be prepared and approved by the Site Incharge and it has to be followed as closely as possible in the actual execution of the task. Before commencement of each stage the foreman shall brief the workmen in detail regarding the safety aspects to be kept in view.

1.4.4 PRECAUTIONS BEFORE STARTING DEMOLITION WORK

- a) Danger signs should be conspicuously posted all around the structure and all doors and openings giving access to the structure shall be kept barricaded or manned except during the actual passage of workmen or equipment.
- b) Provision shall be made for at least two independent exits for escape of workmen during any emergency.
- c) During night red light shall be placed on or about all the barricades.
- d) No unauthorized person shall enter the site of demolition outside working hours and a watchman should be deployed to ensure it.
- e) All necessary safety appliances shall be issued to the workers and their use explained and it shall be ensured that the workers use all the safety appliances while at work.
- f) Glazed doors and windows shall be removed and all fragile and loose fixtures shall be removed. All loose plaster shall be stripped off. This will prevent large amount of dust generation as fugitive emission.

1.4.5 SEQUENCE OF DEMOLITION OPERATIONS

- a) The demolition shall always proceed systematically storey by storey in descending order and the work on the upper floors shall be completely over before any of the supporting members or other important portion on the lower floor is disturbed.

1.4.6 REMOVAL OF MATERIALS

- a) Dismantled materials may be thrown to the ground only after taking adequate precautions.
- b) The malba / debris should be segregated for usefulness and the remaining materials should be removed from the demolition site.

1.4.7 MISCELLANEOUS

- a) No demolition work should be carried out in night.
- b) No demolition work should be carried out during storm and heavy rain.
- c) A warning device shall be installed in the area to warn the workers in case of any danger.
- d) Construction sheds should be located away from areas of falling debris.
- e) PPEs such as Safety helmets, goggles made of celluloid lens, leather or rubber gloves, screens, safety belts and first aid and fire prevention measures should be provided.



CHAPTER 2

STORAGE, TRANSPORTATION, HANDLING AND USE OF EXPLOSIVES, GASES AND OTHER FLAMMABLE MATERIALS

The use of explosives is very essential in hard ground open excavation, tunneling and shaft sinking operations of hydro project construction. Selection and judicious use of proper kind and quality of explosives is essential for success, safety and efficient progress of every job. Proper storage, transportation, handling and use of explosives is important not only to ensure that these materials are kept out of reach of the unauthorised persons and to reduce the hazards of accidental explosion but also to maintain them in good condition for use. The storage, transportation, handling & use of explosives shall be strictly in accordance with the provisions of Indian Explosives Act, 1884, and Rules made there under.

2.1 EXPLOSIVE MAGAZINES:

The following precautions shall be taken for operation & maintenance of magazines.

- a. The magazines shall be clean and the floor be cleaned with a brush on each occasion the magazine is opened for delivery or receipt of explosives.
- b. All magazine keepers shall always ensure that smoking material and matches are not taken into the magazine.
- c. Adequate quantity of water and fire fighting equipment shall be provided in the magazine.
- d. All the tools used in the magazines for opening of explosive boxes shall be of wood or soft non-ferrous metal such as brass, copper or bronze. Iron and steel tools are prohibited as they may cause sparking.
- e. The area surrounding the explosive magazines shall be kept free from bushes and other vegetation.
- f. Empty boxes, loose packing material or cotton waste shall not be kept in magazine premises.
- g. The magazines shall be well ventilated and it is advisable to keep magazines open every day for a period of one hour.
- h. Detailed records of all outgoing and incoming stocks shall be kept. Explosives shall be used according to their dates of manufacture.
- i. All magazines shall be securely locked, when not attended.
- j. Packing cases of explosives shall be stacked on trestles clear of floor and a 15 cm air space shall be left between the cases and walls to allow circulation of air
- k. Care shall be taken that repairs to the magazines are attended to on priority basis
- l. Every explosive magazine shall also prominently display;
 - a) A copy of Explosives Rules.
 - b) A statement showing the stock in the magazine and



- c) Certificate showing the last date of testing of the lightning conductor
- d) A copy of the Licence and lightning conductor test certificate shall also be preserved in the magazine.
- m. The magazine, on no account shall be opened during or on the approach of a thunderstorm and no person shall remain in the vicinity of the magazine during such a storm
- n. Magazines shall be guarded at all times Guards shall be properly trained in handling fire fighting equipment
- o. Magazine shoes, without nails, shall be kept at all times in the magazine Persons entering the magazine shall put on the magazine shoes provided for the purpose
- p. Wooden tub or cement trough, approximately 300 mm high and 450 mm in diameter filled with water shall be fixed near door of the magazine

2.2 TRANSPORTATION OF EXPLOSIVES:

- a Explosives shall be transported in specially fabricated explosive van confirming to the provisions of Explosives Rules. 1983
- b The van shall bear the inscription "EXPLOSIVES VAN" so as to warn the workers and the public
- c Metal tools, oil matches, electrical storage batteries, acids or other corrosive compounds, etc, shall not be carried in the vehicle
- d At the back of the van, there shall be tow chains hanging from the body in such a way that all the time they touch the ground to provide necessary Earthing for safety against lightning or short-circuiting of the vehicle
- e The driver should have valid license, physically fit and familiar with the precautions to be taken while carrying the explosives in the vehicle
- f. Two Carbon dioxide fire extinguishers, each of not less than 3 kg. capacity, confirming to relevant IS, shall be carried on each vehicle. The driver shall know how to operate the fire extinguishers.
- g. A motor vehicle carrying explosives shall not be re-fueled except in emergencies and even then only when the motor has been stopped other precautions have been taken to prevent accidents.
- h. Loading, unloading and handling of explosives shall be supervised by qualified personnel. At the time of loading or unloading of explosives, no electrical switch should be operated.
- i. The containers shall be of standard make as designed in accordance with Explosive Rules and relevant Indian Standards.
- j. Containers used for storing explosives or detonators shall be used for that item only.

2.3 OTHER SAFETY PRECAUTIONS

- a. Smoking shall be prohibited in the vehicle carrying explosives and in its vicinity.
- b. No unauthorised person shall be allowed in the vehicle carrying explosives.
- c. Explosives and detonators of blasting caps shall not be permitted to be transported in the same vehicle.
- d. Detonators and other explosives for blasting shall be transported to the site of work in the original containers or in securely locked separate non-metallic container and shall not be carried loose or mixed with other materials,



- e. Care shall be taken in loading and unloading of explosives. The filled containers shall not be handled roughly or dropped.
- f. Drivers shall not leave the vehicles unattended while transporting explosives.
- g. The speed of the vehicle shall not exceed 25 km/h on rough roads and 40 km/h elsewhere.
- h. Vehicles transporting explosives shall not be taken into a garage, repair shop or parked in congested areas, public parking or similar places.
- i. Explosives shall not be transported on public highways during darkness, except in emergencies and even then only when the written approval of the project authorities has been obtained. Such vehicles shall be fitted with adequate warning lights on both ends, while operating in darkness.
- j. Explosives shall not be transferred from one vehicle to another on public highways, except in cases of emergency.
- k. For transportation by road, the quantity of explosives carried in single vehicle shall not exceed 75 % of the rated load carrying capacity of that vehicle or 3,600 kg, whichever is less.
- l. Place of Loading and unloading -Loading and unloading of explosives shall be done at safe distance from dwelling houses, powerhouse buildings, transmission tower, stores of petroleum, stores of timber or any other flammable materials.
- m. The explosive van used for transportation of explosives shall be inspected before every use with following checklist:
 - a) Fire extinguishers -for their healthy condition.
 - b) Electrical wirings -for complete protection to prevent short- circuiting.
 - c) Chassis, motor, pan and underside of the body of the vehicle -for reasonably clean and free of excess oil or grease.
 - d) Fuel tank and feed line -for no leaks.
 - e) Brakes, lights, horn, windshield, wipers and steering apparatus - for their good functioning.
 - f) Tyres -for proper inflation and defects.
- n. Supervision:

Explosive shall be handled by or under the supervision of competent persons who are fully experienced in the work and who have received adequate instructions as to the dangers connected therewith and the precautions to be observed.

 - (i) Explosives shall not be transported to the site of operation except in suitable cases or containers which are so made as to prevent any spillage of explosives and any danger of sparks or other sources of ignition during conveyance. No explosive shall be removed from such cases or containers except when it is to be used forthwith for the purpose of the work.
 - (ii) No explosives shall be transported in a mechanically propelled vehicle unless such vehicle is locked and is of a type approved in writing by the Chief Inspector of explosives.

The following rules should also be observed:

 - (a) Vehicles must have springs under the body. Unsprung country carts should not be used. Tyre pressures shall be as per India Explosives Regulations.



- (b) Detonators and igniters must not be carried in the same vehicle with explosives.
 - (c) The speed of vehicle must not exceed 24 kms per hour.
 - (d) Besides the driver, only one helper shall be accommodated in the vehicle. The vehicle carrying the explosives must not be used to transport workmen or other materials to work spots although there may be enough space for men or materials.
 - (e) Drivers must not leave the vehicle unattended while transporting explosives.
 - (f) All vehicles transporting explosives shall be marked or placarded on both sides and ends with the word 'EXPLOSIVES' in white letters not less than 75mm tall on a red background. All explosive boxes shall bear explosives Lot No Mfg date, expiry date etc clearly on them.
 - (g) A motor vehicle carrying explosives should not be refueled except in emergencies and even then only when motor is stopped and other precautions taken to prevent accidents. Such vehicles should invariably have at least two fire extinguishers placed at convenient points.
 - (h) Vehicles transporting explosives shall never be taken into a garage, or repair shop, or parked in congested areas, or stored over night or at any other time in a public garage or similar building.
 - (i) Explosives shall not be transported on a public highway during hours of darkness except in extreme emergency and even then only with the written approval of the project officials.
 - (j) Explosives shall not be transported in any form of trailer, nor shall any trailer be attached to a motor truck or vehicle hauling explosives.
 - (k) No transfer of explosives from one vehicle to another shall be made on any highway except in case of emergency.
 - (l) Persons employed in the transport or handling of explosives should not carry with them or in the vehicles, matches, loaded fire arms, petrol or any flame producing devices.
 - (m) All explosives should be adequately protected against theft.
 - (n) Smoking shall be prohibited during handling and transport of explosives.
- (iii) Motor vehicles used for transporting explosives shall be carefully inspected daily to ensure that:
- (a) Filled and serviceable fire extinguishers are in position;
 - (b) The electric wiring is well insulated and firmly secured;
 - (c) Chassis, engine and body are clean and free from surplus oil and grease;
 - (d) Fuel tank and feed lines are not leaking;
 - (e) Lights, breaks and steering mechanism are in good working order; and
 - (f) Vehicle is in proper condition in all respects for the safe transportation of explosives.
- (iv) Boxes of explosives should not be handled roughly or allowed to fall.
- (v) Containers of explosives shall be opened only by means of non-sparking tools or instruments.



- (vi) After the loading of a blast is completed, all excess explosives and detonators shall be removed to a safe location or returned at once to the storage magazine, observing the same rules as when being conveyed to the blasting areas.
- (vii) Containers for detonators shall always be used only for storing detonators.

2.4 STORAGE OF EXPLOSIVES:

- a. Storage of explosives is regulated by the Indian Explosives Act and provision there under should be strictly observed.
- b. Explosives shall be stored only in a magazine which is clean, dry, well ventilated, reasonably cool, correctly located, protected against lightning in accordance with Indian Electricity Act and Indian Explosives Act and rules and regulations framed there under substantially constructed bullet and fire resistant and securely locked.
- c. The storage should be done in such a way that the first stored should be used first and to have this facility, the explosives should be stored in sequence.
- d. Explosives fuse or fuse lighters shall not be stored in a damp or wet place or near oil, gasoline, cleaning solutions or solvents or near radiators, steam pipes, or other sources of heat.
- e. If nitroglycerine from deteriorated explosives has leaked down on to the floor of the explosive magazine, the floor shall be desensitized by washing thoroughly with an agent obtained before hand from the supplier of the explosives. For this purpose, desensitizing agent and the instructions for using them shall always be obtained along with the supply of nitroglycerine.
- f. Boxes of explosives shall not be thrown down or dragged along the floor and may be stacked on wooden trestles. Where there are white ants, the legs of the trestles should rest in shallow copper, lead or bras bowls, containing water.
- g. Packages containing explosives shall not be allowed to remain in the sun.
- h. Each portable magazine, if any, used in the site, shall be located at a safe distance from the work site, enclosed in a fence and properly guarded.
- i. The magazine should, at all times be kept scrupulously clean. High explosives like dynamite should be stored in a dry clean, well-ventilated, bullet-proof and fire-proof building constructed in accordance with Indian Explosives Act, on an isolated site. The area around the magazine for a distance of 8m shall be kept clear of all vegetation and combustible matter. There shall be barbed wire fencing and security lights around the magazine and security guards shall be posted for 24 hours.
- j. No unauthorised person is at any time to be admitted into the magazine.
- k. The person in charge of the magazine is to take care that the magazine is well and securely locked.
- l. The magazine on no account is to be opened during or on the approach of a thunderstorm and no person should remain in the vicinity of the magazine during such storm. Sufficient number of lighting conductors should be provided on top of the magazine.
- m. Magazine shoes, without nails, should be kept at all times in the magazine, and a wood tub or cement trough, about 30 cms high and 45cms in diameter, filled with water should be fixed near the door of the magazine.
- n. Persons entering the magazine must put on the magazine shoes provided for the purpose, and be careful not to allow the magazine shoes to touch the ground outside the clean floor.



- o Persons with bare feet shall, before entering the magazine, dip their feet in water, and then step direct from the tub over the barrier (if there is one) on to the clean floor.
- p) A brush or broom should be kept in the lobby of the magazine for cleaning the magazine on each occasion it is opened for the receipt, delivery or inspection of explosives.
- q) Light should be obtained from an electric storage battery lantern. Electric lights from the supplying main, taken through conduit wiring and properly earthed may be obtained with the approval of Chief Inspector of Explosives.
- r) No matches should be allowed in a magazine.
- s) No person having articles of steel or iron on him is to be allowed to enter a magazine.
- t) Oily cotton rags, cotton waste and articles liable to spontaneous ignition should not be taken into a magazine.
- u) Workmen, sweepers etc should be examined before they enter the magazine to see that they have none of the articles mentioned in rules (x), (xi), (xii) on their person. All other men entering a magazine should not also have such articles on their person.
- v) No tools or implements other than those of copper, brass, gun metal or wood should be allowed inside the magazine. Tool should only be used with great gentleness and care.
- w) Boxes of explosives should not be thrown down or dragged along the floor and should be stacked on wooden trestles. Where there are white ants, the legs of the trestles should rest in shallow copper, lead or brass bowls, containing water.
- x) Packages containing explosives shall not be allowed to remain in the sun.
- y) The order of storing should be such as to allow the oldest explosives to be used first. There should be sufficient space between the stacks.
- z) Empty boxes should not be stored in the magazine nor let any packing material lie loose.
- za) Blasting caps and electric blasting caps should never be stores in the same box, magazine or building with other explosives.
- zb) The following should be hung up in the lobby of the magazine:
 - a) A copy of these rules
 - b) A statement showing the stock in the magazine; and
 - c) Certificate showing the last date of testing of the lighting conductor.
- zc) All magazines that contain more than 11kgs of high explosives such as Blasting Gelatine, Carbonits, Celtite Dynamite, Gelnite, Monobel Powder, Phoenix Powder, Roburite, Tonite and Ammonal etc. should be inspected atleast twice a year by the officer incharge thereof.
- zd) Adequate fire fighting equipment shall be provided in the magazine.
- ze) Sign boards reading “**DANGER, HIGH EXPLOSIVES,**” “**PROTECTED AREA**”, “**NO SMOKING**” etc shall be conspicuously displaced in the front of the magazine.
- zf) Proper CRP/ Police Guard shall be posted to guard the magazine.

2.5 HANDLING AND USE OF EXPLOSIVES:

- a. Handling of explosives shall be avoided during thunderstorm or when thunderstorm is expected. All persons shall retire to place of safety.
- b. Any package containing explosives shall not be dragged, dropped or handled toughly. The packages shall be opened at a safe distance and at a shielded location vis-8-vls the magazine.
- c. Sparking metal tools shall not be used to open kegs of explosives.



- d. Smoking shall not be permitted nor matches, open lights, fire, flame, or any other device capable of producing sparks or flame shall be carried while handling or using explosives.
- e. Explosives shall not be placed where these may be exposed to flame, excessive heat, sparks or impact.
- f. The covers of the explosive cases or packages shall be replaced every time after taking out part of the contents as long as any explosives are left in them.
- g. Explosives shall not be carried in the pockets or folds of clothing by any person.
- h. Primers shall not be made up in a magazine, or near excessive quantity of explosives, or in excess of immediate needs.
- i. Nothing shall be inserted in the open end of a, blasting cap except fuses.
- j. No person shall strike, tamper with, or attempt to remove or investigate the contents of a blasting cap or an electric blasting cap or attempt to pull out the crimped safety fuse out of a blasting cap.
- k. Children and unauthorised or unnecessary persons shall not be present where explosives are being handled or used.
- l. No attempt shall be made to soften hard-set explosives by heating over a fire or by rolling the explosive on the ground.
- m. The blasting powder, explosives, detonators, fuses, etc, shall be in good condition and not damaged due to damp moisture or any other cause. They shall be inspected before use and damaged articles shall be discarded totally and removed immediately.
- n. No attempt shall be made to reclaim or use fuses, blasting caps, electric blasting caps or any other explosives, which have been water soaked, even if these have been dried out. The manufacturers shall be consulted.

2.6 EXPLOSIVES DISPOSAL:

- a. No explosive shall be abandoned. These shall be disposed off or destroyed strictly in accordance with the approved methods and in doing so the manufacturers or the appropriate authority shall be consulted. The expired deliveries shall be sent back to the manufacturer.
- b. Explosives, caps, boxes, lines or material used in packing of explosives shall not be left lying around in places to which children or unauthorised persons or livestock can have access.
- c. Paper or fibrous material employed in packing explosives shall not be put to any subsequent use. Such material shall be destroyed by burning in the presence of a responsible person.

2.7 ACCOUNT:

- a. A careful day-to-day account of the explosives shall be maintained in a register in an approved manner, which shall be open to inspection at all times by the concerned authorities.
- b. Explosives shall be issued only to competent persons 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 shall be preserved by the person-in-charge of the magazine.

2.8 GLASSES AND FLAMMABLE SUBSTANCES:



Gases and flammable liquids also play a vital role in the construction, installation and erection of different components of hydropower projects. Discrete use of gases, flammable liquids and other chemicals can hasten the construction operations. Gases for cutting, welding, etc. and flammable liquids like petrol, diesel, kerosene, coal tars and various hydrocarbons are used extensively in project activities. 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 widely used. It is essential to take necessary precautions in storage, transportation, handling and use of these gases and hazardous substances.

- a. Flammable liquids vaporize 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.
- b. 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 liquids in use are of fundamental importance.
- c. As a safeguard against explosions, the test shall be carried out for presence of flammable mixture in the containers. During construction of various underground works of river valley projects, it shall 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.
- d. The tests shall 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 shall be adopted immediately so as to avoid major mishap.
- e. Locating Dangerous Gases / Flammable liquids in the containers / confined pockets – Some times workers employed in some of the processes (may be underground or on ground) come across unavoidable or accidental contamination not only in the immediate work area, but also over a considerable territory.
- f. The presence of vapours or fumes of dangerous gases shall be detected by the instruments in accordance with the relevant Indian Standards. Flammable limits or some of the gases are as below.

Table: 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

2.9 Detection of Dangerous / Flammable gases:

- a. Detection of carbon monoxide – The 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. The combustible gas indicator is used to detect and measure these gases. 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 – This 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. Chlorine – High concentrations of chlorine may cause immediate irritation and severe poisoning, low amounts are not immediately noticeable and prolonged exposures are likely to promote respiratory distress. Chlorine detector provides a quantitative method for determining chlorine concentrations.
- e. Methane – It is a colorless and odorless 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.
- f. The explosibility of methane gas is between 5 to 15 percent. There will be no 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 will be 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.

2.10 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. 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.
- b. 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.

- c. A combustible gas indicator shall be used only by experienced person and operator shall follow the manufacturer's instructions.
- d. Safety measures – When the presence of flammable liquids / dangerous gases is indicated, following safety measures shall be adopted:
 - Before taking up a river valley project, the detailed geological subsurface probing shall be carried out so as to know about the possibility of the presence of dangerous gases / flammable liquids.
 - 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 shall be withdrawn and electricity cut off.
 - If there is any possibility of presence of dangerous gases / flammable vapours, while doing underground works / tunneling, the permitted explosives and approved type exploders (as advised by the dealers) shall be used and flame-proof electric equipment and lights (as per Electricity Rules) shall be installed so as to avoid sparking of loose connections. Lights shall be kept sufficiently away from the working faces.
 - Smoking and carrying of naked fires, matches, lighters or other spark-producing device shall be permitted in the building, or area where flammable liquids / dangerous gases are stored, handled are used.
 - 'NO SMOKING' signs in red letters shall be posted conspicuously in such buildings and areas.
 - Ventilation and dilution – All works, especially underground works shall have proper and efficient ventilation system. In case, the presence of dangerous gases / vapours is indicated, the same shall not be bruised of wafted by any means and steps shall be taken to remove the gas by improving the ventilation by proper coursing through brattices, sheet, etc., after rendering it harmless by dilution through supply of air, if necessary.
 - The working area shall be examined for dangerous gases within 2 hours before the beginning and at least after every 2 hours during the working shift.
 - When there is a rock fall anywhere in the underground works, the safety measures mentioned above shall be immediately followed even if the proportions of such gases are within permissible limits before the rock fall. The work shall be restated only after ensuring the accumulation of gases to be less than permissible proportions.
 - Bonding and grounding – To eliminate a spark from discharge of static electricity during filling operations, a wire bond shall be provided to equalize the potential between the storage container and the container being filled. In addition, it is advisable to have the binding wire or one of the containers grounded.
 - Non-conductive materials, such as fabric, rubber, or plastic sheeting passing through or over rolls also create charges of static electricity. Static from these materials as well as from belts shall be discharged with grounded metal combs.
 - Preventing dangerous mixtures – Accidental mixing of flammable liquids shall be prevented; for example, gasoline mixed with fuel oil may change the flash point sufficiently to make the fuel hazardous in ordinary use.



- Control value on equipment containing flammable liquids shall be identified by colour or tag or both.
- e. Inhalation – If a worker has been exposed to dangerous gases like carbon monoxide or methane emanating from some hidden source in underground excavations, he shall be at once removed to an uncontaminated area. Under no circumstances shall a rescuer enter the site of excavation to remove a victim of over exposure without proper respiratory protection. If breathing has stopped, an effective means of artificial respiration shall be started immediately. If oxygen inhalation apparatus is available, oxygen shall be administered but only by a person authorized for such duty by a physician. The patient should be kept warm but not hot. Emergency procedures shall be established for summoning ambulance, physician or other agency promptly, so that such assistance will be enroute to the location before the rescue is accomplished.
- f. Oxygen content of the atmosphere in the confined space shall be determined by pre-entry and subsequent tests made with approved instruments. 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).
- g. The various life saving apparatus such as filter self rescuer, oxygen breathing apparatus, personal protective equipment, hats, boots, goggles, etc. shall be made available for used by workers employed in river valley projects where there is even slightest possibility of emission of any toxic gases or lack of permissible percentage of oxygen in the atmosphere in the underground works.
- h. Due importance shall be given to educate labour of safety rules. Periodical safety meetings shall be held to exchange ideas and experience.
- i. The various types of appliances required for fire protection shall conform to relevant Indian Standards. All preventive measures and availability of necessary appliances / material against fires shall be ensured at strategic points or as defined in the relevant Indian Standards.

2.11 COMPRESSED GAS CYLINDERS:

Gases like Chlorine, Oxygen, Acetylene, Carbon dioxide; Ammonia, etc are of immense use in river valley projects. Chlorine is used for disinfecting the drinking water. Ammonia is used in refrigeration plants and ice so produced is used in cooling of concrete. Carbon dioxide is used in fire fighting system. Cutting & Welding processes using oxy-fuel gas flames are necessary part of river valley projects. Their improper use may result in loss of life by fire and explosion.

2.11.1 Storage

Compressed gases are usually contained in cylinders of different shapes and sizes. Gas cylinders are painted in different colours accordingly to the contained gases to make the identification easier, following instructions shall be observed in the storage of cylinders:

1. A well-ventilated storeroom shall be provided for handling and storage of cylinders. Empty cylinders shall be stacked away from full cylinders. 'Full' or 'Empty' notices shall be displayed on each relevant stack.



2. When stacking the cylinders vertically, it shall be ensured that they are properly secured by suitable brackets or stands so that they do not fall.
3. If cylinders are stacked horizontally, proper blocks shall be used at each end of stack to prevent their rolling. Large size cylinders shall be placed at the bottom. One vertical stack shall not contain more than four cylinders.
4. Cylinders shall not be kept in a battery charging room or in oil storage room or in places where there is a likelihood of oil, acid or any other corrosive liquid being splashed on them.
5. Cylinders shall be stored far away from sources of heat, such as furnaces, boilers and heating apparatus. Cylinders shall not be exposed to direct rays of the sun. Tarpaulin or any other cover shall 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 $3.13 \times 10^{-2} \text{ N/m}^2$ 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.

6. It shall always be ensured that the cylinders are protected from rusting or from corrosive conditions.
7. Cylinders shall not be directly placed on wet soil, proper dunnage shall be used.
8. It shall be ensured that cylinders do not come in contact with electrical apparatus or live wire.
9. Under no circumstances shall 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.

2.11.2 Handling

Following instructions shall 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 and regulator fitting shall be kept away from all sources of contamination such as oil drums, storage batteries, paint drums, 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 shall not be lubricated.
- d. Only the standard key shall be used for opening the valves and the key shall be free from any oil or grease. Leverage of keys or spanners shall not be increased and not attempt shall be made to get gas from cylinders with broken valves thereby rendering the cylinder useless.
- e. Cylinder shall not be used as rollers, work supports or jacks.
- f. Cylinders shall 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 shall 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, shall be handled in the same manner as leaking cylinders.
- i. Handling of acetylene cylinders shall need special attention, as acetylene is 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 shall, therefore be handled very carefully to prevent damage, which might lead to bursting of cylinders or leakage through the cylinder valve. They shall not be banged, jolted violently, dropped or thrown about. When being unloaded from a truck, the cylinder shall be lowered gently.

2.11.3 Unloading of Gas Cylinders

Gas cylinders shall be handled with care. They shall not be dropped or allowed to strike against each other, to ensure safety. The following method of unloading gas cylinders from vehicles is recommended:

- 10. Whenever possible, the cylinder shall be unloaded directly on a raised platform by rolling over a coir mattress.
- 11. If a suitable raised platform is not available, each cylinder shall be slide down over a heavily reinforced 15cm 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.
- 12. Cylinders shall not be dropped from a height.
- 13. It shall be made sure that the first cylinder has rolled away before the next one is slide down.
- 14. Lifting magnet shall not be used for loading and unloading.
- 15. A fiber 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 to prevent slipping. Use of chain sling is unsafe, as it is very likely to slip, over a cylinder.
- 16. From the unloading platform to the storehouse or from storehouse to the plant, the cylinders shall be transported by means of a handcart. Such a handcart shall be provided with a chain or belt for securing the cylinders in proper position.
- 17. If a cylinder is to be transported over a short distance and a suitable hand-cart is not available; it shall be rolled over its bottom edge but never dragged.
- 18. Reporting of Gas cylinder accidents – In accordance with the provision of Gas Cylinder Rules, all accidents caused in using gas cylinders shall be reported to Chief Inspector of Explosives.

* * *



CHAPTER 3

DRILLING AND BLASTING

Drilling and Blasting is a specialized job involving a numerous hazards, which often lead to accidents. It is necessary that certain safety precautions shall be scrupulously followed in drilling, loading and blasting operations with a view to minimize the risk of accidents and injuries.

3.1 DRILLING AND LOADING:

- a. No drilling shall be started until previous holes in the blasted area are flushed with air and water.
- b. 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.
- c. The face of rock shall be carefully examined before drilling, to determine the possible presence of unfired explosive. No attempt shall be made to drill at a site if undetonated explosives are suspected.
- d. The position of all holes to be drilled shall be marked out with white paint.
- e. The bore hole shall be carefully checked for length, presence of water, dust, etc., with a wooden tamping pole or a measuring tape before loading. It shall be cleared of all debris before explosives are inserted.
- f. The diameter of the bore of each hole shall be greater than the outside diameter of the cartridges of explosive. The line of detonating fuse extending into a borehole shall be cut from the spool before loading the remainder of the charge. Use of short pieces of fuse shall be prohibited for detonation purposes.
- g. Surplus explosives shall not be stacked near working areas during loading.
- h. Loading and drilling shall not be carried out at the same time in the same area.
- i. A borehole shall not be loaded with explosives after spring (enlarging the hole with explosives) or upon completion of drilling without making sure that it is cool and that it does not contain any hot metal, burning or smoldering materials. Temperatures in excess of 65°C are dangerous.
- j. A borehole near another hole loaded with explosives shall not be sprung.
- k. Cartridges or explosives shall not be forced down a borehole or on obstruction in a borehole.
- l. No force shall be used for inserting a blasting cap or an electric blasting cap into explosive. The cap shall be inserted into a hole made with a pricker designed for the purpose. A hitch of the electric blasting cap leading wire shall be made on the primer cartridge so as to prevent pulling out of the electric blasting cap from the explosive charge. In case of detonating fuse, the fuse shall be tied to the explosive cartridge so that the blasting cap is not pulled out. Care shall be taken so that the electric blasting cap, loading wire or the length of the safety fuse does not get damaged during loading of the charge.
- m. No attempt shall be made to slit, drop, deform or abuse the primer.



- n. No holes shall be loaded except those to be fired on the next round of blasting and after blasting, all remaining explosives and detonators shall be immediately returned to an authorized magazine.
- o. Blasting caps or electric blasting caps shall not be connected to detonating fuse except by methods recommended by the manufacturers of caps.
- p. No cartridge shall be cut or explosive removed from it for any purpose whatsoever.
- q. Metallic devices of any kind shall not be used in tamping. Wooden tamping tools with no exposed metal parts except non-sparking metal connectors for jointed poles shall be used. Violent tamping shall be avoided. Primer shall not be tamped.
- r. Care shall be taken to confine the explosives in the borehole with sand, earth, clay or other suitable non-combustible stemming material.
- s. Kinking or injuring of fuse or electric blasting cap wire shall be avoided when tamping.
- t. No person shall be allowed to deepen drill holes, when have contained explosives, or blasting agents, or insert a drill, pick or bore in butts of old holes even if examination fails to disclose explosives.
- u. Drilling shall not be resumed after blasts have been fired until a thorough examination has been made to make sure that there are no unexploded charges in the remaining butts of old holes or otherwise, which the drills may strike.
- v. Rock drillers shall be equipped with approved respirators for use in siliceous dusty atmosphere arising out of drilling operations.
- w. In tunneling work, welding / cutting or metal shall not be done, inside the tunnel at the time of loading at the face, until the blast has been fired.
- x. Blasting shall be carried out only with the permission of the engineer incharge. The blasting operation shall 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 operations shall be of approved type.
- y. The blaster shall 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 working knowledge of Rules & Regulations pertaining to explosives. The blaster shall be in good physical condition and not be under influence of drugs, alcohol, intoxicants, etc.
- z. Blaster shall keep an accurate up-to-date record of explosives, blasting agents, blasting supplies used in a blast and shall keep an accurate running inventory of all explosives and blasting agents stored at operation site.

3.2 ELECTRICAL SHOT-FIRING CIRCUIT:

- a. In deciding the sizes of wire, fuses, circuits, blasting switches, etc., instructions issued by the manufacturers of these articles shall be followed.
- b. No person shall attempt to uncoil the wires and open out the short circuited bare loading wires of the electric blasting cap during approach of dust storm or near any source of large charge of static electricity or near a radio transmitter. The manufacturer of the cap or the collector of explosives shall be consulted regarding the distance from the transmitter beyond which electric blasting shall be conducted.
- c. Firing circuit shall be kept completely insulated from the ground or other conductors, such as bare wires, rails, pipes or other paths of stray current.



- d. There shall not be any electric live wires or cables of any kind near electric blasting caps or other explosives except at the time and for the purpose of firing the blast.
- e. All electric blasting caps shall be tested singly and also when connected in a circuit in series using only an approved type of circuit continuity tester or ohmmeter.
- f. No attempt shall be made to use in the same circuit either electrical blasting caps made by more than one manufacturer or electric blasting caps of different design or function even if made by the same manufacturers unless such use is approved by the manufacturers.
- g. No attempt shall be made to fire a circuit of electric blasting caps with less than the minimum current specified by the manufacturer of that electric blasting cap.
- h. Care shall be taken to ensure that all wire ends for electrical connections are bright and clean.
- i. The electric cap wires or loading wires shall be kept short-circuited until ready to fire.
- j. When energy for blasting is taken from power circuit, the voltage shall not exceed 220 V.
- k. The blasting switch shall be strictly according to the specifications, externally operated double-pole double throw switch, which when locked in the open position will short circuit and ground the leading wires. The switch shall be installed at the location where the firing is to be controlled.
- l. A Safety switches of the same type as the blasting switch shall be installed between the blasting switch and the firing circuit and lead lines, at a distance not to exceed 180 cm from the blasting switch.
- m. Both the safety switch and the blasting switch shall be locked in the open position immediately after firing the shot and before any person is permitted to the return to the blasting area. Key to the switches shall remain in the possession of the blaster at all times.
- n. Copper wires with solid cores of appropriate gauge shall be used or firing lines; the wires shall be adequately insulated and in sound condition.
- o. Blasting operations in the proximity of overhead power lines, communication lines, utility lines, or other structures shall not be carried out until the operator or the owner, or both of such lines have been notified and precautionary measures deemed necessary, have been taken.
- p. All holes loaded on a shift shall be fired on the same shift.
- q. As far as possible, blasting shall be carried out using suitable exploder with 25 percent excess capacity. Electric power from the mains shall be used only when it is absolutely necessary.
- r. Each electric blasting cap shall be tested with an approved galvanometer before and after tamping in the hole to determine whether it will carry the current. All testing shall be done by placing the galvanometer outside the tunnel and away from the tunnel face.
- s. The number of electric blasting caps used in a circuit shall not exceed the tested capacity of the blasting machine.
- t. The circuit, including all caps, shall be tested with a circuit tester or galvanometer before being connected to the firing line.

3.3 BLASTING WITH SAFETY FUSE:

- a. The fuse shall be carefully handled to avoid damaging the covering. In very cold weather, the fuse shall be slightly warmed before using so as to avoid cracking the waterproofing.



- b. The minimum length of fuse shall be not less than that required by state laws; in any case, it shall be not less than 750 mm. The maximum burning rate of the fuse shall be such that it will allow sufficient time to all concerned persons to reach a place of safety before the blast occurs; the burning rate of the fuse shall, in any case, be not more than 600 mm/min. Recommended minimum fuse lengths and maximum burning rates for normal conditions are as follows.

No. of Holes	Minimum Fuse Length (mm)	Maximum Burning Rate (mm/min.)
4 – 10	1,800	450
11 – 12	2,150	450

- c. The fuse shall not be cut until all preparations have been taken to insert it into a blasting cap. About 20 to 50 mm length of the fuse shall be cut from its end to ensure a dry end. It shall be cut squarely across with a clean and sharp blade. The fuse shall be seated lightly against the cap charge and care shall be taken to avoid twisting after it has been placed in position.
- d. Blasting caps shall not be crimped by any means other than a cap crimper designed for the purpose. It shall be necessary to make sure that the cap is squarely crimped to the face.
- e. The fuse shall be lighted with a fuse lighter designed for the purpose. If a match is used, the fuse shall be slit at the end and the match head held in the slit against the powder core and then 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.
- f. The fuse shall not be lighted until sufficient stemming has been placed over the explosives to prevent sparks of live match head from coming into contact with explosives.
- g. The explosives shall not be held in hands when lighting the fuse.
- h. Not more than 12 holes shall be loaded and shot at one time if cap and fuse are used for detonating.

3.4 UNDER GROUND WORK:

- a. Only permissible explosive shall be used and that too in the manner specified by the appropriate authority. In case ANFO (Ammonium Nitrate Fuel Oil mixture) is used, due care shall be exercised in doing more extensive temping required so as to eliminate chances of static current being generated.
- b. Excessive quantities of explosives shall not be taken underground at any time. Black blasting powder or pellet powder shall not be used with any other explosives in the same boreholes.
- c. For blasting in tunnels and shafts precautions detailed in IS:5878 (code of practice for construction of tunnel, Part-2 Under ground excavation rock, section-1 Drilling and blasting) shall be followed. The poisonous gases shall be promptly removed by using exhaust fans in shafts and reversible axial flow fans in tunnels. The air duct shall be of such size as not to allow too much pressure drop so that the velocity of the air at the delivery end is not less than 0.2 m/s.

3.5 BEFORE AND AFTER BLASTING:



- a. Before blasting, sufficient warning shall be given to enable the people working in the blasting area to get off the danger zone. All persons, other than blaster, shall leave the danger area at least 10 minutes before the blasting starts. The danger zone shall be suitably cordoned off and flagmen posted at important points.
- b. General public in the vicinity also shall be informed about blasting.
- c. All approaches to the project site, where regular blasting operations are undertaken, shall be sign-posted for warning the public and indicating the days and timings when blasting is to be carried out.
- d. All approaches to the project site shall be closed by barriers at a distance of not less than 400 m, 10 minutes before firing is to take place.
- e. Loud wailing not of not less than 1 minute duration shall be sounded on 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 of not less than 1-minute duration.
- f. Each borehole shall be thoroughly cleaned before a cartridge is inserted. Wooden tamping rods (not pointed, but cylindrical throughout) shall be used in charging the holes. The cartridges shall be gently placed and not rammed. The primer cartridge shall be on the top.
- g. The blaster shall not return to blasting site after firing, until at least 5 minutes have elapsed. In case of electric shot firing, the shot holes shall be examined after blasting and in case of misfire no person shall be allowed to approach the blasting area for at least 5 minutes. In case of blasting with safety fuse, utmost care shall be taken to count the number of loud reports to ensure that all the shots have fired and in the event of misfire, no person shall be allowed to approach the blasting site for atleast 30 minutes. In any case all holes shall be carefully inspected for residual undetonated explosives after firing the shots. No other person than those duly authorized shall approach the holes until the 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 shall be remedied and the shot fired.
 - The stemming shall 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 shall be siphoned or pumped out, then a fresh new charge placed and duly detonated, and
 - A new hole shall be drilled 60 cm away from the old bore and parallel to it and about 30 cm less in depth and the new hole charged and duly fired.
 - If a shift change is unavoidable, the person in charge of the outgoing shift, 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.

3.6 EXPLOSIVES DISPOSAL:

- a. No explosive shall be abandoned. There shall be disposed off or destroyed strictly in accordance with the approved methods and in doing so the manufacturers or the appropriate authority shall be consulted.
- b. Explosives, caps, boxes, lines or material used in packing of explosives shall not be left lying around places to which unauthorized persons can have access.



- c. Paper or fibrous material employed in pacing explosives shall not be put to any subsequent use. Burning in the presence of a responsible person shall destroy such material.



CHAPTER – 4

CONSTRUCTION

References:

IS 4435:1967 Safety Code of Wooden Trestles and Ladders

IS 4912:1978 Safety Requirements for floor, wall openings, railings and toe board.

IS 2750:1964 Specification for steel scaffoldings

IS 4014 1967 (Part I and Part II) Specifications for steel tubular scaffoldings

IS 1161:1998 Specifications for Steel tubes for structural purpose

IS 3696:1987 Part I Code for Scaffoldings

IS 3696:1991 Part 2 Code for Scaffoldings

IS 3016:1982 Fire Protection in welding and Cutting Operation

IS 818:1968 Health and Safety requirements in Electric Welding & Gas Cutting Operation

IS 7293:1974 Safety Code for working with Construction Machinery

4.0 FALL PROTECTION

Contractor will ensure Fall Protection Program to eliminate fall hazards, to prevent falls, and to ensure that workers who may fall are not injured. Contractor will accomplish fall protection through the following:

- Making fall protection part of detailed Work Plans by identifying and evaluating fall hazards.
- Eliminating fall hazards by engineering solutions, if possible.
- Train workers to recognize fall hazards.
- Use appropriate equipment to prevent falls and to protect workers if they fall.
- Inspect and maintain fall-protection equipment before and after using.

Contractor must do the following to control and eliminate these causes:

- By doing an effective job of building the safety attitude and increasing awareness.
- By ensuring that walkways are free from debris, air hoses and electric cords, and projecting materials to eliminate tripping hazards.
- Cleaning up foreign substances such as grease, oil, and mud to alleviate slipping hazards.
- Making sure that work areas and walkways are well lit.



- Keeping floor elevations clearly marked or ramped.
- When possible, utilize access to the work that does not require tie-off. This includes stairways, stair towers, and inclined ladders up to 10m in height.
- When another means of access is not practical, a vertical safety line with a ladder climbing safety device (LCSD) will be used while climbing.
- If an (LCSD) is not yet in place or is not practical, then a system of 100% tie-off procedure will be used.

-

While Climbing or Moving to a Work Area:

If a Ladder Climbing Safety Device is not in place, and it is necessary to climb or move laterally to a work area, a system of two lanyards will be used where one lanyard is secured to a tie-off before the other lanyard is unhooked.

Cutting or Welding while Tied-Off

If it is necessary to use a cutting torch or welder while using a tie-off, a steel cable or chain with proper double locking hooks should be used for the first or “working” tie-off. The second tie-off should be positioned so as not to be damaged by sparks and should be carefully inspected after any cutting or burning. If there is any damage, it shall be destroyed and a replacement shall be used.

Standard Equipment

The personal fall protection equipment to be used in normal applications shall be a body harness, a 1.1m lanyard with a locking snap hook (also referred to as double locking), and a shock absorber. The shock absorber can be built into the harness, the lanyard or can be separate.

Tie-Off in Lifts

Employees will be required to be tied off when working in a manlift or scissor lift. The lifts should have an approved anchorage point designed into the lift. If not, tie to a handrail. At no time should an employee be tied off independent of the lift.

4.1 SCAFFOLDS:

4.1.1 Scaffolds of proper type shall be provided for all work that cannot be done from the ground or from part of a permanent structure or from ladder or other available means of support and safe means of access shall be provided to every place at which workers are required to work.

4.1.2 Every scaffold and every part thereof including supports shall be of good construction, of suitable and sound material and of adequate strength for the purpose of which it is used and it shall be properly maintained. Construction and dismantling of every scaffold shall be under the supervision of a competent person. Boards and planks



used for the floors shall be of uniform thickness, butt jointed, closed laid, and securely fastened in place.

- 4.1.3 Every scaffold shall be securely supported or suspended and shall, where necessary be sufficiently and properly strutted or braced to ensure stability. The use of crossbraces or framework as means of access to the working surface shall not be permitted.
- 4.1.4 All scaffolds or working platforms of any nature shall be securely fastened to the building or structure, or if independent of the building shall be braced or guyed to prevent sway.
- 4.1.5 In the construction of dams sufficient anchorage shall be provided in the dam itself at the time of construction. The projecting anchorage shall be cut off only on completion. It is safer to avoid support on the sloping runners. The joints should be provided with bolts and nuts and not bent rods.
- 4.1.6 SUSPENDED SCAFFOLDS:
- (i) Outriggers or other means of supports of suspended scaffolds shall be of adequate length and strength, (not more than 2m length unless specified by the Engineer-in-Charge) properly constructed, in stalled and securely fixed by anchor bolts or other equivalent means.
 - (ii) Roses, chains or other means of suspension shall be of good construction, sound material, and adequate strength and free from patent defects and properly secured. The ropes and chains shall have a factor of safety of 8.
 - (iii) The platform shall not be less than 45 cm wide and points of suspension not more than 3 meters apart and so arranged or secured that at the working position the edge is as close as practicable to the working face when persons have to work in a sitting position.
 - (iv) All rolling scaffolds shall be equipped with positive locking device to prevent accidental movement of the scaffolds. These shall be periodically tested.
 - (v) Suspended scaffolds shall be tested as frequently as may be necessary to ensure that minimum safety factors are maintained. The test will be made by raising the working surface 30cms above the ground and loading it with at least three times the maximum weight that will be imposed upon it.
- 4.1.7 Skips, buckets, baskets and similar equipment shall only be used for work of short duration when use of suspended scaffold is unreasonable and shall be used under the supervision of a responsible person. The skip, bucket or basket shall be at least 75 cms deep.
- 4.1.8 Trestle scaffold shall not be of more than three tiers and the working platform shall not be more than 4.5 metres above the ground or floor or other surface upon which



the scaffold is erected, and no trestle scaffold shall be erected on a suspended scaffold.

- 4.1.9 Men shall not be allowed to work from scaffolds during storms or high winds.
- 4.1.10 If scaffolds are not be used to a great extent or for a long period of time, a regular plank stairway, wide enough to allow two people to pass, shall be erected. Such stairways shall have handrails on both sides.
- 4.1.11 When work is being performed above a scaffold platform, a protective overhead covering shall be provided for the men working on the scaffold.
- 4.1.12 Whenever workmen have to work or constantly pass under a scaffold on which men are working, a screen or other protection shall be provided to catch any falling material. Such protection shall extend outside the scaffold properly in order to catch any material falling off the edges of scaffold platforms. 12mm wire mesh netting of No. 18 gauge or better may be used for this purpose.
- 4.1.13 Side screens shall be provided on scaffolds erected along passageways or other thoroughfares.
- 4.1.14 On high scaffolds, a netting or equivalent guard shall be provided for the space between toe- boards and railings.
- 4.1.15 During dismantling of scaffolds, necessary precautions shall be taken to prevent injury to persons due to fall of loose materials, bracing and other members of the scaffold shall not be removed pre-maturely. While dismantling, the entire scaffold shall be maintained stable and rigid so as to avoid the danger of collapse. Nails from the planking and various members of the scaffold shall be carefully removed and all material carefully piled.

BALLI - STAGINGS:

- 4.1.16 These staging used upto a height of 12 meters shall be designed and erected with adequate bracings securely fastened under the supervision of an experienced and competent person and shall be regularly inspected and properly maintained.

4.2 PLATFORMS, GANGWAYS AND RUNS:

- 4.2.1 All working platforms, gangways and runs from which workers are liable to fall more than 2 metres shall be:
 - a) Of adequate width depending upon the type of work done and closely boarded, planked or plated. For platforms, the width shall not be less than 60 cms. For gangways or runs are used for passage or materials the width shall not be less than 60 cms.



b) Provided with suitable guardrails of adequate strength to height of 1 meter above the working surface and toe-boards of at least 20 cms in height to prevent fall of persons, materials or tools.

4.2.2 Every platform, gangway, run or stairs shall be kept free from any unnecessary obstruction, material or rubbish and from any projecting nails, and when they become slippery appropriate steps shall be taken by way of sanding, cleaning or otherwise to remedy the defect.

4.2.3 Each supporting member used in the construction of runways, platforms, ramps and scaffolds shall be securely fastened and braced. The supporting member shall be placed on a firm, rigid, smooth foundation of a nature that will prevent lateral displacement. The thrust-out members from which a scaffold is suspended shall be sufficiently strong and shall extend at least 30 cms outside the platform being suspended and have a stop block or bolt at the outer end.

PLATFORMS:

4.2.4 The minimum uniformly distributed design load per sq. meter of platforms shall be 300 kg. In case of stone masonry it shall be 450 kg per sq. meter. Any concentrate load at any point in the span shall not exceed the designed uniformly distributed load. A factor of safety of 4 shall be adopted. Planking shall not be less than 30 mm thick.

4.2.5 A scaffold platform plank shall not project beyond its end-supports to a distance exceeding four times the thickness of the plank unless it is effectively secured to prevent tipping.

4.2.6 Cantilever of scaffold planks shall be avoided. Ledgers or putlogs should be erected to support the ends of such planks.

4.2.7 Where planks are butt jointed, two parallel putlogs must be used, not more than 10 cms apart, giving each plank sufficient support.

4.2.8 The following minimum widths of platforms for various types of scaffolds are recommended:

a) Where platform is not more than 2 metres above the ground or solid floor,

- (i) For painters, decorators and similar workmen.....30 cms
- (ii) For other type (Men and Tools only)50cms

b) Where platform is more than 2 meters above the ground or solid floor;

- (i) Foremen, tools & materials..120 cms
- (ii) For men tools materials & vehicles...150 cms

GANGWAYS AND RUNS:



- 4.2.9 All planks forming a gangway or run shall be so fixed and supported as to prevent undue or unequal sagging.
- 4.2.10 No gangway or run, the slope of which exceeds 1 vertical to 1½ horizontal shall be used.
- 4.2.11 Where the slope of a gangway or run renders additional foot-hold necessary, and in every case where the slope is more than 1 vertical to 4 horizontal, there shall be provided proper stepping laths which shall:
- (i) Be placed at suitable intervals, and
 - (ii) Be of the full width they may be interrupted over a width of the gang way or run except that of not more than 10 cms to facilitate the movement of borrows.

4.3 LADDERS:

- 4.3.1 Every ladder and step-ladder shall be of good construction, sound material and adequate strength. These shall be inspected at least once a fortnight and observations recorded.
- a) No ladder with defective or missing rung or with any run, which depends for its support solely on nails, spikes or other similar fixing, shall be used.
 - b) Wooden ladder should not be painted as paint covers up defect but linseed oil or clear varnish should be used.
- 4.3.2 The use of ladders for other than a means of access should be eliminated as far as possible.
- 4.3.3 Whenever a platform is 1.5 meter or more above the ground, a ladder or stairway shall be provided, one for each successive platform. Safe access from and to ladders or stairs must be provided at all platforms.
- 4.3.4 Every ladder used for a vertical height of more than 9 meters shall be provided with an intermediate landing and vertical distance between two successive landing places shall not exceed 9 metres. All intermediate landings shall be provided with suitable guardrails to a height of at least 1 meter above the landing place.
- 4.3.5 Where a ladder is used as a means of communication or as a working place the ladder shall rise, or adequate hand-hold shall be provided, to a height of at least 1 meter above the place of landing of the highest rung to be reached by the feet of any person working on the ladder, as the case may be, or if that is not possible to the greatest practicable height.
- 4.3.6 When using a ladder or a step ladder, the user should always face the ladder. The transportation of materials by ladder should be reduced to the minimum. Tools and materials should wherever practicable, be pulled up with a rope.



- 4.3.7 Ladders should not be placed in front of doors opening towards the ladders or against window sashes. Stepladders should be opened out fully before use. Two ladders should be spliced together to provide access to a greater height than when a single ladder is used.
- 4.3.8 When permanent or portable ladders are used, the upper ends shall extend 110 cms above the platforms. Portable ladders shall be securely fastened at the bottom and top.
- 4.3.9 All ladders shall be periodically inspected. The stability of ladders should be tested before using it.
- 4.3.10 A ladder should not be placed upon a box, barrel or other movable insecure object.
- 4.3.11 Portable ladders should be in a safe position before being climbed. The slipping of a ladder at either end should be carefully guarded against, especially where the supporting surfaces are smooth or vibrating. If necessary, a person shall be stationed at the base of the ladder to prevent it from slipping.

4.4 OPENING. DANGEROUS CORNERS, BREAKS OR EDGES & SLOPING SURFACES:

- 4.4.1 Every accessible opening through which any person is liable to fall a depth of more than 12 metres or to fall into any liquid or material so as to involve risk of drowning or of serious injury shall be provided with guard rails 1 meter above the edge and toe boards at least 20 cms high or a covering to prevent fall of persons, tools or materials through the opening.
- 4.4.2 Every dangerous corner, break or edge of any structure which is accessible to any person shall be provided with guardrails of adequate strength and, if necessary, with the toe boards.
- 4.4.3 Every person employed on a sloping surface of a vertical fall of more than 2 metres shall be provided with suitable ladders or crawling boards properly secured and a suitable working rails and in case it is impracticable or inappropriate to provide such ladders, crawling boards or working platforms, safety belt of sound materials and in good condition with a rope of adequate strength and length enabling the wearer to attach himself to a secure anchorage shall be supplied, or where the wearer cannot so attach himself, a second person shall attach or hold the rope in a secure manner.

4.5 FORM CONSTRUCTIONS AND CONCRETE PLACEMENT:

FORM CONSTRUCTION:

- 4.5.1 Safety hazards in form-work construction such as those due to poor housekeeping, leaving materials and tools where they may fall and cause injuries; the tops of forms used as walkways not equipped with standard guardrails and toe-boards on the open



side, and failure to properly secure form of scaffolds can be reduced, if not eliminated, by careful planning.

HANDLING FORMS:

- 4.5.2 All forms or form panels that are to be used or reused should have u-bolts, sufficient in number and size, to carry the weight of forms or form panels, all temporary bracing shall be securely fastened to prevent member from falling where panels are being moved.

RAISING:

- (a) All form - raising operations should be conducted in a safe and orderly manner and only experienced workmen should be allowed on this type of work. All form raisers shall use safety belts when required to go over the side unless scaffolds are in place on the form.
- (b) Frames shall be designed and maintained to withstand all loads imposed upon them. All head and tail jacks shall be maintained in good working order. Tail jack fasteners of sufficient length and size shall be securely anchored in the concrete.

STRIPPING :

- (a) All form stripping shall be conducted in a safe and orderly manner and in accordance with the rule for good housekeeping. All stripped lumber shall be placed in piles or removed immediately from the work area. All protruding nails or superfluous bolts or studs used to fasten the shuttering shall be cut or bent down soon after the stripping.
- (b) Boatswain's chairs, safety belts, and ropes shall be used where workmen are exposed to falling hazards of such stripping operations and shall be protected from falling objects.

CONCRETE PLACEMENT:

- 4.5.3 All employees placing concrete should wear hard hats and rubber boots with trouser legs outside. Shirtsleeves should be rolled down, gloves should be worn, and every reasonable precaution taken to keep cement and concrete off the skin. Provision should be made for concrete workers to take a shower before leaving the jobs at the end of their shift.
- (a) The water in freshly mixed concrete contains lime and alkalis and may cause severe and painful damage to skin and eyes. Such contacts should be avoided by using proper protective clothing, boots, gloves, goggles etc. If they should occur, the workman should immediately remove liquids or substances by washing in water.
- (b) Cement, and concrete when dumped or dropped splashes like water and this is another way the burning lime and alkalis can get into unprotected eyes.
- 4.5.4 Men in good physical condition should be employed to operate vibrators. Lowering of vibrators from one level to another by use of air hose or electric cable shall not be permitted.



- 4.5.5 When concrete is transported by means of chutes, the towers shall be of substantial construction, sound material and ample strength to carry the greatest load that could possibly occur. They shall be properly guyed and provided with safe access. At each level of the chute where men work, landing platforms shall be provided and the chute shall be properly guyed and the area below the spout shall be barricaded when practicable to keep people out of the areas where they might be injured by falling concrete.

CONCRETE BUCKETS:

- 4.5.6 Concrete buckets for use with cranes and cable ways shall be constructed without flanges or other projections that may collect concrete which might be dislodged and fall on workmen. Buckets shall have an air connection to operate the dumping mechanism. All concrete buckets that are dumped by control of a cableway operator shall be equipped with safety catches that must be manually released before the concrete can be dumped. No man shall ride a bucket for any purpose.
- 4.5.7 When it is necessary to drift a bucket to a place not accessible by the crane, the drifting shall be done by some mechanical means and not by men pushing or pulling the bucket. Drifting the bucket by swinging the crane shall be prohibited.
- 4.5.8 Only those workmen who are known to be careful and reliable should be employed as signalmen to direct the spotting of buckets. Signalmen should be so stationed in a safe place, that they could see the entire area where concrete is being placed. A man should be specially designated to watch the movement of the bucket and warn the crew and vibrator operators of the approaching bucket so that all workers may clear out of the area affected by the bucket.
- (a) Workman / inspectors shall not enter a bin containing cement, aggregates unless wearing a safety belt with life line attached and attended by another worker who will pay out and keep minimum slack in the line at all times.

MIXER:

- 4.5.9 All mixer gears, chains and rollers shall be guarded. If the mixer has a charging skip, it shall be guarded by bars on the sides to prevent any one walking under the skip. The cable and sheaves should be inspected daily when the mixer is in continuous daily operation. When it is necessary to get inside mixer for cleaning, repairs or inspection, the control switches shall be locked and notice to the effect pasted on it to prevent inadvertent starting of the mixer.

MIXING PLANT:

- 4.5.10 Mixing plants shall be adequately designed and precautions taken to protect workmen from falling objects. Walkways, platforms, stairways and ramps shall be well built and protected. The operations of the plant shall be coordinated by signals or interlocking devices as may be necessary to ensure the safety of all workmen. An air



exhaust system shall be installed to remove cement and other dusts from the inside of the plant. Respirators should be worn when necessary.

4.5.11 PUMP CRETE:

- (a) The scaffolding supporting the pipe shall 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 use the scaffold at the same time while the pump is operating. A factor of safety of four shall then be used.
- (b) The pipeline shall be anchored at all curves and near the end. The toggle and flange connections shall be inspected before each placement to ensure tight joints. Air release valves shall be installed at high points to release entrapped air. The use of these valves will assist in preventing line plugging which in turn reduce accident possibilities.
- (c) The work of cleaning a pipeline must be carefully done. Experienced workmen should be employed. There is danger of injury to workmen and also possibility of wrecking the scaffold. If and when necessary to open a pipe to clear it of an obstruction, the work must be carefully done in order that workmen may not be injured by concrete blown out by air pressure in the pipe.
- (d) All workmen, when working in the vicinity of a pump Crete machine should be provided with goggles and be required to wear them.

SAND BLASTING:

4.5.12 If sand and air blast are used, the sand blaster shall wear the regulation sand blaster's hood, goggles and protective clothing. Operators of sand blast machines shall also take care in direction the blast so that no one is caught in the blast or the rebound. All employees whose work requires that they be in the vicinity of the sand blasting operations shall also wear goggles and respirators if a dry sand blast is used.

RE- INFORCEMENT:

4.5.13 Reinforcing steel shall be piled on wood sills, and segregated as to sizes and lengths. Wood stakes shall be used to separate the various piles. Lanes and driveways shall be kept clear.

- (a) The main accident hazards in bending reinforcing steel are due to sharp burrs in cutting and the whipping of long flexible rods. Tripping hazards will be present unless the rules of good house keeping are observed. Employees on this work should wear heavy gloves or hand pads. A leather or heavy denim apron is desirable. The area about the bender shall be kept clear for a distance equal to the length of the longest bar.
- (b) All persons placing reinforcement steel where a falling hazard is present shall use safety belts. The tie-off rope may be short with a hook on the end to engage the steel. The common practice of a carrying wire for ties in a coil over one shoulder and under the



opposite arm introduces hazards that can be obviated by carrying the wire on a reel that is worn on the belt.

CEMENT HANDLING:

4.5.14 Workmen engaged in handling bulk cement in confined places should wear tight-fitting goggles, approved respirators and protective clothing that fits snugly around the neck wrists and ankles.

4.5.15 Workmen should be instructed to ensure personal cleanliness to guard against cement dermatitis and should be advised to report any susceptibility to cement burns. Hand cream or petroleum jelly shall be provided for the use and protection of men handling cement.

4.6 GROUTING, GUNITING & SHOTCRETING:

4.6.1 Many of the hazards of grouting, guniting and shotcreting operations are common to other construction operations, and are therefore, covered by the above provisions. However, some of the principle hazards particularly incident to grouting and guniting are as given below:

MACHINERY HAZARDS:

4.6.2 All openings of grout mixers shall be adequately guarded. All flywheels, and all other moving parts including compressor drive belts, shall likewise be fully guarded.

GROUT PIPE HOSES:

4.6.3 All pipes or hoses used to convey the grout shall be of sufficient strength conforming to standard specification to withstand the maximum pressures that may be reached during the operation. Pumps shall not be operated at pressure in excess of their rated capacities, or the safe working strength of the conveying system. All hose couplings shall be of standard types, and makeshift wire connections shall not be used. Pipe or hose laid along ladder ways, catwalks or ramps shall be located at one side of the travel way in order to prevent tripping hazards.

TOOLS:

4.6.4 Proper tools for the work to be done shall always be provided and maintained in good condition. Only wrenches with jaws in proper condition shall be used. In using a wrench it should always be so placed that the pull tends to force the jaws further on the nut, and the user should make sure that his footing is secure before applying force to the wrench.

SAFETY BELTS:

4.6.5 Men working in elevated position shall use suitable safety belts, boatswains' chairs, or lines to guard against falling.

GALLERY LIGHTING AND VENTILATION



4.6.6 All galleries or shafts, where foundation grouting is in progress, shall be adequately lighted and ventilate and reasonably free from water. Workmen should be provided with pocket flashlights for use, in case the light circuit fails. All unused shafts, vertical stairwells, or other openings in galleries shall be barricaded.

TELEPHONE SYSTEM :

4.6.7 Wherever feasible, a telephone system should be used to provide positive and quick method of communication between all control locations or grout operations.

4.7.8 Only experienced man should be employed for guniting and shotcreting which is a special type of concrete work. The nozzle man and helper shall be provided with cup type safety goggles, and shall use them as protection against rebound material. The nozzle man should operate the nozzle so as to keep the rebounds at a minimum, and care must be taken not be trap the rebound on cleaning men in the blast.

a) All scaffolds or platforms used in placing gunite shall be substantially built. No makeshift type of construction shall be permitted.

b) All hoses and mixers shall be inspected daily and maintained in a safe working condition.

c) All other workmen shall be excluded from the immediate working area.

4.7 STRUCTURAL STEEL ERECTION:

4.7.1 Heavy members must be maneuvered into places, but the short time required to make the erection joint at any connection does not ordinarily justify the erection of a rigid scaffold. When scaffold and ladders for use of the welders, riveters or erectors are necessary, the safety rules and regulations laid down in the manual should be followed.

4.7.2 All employees working in places where they are exposed to falling hazards should use safety belts.

4.7.3 Wherever workmen are exposed to unusual falling hazards from which it is impracticable to protect them by temporary floors or scaffolds, a safety net should be suspended below the place where men are working. Such nets shall be of 10 cms mesh and shall be made of Manila rope of at least 20mm diameter with an outside or border rope of 18 mm diameter. The border shall be provided with loops so that the nets can be attached to the structure or to each other.

4.7.4 Hardhats should be worn by employees working on or around erection operation and should be worn with chin straps fastened.

4.7.5 All employees when handling steel cables or other rough or sharp edged materials should wear Gloves of suitable type.



- 4.7.6 Goggles should be worn when grinding, chipping, scrapping, caulking, cutting and heating rivets.
- 4.7.7 Good footwear should be worn by all employees and the soles should be kept free from mud and grease. Safety toe shoes should be worn at all times.
- 4.7.8 Workmen should stand in clear when derrick is sorting for shifting steel beams. The signalman and the operator should check to see that all men have cleared out before lifts are made.
- 4.7.9 Workmen should not stand, walk or work beneath suspended loads.
- 4.7.10 When guiding a beam, it should be so held that the hands do not get jammed against other objects.
- 4.7.11 When lifting and object in a group, one person should be designated to give the signal for all to lift or set the object down in unison.
- 4.7.12 When lifting, legs should be bent, body kept straight and leg muscles used for the lift.
- 4.7.13 There shall be no riding on steel that is being hoisted, no riding on the overhauling weights, hooks, cables or slings, nor sliding down on ropes or cables.
- 4.7.14 Public or workers in other trades operating close to steel erectors should be safeguarded at all times.
- (a) They should be cautioned and instructed on any exposure condition existing or that may arise and result in accident.
 - (b) They should be advised to wear hard hats when required to work close by.
 - (c) They should be instructed not to operate directly underneath scaffolds that are being used.
 - (d) Red flags or warning signs should be strategically posted to assist in cautioning and instructing others.
- 4.7.15 When receiving or unloading steel on job site adequate protection such as barricades, sign flags and watch-man should be provided to protect the public.

4.8 WELDING AND CUTTING:

- 4.8.1 All welding and cutting shall be done by workmen who are thoroughly strained in the work or by trainees under competent supervision. Shields shall be placed around the work to protect person from glare.
- 4.8.2 Welding and cutting shall not be done in the immediate proximity of flammable materials.
- 4.8.3 Welders and helpers shall wear non-combustible helmets and gloves during welding operations. They should be careful to keep out of the line of sparks and hot metal and



they should wear clothing free from grease, gasoline, oil and other flammable materials.

- 4.8.4 Oxygen and acetylene cylinders or container shall never be by permitted in small spaces of compartments where welding operations are in progress.
- 4.8.5 A helper shall always be at hand to shut off the gas in case of an accident when the welder is working in a space from where escape is difficult.
- 4.8.6 All welding operations should be carried out in a well-ventilated space. Where any considerable amount of welding is to be done, an exhaust system for carrying away the fumes should be installed. If brass, bronze or zinc is to be welded, a suitable respirator should be worn if exhaust system is not installed.
- 4.8.7 All torches, regulators, cylinders and other such equipment shall be of an approved design, regularly inspected and kept in good condition. Defective apparatus and equipment shall be removed from service, replaced or repaired and re-inspected before, again being placed in service. Only persons who are thoroughly familiar with such apparatus shall make repairs.
- 4.8.8 Welder and helpers shall wear suitable eye-protective devices during welding and cutting operation. Eye exposed to welding or flashes should be washed with rose water for better relief.

FIRE PROTECTION:

- 4.8.9 To avoid fire hazards, the following additional precautions should be observed on all oxy-acetylene cutting and welding:
 - (a) Keep hose and cylinder valves free from grease, oil, dust and dirt.
 - (b) Keep cylinders away from stoves, furnaces and other sources of heat.
 - (c) Only 'Gas Lighter' shall be used to light the torch.
 - (d) Avoid use of oxy-acetylene flame in confined spaces.
 - (e) Clean thoroughly with steam all containers that have been used for storage of flammable liquids, or wash with hot water and soda, and ventilate thoroughly before welding and cutting.
 - (f) When testing for leaks use only soap water and watch for bubbles.
 - (g) Valve protection caps shall be in place when cylinders are not in use.
 - (h) All employees shall be made familiar with the location and proper use of fire extinguishers in their area of work.

GAS CYLINDERS:

Due care shall be taken while loading and unloading oxygen/ acetylene gas cylinders.

- 4.8.10 Gas cylinders shall be kept up right in approved safe places where they cannot be knocked over and well separated from radiators, furnaces and combustible materials. These safe places shall be painted with appropriate warning signs. Empty cylinders



should be marked 'EMPTY' and the valves closed. Loaded and empty cylinders should be kept in separate places.

- 4.8.11 Oxygen cylinders shall not be stored in close proximity to acetylene cylinders or other fuel gas inside the building and in no circumstances either oxygen or acetylene cylinder shall be stored under direct rays of sun or in places where excessive rise of temperature is likely to occur.
- 4.8.12 Tempering with or attempting to repair safety devices or valves of gas cylinders shall be prohibited and if trouble is experienced in any cylinder, a report shall be sent to the supplier forthwith describing the character of the trouble and particulars of the cylinder.
- 4.8.13 When acetylene cylinder are coupled, approved flash arrestors shall be inserted between each cylinder and the coupler block or between the coupler and the regulator and only cylinder of approximately equal capacity shall be coupled.
- 4.8.14 Cylinders found to have leaky valves or fittings, which the closing of the valve will not stop, shall be taken into the open way from any source of ignition, and slowly drained of gas.
- 4.8.15 Electric magnets or direct slings shall not be used for handling cylinders and only special cradles shall be used.

HOSES AND TORCHES:

- 4.8.16 The hose shall be specially designed for use on cutting and welding operations. Special care shall be taken to avoid interchange of oxygen and acetylene hoses, as the mixture of these gases is highly explosive. Some coloured code should always be used on each gas-red for fuel gas and black for oxygen. Glycerine shall be used for lubricating valves.
- 4.8.17 Some manufactures dust the inside of the hoses with fine talc. New hoses shall, therefore, be thoroughly cleaned on the interior before attaching to the torch. Compressed air shall never be used to clean hoses as it may contain oil from the compressor. Oxygen shall be used to clean oxygen hoses and acetylene shall be used to clean acetylene hoses.
- 4.8.18 Torches that leak at any connection, or get hot, or flash black shall not be used. Cooper or brass wire shall be used to clean the tips. Hardwood sticks may also be used.

GAS WELDING AND CUTTING OPERATIONS:

- 4.8.19 The gas cylinders shall not be used unless fitted with the following; high pressure gauge on cylinder, reducing valve with pressure regulator and safety relief device, low pressure gauge for indicating pressure on the torch. The fuel gas and oxygen



cylinder shall have left hand and right hand threads respectively, so that they cannot be interchanged.

- 4.8.20 Cylinder valves shall be opened only with hand wheel or tools, specially designed for that purpose, and left in place while cylinders are in use. Cylinder valves shall be closed when not in use.
- 4.8.21 Since explosion may occur, oxygen / acetylene gas cylinders and fittings shall be kept away from oily or greasy substance and shall not be handled with oily hands or gloves. A jet of oxygen shall not be directed at oil surface, greasy clothes, or within a fuel oil or other storage tank or vessel.
- 4.8.22 Under no circumstances shall acetylene be used at a pressure exceeding 1.1 Kg per sq. cm. Oxygen pressure should always be such that acetylene does not flow back into the oxygen cylinder, as oxy-acetylene mixture is highly explosive.
- 4.8.23 After attaching the regulator and before opening the cylinder valve, the operator should see that the adjusting screw of the regulator is released. Oxygen should be permitted to enter the regulator suddenly. The cylinder valve should be opened slowly.
- 4.8.24 Oxygen and acetylene hoses shall be taped or clamped together at 1-meter intervals. Tape shall never be used to make repair to hoses.
- 4.8.25 Oxygen or acetylene cylinder shall never be placed where they can be contacted by electric wires or with ground wires of electrical equipment. If electric arc welding is being done in the same vicinity, such precautions as necessary must be observed to make sure that the oxygen-acetylene gas equipment does not come in contact with electric arc welding equipment.
- 4.8.26 Closed tanks or containers shall never be welded until they are thoroughly cleaned, dried out and ventilated and it has been determined that they contain no explosive or harmful fume.
- 4.8.27 No smoking shall be permitted by workmen or welders while handling gas cylinders.

ELECTRIC ARC WELDING AND CUTTING:

- 4.8.28 The flash from electric arc welding is much more severe than that from oxy-acetylene welding, therefore, the welder shall have adequate eye protection and all persons working in the immediate vicinity should wear suitable coloured goggle unless the work is completely shielded.
- 4.8.29 Welding shall not be done in the [presence of any person not amply protected from the flash. Person should never look at an electric arc with the naked eye; to do so may cause serious eye injury.



- 4.8.30 Only heavy duty electric cable with unbroken insulation shall be used, and all connections shall be water-proof. All connections shall be checked before welding is started, and frequent inspection shall be made during welding operations.
- 4.8.31 when it is necessary to couple several lengths of cable for use as a welding circuit and occasional coupling or uncoupling is necessary, insulated cable connectors shall be used on both the ground line and electrode holder line.
- 4.8.32 Frames of all electric welding machines operated from power circuits shall be effectively grounded.
- 4.8.33 When the operator has occasion to leave his work or stop work for any appreciable time, the power supply switch in the equipment should be opened and the unit shut down.

4.9 PAINTING:

Packages containing paints, varnishes, lacquers or other volatile painting materials shall be kept tightly closed when not in actual use, and shall be placed where they will not be exposed to excessive heat, sparks, flame, or direct rays of the sun.

FIRE HAZARD:

- 4.9.1 Most paint materials are highly combustible, and every precaution should be taken to eliminate danger from fire.
- No attempt should be made to heat paint materials except by placing containers in air, or water at moderate temperature. Dirty wiping rags, paint scraping and paint saturated debris, which always involve the hazard of spontaneous combustion or ignition from other sources, should not be allowed to accumulate, but should be collected and disposed of at frequent intervals.
 - Smoking, open flame exposed heating elements, and other source of ignition of any kind should not be permitted in paint stores or areas where spray painting is done.
 - Fire extinguishers of appropriate capacity shall always be at hand where flammable paint materials are being mixed used or stored. Sand buckets or extinguishers of the carbon dioxide and carbon tetrachloride type are generally affective.

PROTECTION FROM DUST AND FUMES:

- 4.9.2 Apart from its explosiveness, air laden with dust or fumes may cause suffocation or other respiratory injury and may also have toxic effects through the skin or alimentary system. In painting, the dust comes chiefly from operations preparatory to painting such as sand blasting, scaling, scraping and brushing. Injurious fumes are given off when volatile paint materials are being mixed or applied specially when they are sprayed. Dust and fume nuisance is most dangerous in constricted spaces. Coal tar paint fumes are particularly obnoxious.



- a) Workmen must be provided with an ample supply of fresh air. If natural circulation is not adequate, artificial ventilation shall be provided. Ventilation shall be sufficient to carry away harmful accumulations to dust and fumes or workmen shall wear approved type of respirators.
- b) Spray painting operations shall be so confined as not to contaminate the air where other men are working. Spray gun operators should be required to wear clothing which fits snugly at the ankles, neck and wrists and should wear gloves, goggles and respirator.

HANDLING PAINT MATERIALS:

- 4.9.3 Serious harm may result if the skin is exposed to prolonged contact with paint materials. Injury may take form of burns or toxic effects resulting from absorption into or through the skin. It is well to avoid the use of paint solvents for cleaning the skin. These materials are not only injurious themselves, but they also carry poisonous ingredients of the paint into the pores of the skin. There are a number of protective creams which may be applied to the skin before exposure to paint substances, and which wash off easily in warm soapsuds, taking paint off with them. The use of protective creams by all painters is recommended. Food shall never be placed where it might be exposed to fumes or dust from paint. Painters should clean their hands before eating.

CREOSOTE:

- 4.9.4 Creosote is a lumber preservative and is closely related to carbolic acid. Extreme care is required to prevent contact with the skin or eyes, as it will cause severe burns. Protective cream or jellies should be used on exposed skin surface when engaged in handling creosoted materials. Affected parts of the body should be washed immediately, and in most cases the services of a physician should be secured.

4.10 CONSTRUCTION MACHINERY SAFETY

4.10.1 SAFETY FOR WORKING WITH CONSTRUCTION MACHINERY

Scope

This lays down the essential requirements for safety in the operation and maintenance of earth moving, lifting and hoisting, transporting and other construction machinery. It also includes some features of design and construction which are essential for safety working of construction machinery.

Plant & Equipment envisaged for HRT

- Twin boom boomer
- Rock bolter
- Bencher Commando 300
- Bencher ROC 203
- Excavator 1.7 cm / Loaders
- Dumpers 18T
- Truck 10T
- Shotcrete Machine



- Jack Hammer
- Vent. Fan / DG Sets 1250 KVA JCB / Grader
- Vent Duct
- Overt Shutter
- Conc. Pumps 45 cum / hr.
- Transit mixers 6 cum
- Conc. Mixing Plant 30 cum / hr.
- Ditto 45 Cum / hr.
- Compressor 600 Cfm
- Grout Pump
- Concrete mixers
- Dozer
- Mobile Cranes
- Crushing plant
- Needle vibrators
- Steel Gentries
- Explosive
- Transporters

SAFETY IN WORKING WITH CONSTRUCTION MACHINERY

- a. Siting: In siting construction machinery for operation, attention shall be given to the strength of foundation or structures on which the machinery may stand or move or be supported and the proximity of hazard, such as near by structures, public access area, other moving machinery and in case of cranes, overhead electric conductors.
- b. When static load lifting machinery like cranes, winches pile drivers and excavators is required to operate on edges of embankments or in boggy areas, the bearing capacity of the soil shall first be tested and a minimum three layers of criss-cross bearing packing shall be provided in addition to providing proper anchorage to the superstructure of the machinery.
- c. Fencing of Machinery:
 1. All gears, revolving shafts, couplings and all other dangerous parts of machinery shall be effectively guarded unless they are so constructed, installed or placed as to be as safe as if they were guarded.
 2. On all new machinery, all spur and worm gear and other toothed or friction gear which do not require frequent adjustment and every set screw, bolt or key on any revolving shaft, spindle, wheel or pinion shall be encased or so sunken or otherwise effectively guarded so as to prevent danger.
 3. Fencing of dangerous parts of machinery shall not be removed while the machinery is in use or in motion and when removed, it shall be replaced as soon as practicable and in any case before the machinery is again brought into use.
- d. Safe Access – Safe and adequate means of access including handholds and footholds shall be provided to all parts where a person may have to walk, climb or work.
- e. Maintenance:
 1. No part of machinery, while in motion or in operation shall be examined, lubricated, adjusted or repaired except by a duly authorized person. Any repairs to machinery while in motion or in operation shall be carried out only when unavoidable.



2. Parts of machinery shall be cleaned when the machinery is stopped. If the cleaning is unavoidable when the machinery is working, this shall be done by a duly authorized person in conformity with accepted standards of safety.
 3. Electric power shall be shut off and relevant fuses removed when repairs are carried out to any electric machinery.
 4. Any machinery, equipment or part thereof which is suspended or held apart by use of slings, hoist or jacks shall be substantially blocked or cribbed before men are permitted to work underneath or between such machinery, equipment or part thereof.
- f. First aid and Fire fighting:
1. A first aid box or kit shall be provided at the site.
 2. When operation of the construction machinery is confined to one place or is within a restricted area of about 30m radius, a fire point shall be established at a suitable and easily accessible location within the area. The fire point shall be provided with the following equipment, which shall always be kept in serviceable condition:
 - i. 5 kg. Dry Powder Extinguisher conforming to relevant IS - 2 Nos.
 - ii. Sand buckets - 2 Nos.
 3. Where the construction machinery in use is a mobile type and during the course of operation has to shift its location frequently, one 5 kg. DCP extinguisher shall be carried on the machine itself at a suitable position on the machinery so as to ensure its easy availability. It shall also be ensured that these extinguishers are inspected and maintained properly according to relevant IS and that all persons employed on construction work are well conversant with the method of operation of the equipment. When sand is used for extinguishing a machine fire it involves through cleaning immediately after the fire is extinguished. However, this work be undertaken only under the supervision of a competent person.

EARTH MOVING, LIFTING AND HOSTING MACHINERY

- a. Driver's Cabin:
1. The driver shall be adequately protected from the weather by a cabin, which if enclosed, shall be provided with windows that give unrestricted maximum possible view and is well ventilated.
 2. The windows shall be provided with toughened safety glass and wipers.
 3. Wherever the arrangement of the control permits, a set of such design, construction and dimension as will permit safe operation of the machinery without under fatigue and discomfort shall be provide.
 4. The driver's seat shall be provided, if necessary, with fencing, guard rails and toe boards to prevent danger.
 5. A dry powder extinguisher of 5 kg capacity shall be provided in the cabin or any other suitable place on the machinery, and operating and maintenance personnel shall be thoroughly conversant with the use and care of the extinguisher.
 6. Emergency means of escape in case of fire or any accident shall be provided.
- b. Brakes and Controls:
1. Every earth moving and lifting & hoisting machinery having hosting and derricking motions shall be fitted with one or more brakes on each of these motions. Where slewing gear is fitted, on the slewing motion as well, the latter having a device for locking the rotating structure when the machinery is left unattended.



2. Effective braking devices shall be provided on the wheels of the machinery. Where power assisted brakes are provided, a manual parking brake acting on the driving wheels shall also be provided.
 3. Each control shall be clearly identified to show the motion and direction of movement.
 4. Control handles, levers and switches shall be so arranged that these can be operated reliably, safely and easily from the driver's seat.
- c. Drivers and Signalers:
1. Only competent and reliable persons who are at least 18 years of age and who have been adequately trained shall be employed as drivers of earth moving and lifting and hoisting machinery or as signalers to give signals to a driver.
 2. The driver shall not wear loose clothing and shall cover loose hair that might be caught by moving parts.
 3. The driver shall have clear, uninterrupted and unrestricted view of the load and operation area, or shall act upon the instructions of an authorized signaler having such a clear and uninterrupted view.
 4. The driver shall not leave his cabin while the engine or motor is running or the load is suspended. In no case, shall the machinery be left unattended, even for short periods, until all loads are removed and, in case of lifting and hoisting machinery until the hook after removing the load is brought to the highest working position at the appropriate radius. Before leaving, the electric power supply shall be switched off or the engine stopped and appropriate motion brakes and locks shall be applied to put the machine in a safe condition.
 5. Before starting, driver shall ensure that the gear and clutch are in neutral, the brakes where hand brakes are provided, are 'on' and on the throttle is adjusted to the required opening.
 6. Normally the driver shall be required to work only for the prescribed working hour. When unavoidable extra time shall be fixed after taking into consideration human fatigue.
 7. No unauthorized person shall ride on the earth moving machinery.
- d. Inspection and Testing:
1. All earth moving and lifting & hoisting machinery including all parts and necessary gear whether fixed or movable before being taken into use shall be tested and examined by a competent person for specified ratings and for safe operation at intervals as specified by statutory regulations and shall be tested and re-examined after any substantial alternation or repair.
 2. All structural members of control mechanism & transmissions and all safety devices shall be inspected periodically depending on the frequency of use, severity of service and environment.
 3. Steel wire ropes and other ropes including terminal fittings shall be examined at least once a week to check that these are not frayed or damaged.
 4. A through visual examination followed by routine checks on automatic safe load or load-radius indicators and / or cutouts, limit switches , oil and fuel levels and brakes shall be carried out at the beginning of each shift and any defects reported to the person responsible for the safe use of the machinery who shall keep a suitable record. In case of pneumatic tyres, the tyre pressure shall be checked and any deficiency



made good. The machinery shall not be put to service until clearance is given by the responsible person after ensuring that

- the faults have been corrected;
 - all adjustments have been made;
 - working parts are properly lubricated;
 - nuts, bolts etc. are properly tightened, and
 - all safety devices are in place.
- e. Work Near Overhead Power Line: All practical steps shall be taken to prevent the earth moving and lifting and hoisting machinery being operated in dangerous proximity to a live overhead power line. In particular, the machinery shall not be permitted to approach within the following distance of overhead power lines:
- | | |
|------------------|--------|
| 11 kV and below | 1.40 m |
| 33 kV and below | 3.60 m |
| 132 kV and below | 4.70 m |
| 275kV and below | 5.70 m |
| 400 kV and below | 6.50 m |
- If it becomes necessary to the machinery with clearances less than those specified above, it shall be ensured that the overhead power lines shall invariably be shut off during the period of operation of the machinery. Location of any underground power cables in the area of operation shall also be ascertained and necessary safety precautions taken.
- f. Miscellaneous: As far as possible, earth moving and lifting & hoisting machinery shall be adequately marked with red lanterns, red flags or other effective means.
- g. No earth moving and lifting & hoisting machinery shall be operated without the ballast or counter weights in place and the tonnage shall be as specified by the manufacture.

POWER SHOVELS (EXCAVATORS)

- a. Stability: Power shovels (excavators) shall be so operated as not to lose their stability.
- b. Power shovels (excavators) that are equipped with unit for deep digging shall either be so designed that the bucket teeth cannot come nearer the boom than 40 cm or be provided with a reliable stop that prevent the bucket to come nearer than the specified distance.
- c. Boom
- The boom or power shovel (excavator) shall be prevented from accidentally swinging during operation or transport.
 - The boom shall not be pulled tight against the emergency stops while supporting a load.
 - The maximum boom length stipulated by the manufacturer shall not be exceeded. The wire ropes use for the boom suspension as well as for the shovel / bucket shall be of the specified diameter and construction.
 - Due attention shall be paid to the length and condition of the pendant ropes and the end connection. The safe operating radius for the load under consideration shall not be exceeded.
 - History sheet and schedule for replacement of ropes shall be maintained.
- d. Bucket or grab
- The bucket or grab shall be of the right size taking into account the power of the machine or motor, length of the boom, the operating radius contemplated and total weight including the self-weight of the bucket or grab and other lifting accessories.



- While operating power shovels (excavators) the driver shall ensure that no person is working, passing or standing under the raised bucket or grab.
 - The bucket or grab of a power shovel (excavators) shall be prevented from accidental dipping, tipping or swinging in operation. The bucket or grab of the shovel shall be pulled out of the bank as soon as it is full. When not in use, the bucket shall be kept resting on stable ground and shall not be hanging.
 - The bucket or grab of a power shovel (excavator) shall be fixed to restrict movement while it is being repaired.
- e. Miscellaneous
- When power shovel (excavator) is operated near edges of excavations or embankments substantial space shall be provided to prevent it from approaching a dangerous position and the sides of the excavation shall be adequately shored. Heavy equipment, such as excavating machinery and road traffic shall be kept back from excavated sides at a distance not less than the depth of trench or at least 6m from trench deeper than 6m.
 - Power shovels (excavators) shall not be left on a slope with the engine of motor running.
 - The height of the benches in over burden shall not be more than the height of the boom of the machine used for digging excavation or removal.

BULLDOZERS

- a. When a bulldozer is moving uphill, the blade shall be kept low. When running down the hill the bulldozer shall be in the lowest gear.
- b. The bulldozer blade should not be used as brake except in case of emergency.
- c. The blade suspension arrangement (wire rope or hydraulic system) shall be inspected once a week.
- d. After the close of work, the bulldozer shall be left on level ground. Before leaving, the driver shall apply the brakes, lower lade and put the shift lever in 'natural'.

ROAD ROLLERS

- a. No person shall climb a moving road roller.
- b. Road rollers shall not move downhill with the engine out of gear.
- c. As far as practicable, road rollers shall not be left on a highway after the close of work and where this is not practicable, red lights shall be provided at the two ends at night to clearly show the presence of the road rollers on the road.
- d. When the road roller is not in use, brake shall be applied, engine shall be put into gear and wheels shall be blocked.

SCRAPPERS

- a. The scrapper shall be joined to a tractor by a safety line when in operation.
- b. Scrapper moving down hill shall be left in gear.
- c. Scrapper bowls shall be blocked while blades are being replaced. Packing may be used while maintaining / altering the angle of the blade.

LIFTING AND HOISTING MACHINERY

- a. Erection and dismantling



1. When lifting and hoisting machinery is to be erected at site, proper procedures specified by the manufacturers shall be followed during erection and dismantling operations at site, particularly with reference to correct assembly and the sequence or the operations by identification of different parts and components, which make assembly.
 2. The erection and dismantling operation shall be carried out under the supervision of a competent person.
 3. The erection crew shall wear safety helmets.
- b. Stability – Cranes shall be so operated as not to be liable to over turning particularly the following misadventures:
1. By taking load in excess of the safe working load.
 2. By rapid deceleration of slowing motion by severe application of brake.
 3. By braking too hard in order to arrest descending load.
 4. By sudden release of a heavy load.
 5. By pulling loads from the sides.
 6. By operating the crane without sufficient counter-weight.
 7. By positioning the crane at a steep slope.
- c. Jib -
1. When a crane is used at different times with jibs of different lengths, particulars of the lengths and the appropriate safe working loads shall be plainly marked in a prominent place on the crane and each driver, authorized to work, shall be certified after a regular test, that he understands the limitations of each conditions of the working of the crane.
 2. No crane shall, except for the purpose of test, be loaded beyond the safe working load, and for this purpose, either a table showing the safe working loads at different radii of the jib shall be displayed in a prominent place or an automatic safe load indicator which takes into account both the radii of the jib and the weights of the loads being lifted, with both visible and audible warnings shall be provided. Whenever possible, automatic device for cutting off power to hoisting and derricking motions when the safe working load is exceeded shall also be provided.
 3. Where possible, the cranes shall be equipped with limit switches to prevent over-winding and over lowering on the hoisting motion and over – derricking beyond prescribed limits.
- d. Signals
1. A standard code of hand signals shall be adopted in controlling the movements of the crane and both the driver and the signaler shall be thoroughly familiar with the signals.
 2. The driver of the crane shall respond to signals only from the appointed signaler but shall obey stop signal at any time no matter who gives it.
- e. Loads
1. Before lifting, the load shall be checked to ensure that it is secure.
 2. When handling loads near to maximum safe working load, crane motions shall be operated with extra care. The load shall initially be lifted just clear of the supporting surface and brought to rest, while the slings, balance of the load, etc, are checked before proceeding. Proper care shall be exercised by the driver, at all times to avoid shock or side loadings on the jib.



3. The slinger or other persons shall stand well clear of the load and shall not walk, crawl or stand under the suspended load.
- h. Ropes – Before lifting operations commence, the hooks shall be lowered to the required lowest point to ensure that at least two dead coils remain on the drum, and to the highest point to check that the drum capacity will not be exceeded.
- i. Tower Cranes
1. Climbing operation – When a climbing tower crane is erected and its height extended within a structure or building the climbing operation shall be carried out in accordance with the manufacturer’s instructions. All climbing frames, ladders, locking devices and machinery shall be correctly installed, adjusted and kept in good working order. At the end of the climbing operation wedges securing the tower shall be driven home and secured.
 2. In case of mobile towers cranes, their movement shall be preferably on a level track. If there has to be a gradient in the track this shall be within the permissible limits as specified.
- j. Mobile Cranes
1. When traveling up a gradient, the load shall be derricked out and when traveling down a gradient, the load shall be derricked into the minimum radius, and this position shall be corrected on reaching level ground. Cranes shall not move down the hill with the engine off or with the engine out of gear.
 2. The mobile cranes shall be fitted with suitable horn, head lights, side lamps, rear and stop lights and flashing directional indicator.
 3. On cranes with cantilever type jib, when traveling without load, the jib shall be lowered to a horizontal position.
 4. When a load to be handled at a particular radius exceeds the rated load, the fore and aft out riggers shall be used and blocked.
 5. During operation of the rubber tyred crane, air brakes shall be put in ‘ON’ position.
 6. The pneumatic tyres shall be maintained at the correct pressure at all times.
- k. Handling of Cranes
1. Cranes rails, where used, shall be installed on firm ground and shall be properly secured. In case of tower cranes, it shall be ensured that the level difference between the two rails remains within the limits prescribed by the manufacturer to safeguard against toppling of the crane.
 2. Electrical wiring, which can possibly touch the crane or any member being lifted, shall be removed, or made dead by removing the controlling fuses and in their absence controlling switches.
 3. All practicable steps shall be taken to prevent the cranes being operated in dangerous proximity to a live overhead power line. In particular, no member of the crane shall be permitted to approach within the distance of overhead power lines.
 4. If it becomes necessary to operate the cranes with clearances less than those specified, it shall be ensured that the overhead power lines shall invariably be shut off during the period of operation of cranes. Location of any underground power cables in the area of operation shall also be ascertained and necessary safety precautions shall be taken.
 5. Cranes shall not be used at a speed, which causes the boom to swing.
 6. A crane shall be thoroughly examined at least once in a period of 6 months by a competent person who shall record a certificate of the check. A crane, including all



- ropes, clamps and hooks shall be inspected by a responsible person and defective ropes, clamps, hooks, etc., replaced before taken into used every time.
7. The operator of the crane shall follow the safe reach of the crane as shown by the manufacturers.
 8. Unauthorized persons shall not be allowed to move near and around the crane. No person shall be lifted or transported by the crane on its hook or boom.
 9. Concrete buckets handled by crane or overhead cableway shall be suspended from deep-throated hooks, preferably equipped with a swivel and safety latch. In the concrete buckets, both bottom drop type and side drop type, closing and locking of the exit door of the bucket shall always be checked by the main incharge of loading concrete in the bucket to avoid accidental opening of the exit door and consequent falling of concrete.
 10. When the bucket or other members being lifted are out of sight of the crane operator, a signalman shall be posted in clear view of the receiving area and the crane operator.
 11. A standard code of hand signals shall be adopted in controlling the movements of the crane and both the driver and the signaler shall thoroughly familiar with the signals.
 12. The driver of the crane shall respond to signals only from the appointed signaler but shall obey stop signal at any time no matter who gives it.
 13. If a traveling gantry crane is operating over casting beds, a warning signal, which sounds automatically during travel, should be provided to avoid accidents to workmen crossing or standing in the path of the moving loads.

TRANSPORTING MACHINERY (MOTOR TRUCKS, TRACTORS AND DUMPERS)

- a. Driver's Cabin
 1. Motor trucks, tractors and dumpers shall be equipped with a cabin or a canopy of sufficient strength and so installed as to provide adequate protection to the driver.
 2. If the cabin is enclosed, it shall be provided with windows giving maximum possible view and shall be well ventilated. The driver shall be able to make an easy exit in case of any emergency.
 3. Driver's seat shall have backrest and the seat shall be of such design, construction and dimensions as will absorb vibration sufficiently and provide reasonable comfort.
 4. Motor trucks and tractors shall be equipped with a footboard or steps and handholds 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.
- b. Brakes and Controls – Motor trucks, tractors and dumpers shall be equipped with brakes that will hold them under the heaviest load that may be hauled in any operating conditions and shall enable the vehicle to be locked when stationary.
- c. Draw Gears – Motor trucks, hauling trailers and tractors shall be equipped with draw gear such that during coupling no worker can come between the vehicles being coupled or the vehicles being coupled cannot run into each other.
- d. Vehicle shall not move down the hill with the engine off or with the engine out of gear.
- e. Drivers
 1. Only competent and licensed person shall drive motor trucks and tractors.
 2. Drivers shall be required to leave the cabins and stand in the clear while the motor trucks are being loaded.



3. Drivers of tripper trucks used for hot mix plants and batch mix concrete plants and similar operations shall wear the industrial safety helmets conforming to IS:2925 (Specifications for industrial safety helmet).
- f. Other Operating Conditions
1. Every effort shall be made to avoid motor trucks being loaded in a place where there may be danger from materials, such as rocks falling from buckets passing overhead.
 2. Motor trucks shall be stationed at such a distance from the power shovel (excavator) that there is a clearance of at least 0.6 m between the trucks and the superstructure of the power shovel (excavator) even when it pivots.
 3. Where the driver does not have a clear field of vision the movement of motor trucks and tractors shall be controlled by a code of standard hand signals.
 4. When uncoupling vehicles, both vehicles shall be blocked by brakes or chocks.
 5. Vehicle being loaded or unloaded shall be effectively braked or blocked.
 6. Motor trucks shall not be loaded beyond their capacity.
 7. Before a loaded motor truck starts, the load shall be inspected to ensure that it is secure, evenly distributed and of safe height, length and width.
 8. Sufficient stop blocks shall be provided at every tipping point and these shall be used on every occasion when material is dumped from the truck dumper or other such vehicle.
- g. Trucks:
1. When trucks are being used on the site, traffic problems shall be taken care of. A reasonably smooth traffic surface shall be provided. If practicable, a loop road shall be provided to permit continuous operation of vehicles and to eliminate their backing. If a continuous loop is not possible, a turnout shall be provided. Backing operations shall be controlled by a signalman positioned so as to have a clear view of the area behind the truck and to be clearly visible to the truck driver. Movement of workmen and plant shall be routed to avoid crossing, as much as possible, the truck lanes.
 2. All the trucks shall be fitted with reverse horn, which shall automatically sounds when the vehicle is moving in reverse direction. The purpose of fitting this horn is to alert the people working while a vehicle is moving in reverse direction towards them.

OTHER CONSTRUCTION MACHINERY

- a. Handling of Mixers
1. All gears, chains and rollers of mixers shall be properly guarded. If the mixer has a charging skip the operator shall ensure that the workmen are out of danger before the skip is lowered. Railings shall be provided on the ground to prevent anyone walking under the skip while it is being lowered.
 2. All cables, clamps, hooks, wire ropes, gears and clutches, etc, of the mixer, shall be checked and shall be cleaned, oiled and greased and serviced once a week. A trail run of the mixer shall be made and defects shall be removed before operating a mixer.
 3. When workmen are cleaning the inside of the drums, the operating power of the mixer shall be locked in the off position and all fuses shall be removed and suitable notice hung at the place.
- b. Concrete Vibrators
1. Vibrating unit shall be completely enclosed and belt transmitting the power to the unit adequately guarded.
 2. Vibrating needles of poker type vibrator shall be completely sealed against concrete.



3. Electrically operated compactum vibrators shall be totally enclosed units.
 4. Air-operated type vibrators shall have arrangements to change the speed of rotating shaft and air motor to rotate the vibrating needle, which shall be completely sealed against concrete.
 5. Power operated vibrators shall be provided with effective means of stopping the vibrator (if possible by disengaging the vibrator from the engine / motor drive).
 6. Where possible, the vibrators shall be fitted with shock absorbing handles with rubber or other suitable grips for ease in handling.
 7. Electrically operated vibrators shall be protected against overloads by suitable overload relays and shall be effectively earthed and where the operator has to be in direct contact with the vibrator during its operations, low voltage drive with suitable transformer is recommended.
 8. While starting the poker vibrators, the needle shall not be resting on a hard surface to avoid bouncing.
 9. Excessive bending of the flexible shafts of the poker vibrators while in operation shall be avoided.
- c. Asphalt Plants
1. Piping for hot oil and asphalt shall be adequately inserted to protect workers from injury by burns and flexible piping shall be metal encased. The flexible pipe, when not in use, shall be left in the ground.
 2. Operation of asphalt plant shall be under the supervision of a competent person and the plant shall be inspected by a competent person at periodical intervals.
 3. Workers handling hot asphalt shall wear gloves, rubber boots, goggles and if necessary, to prevent danger, suitable protective clothing.
 4. No open light shall be used for ascertaining the level of asphalt and thinners shall not be heated over an open flame.
 5. If burner goes out, the fuel supply shall be cut off and hot tube shall be thoroughly blown out by the fan so as to prevent backfire.
 6. Spilled asphalt shall be promptly cleaned up.
 7. A chimney or other suitable exhaust arrangements shall be provided to remove the combustion gases and dust.
- d. Towing of Static Plant – Speed of the vehicles, when towed to static plants like compressors, concrete mixers, batching plant etc, shall not exceed 15 kilometers per hour under any circumstances.
- e. Electric Power Operated Machines – Bodies of all electric power operated machines shall be well earthed. This should be checked from time to time.

4.10.2 INSPECTION OF PLANT, MACHINERY AND EQUIPMENT INCLUDING VEHICLES

Purpose

To ascertain effective functioning / provision of safety features of P & M equipment including vehicles.

Scope

All P & M Equipment, vehicles used in the site – both hired & own.



Responsibility

Site Safety Coordinator (SSC)

Reference

Crane Inspection Checklist

Vehicle and Earth Moving Equipment Inspection Checklist

Procedures

1. SSC periodically selects P&M, Equipment and / or Vehicles for inspection in batches / areawise.
2. SSC informs the P&M Incharge of his inspection schedule verbally.
3. SSC requests for involvement of a P&M personnel in the inspection exercise.
4. SSC carries the Crane Inspection Checklist, Vehicle & Earth Moving Equipment Inspection Checklist for his general guidance, but restricts his attention to common salient safety features.
5. SSC highlights unsafe conditions to the P&M personnel accompanying him on spot for corrective action.
6. SSC records his findings in the Crane / Vehicle / Earth Moving Equipment Inspection report form and forwards the same to P&M incharge with a copy to the Site Incharge.

Records

Crane / Vehicle / Earth
Moving Equipment
Inspection Report

Retention

1 year or till the end of project

4.10.3 EQUIPMENT FITNESS CERTIFICATION

Purpose

To ascertain fitness of Plant & Machinery and Equipment including vehicles with respect to safety before deployment at site.

Scope

All Plant & Machinery and Equipments, vehicles used in the site which are owned, hired and used by out subcontractors.

Responsibility

Responsibilities of Site Safety Coordinator (SSC)

- Introduce the relevant system at the specified workplace
- Make all concerned aware of the system
- Keep a check on the process
- Facilitate its implementation and follow-up

Reference

Equipment Fitness Report – Cranes

Equipment Fitness Report – Vehicle & Earth Moving Equipment



Procedures

- a. All Plant & Machinery and Equipment including vehicles shall be subjected to Equipment Fitness certification before deployment.
- b. SSC after receiving the information of arrival of new equipment shall coordinate the certification process.
- c. A team comprising of SSC and P&M Engineer checks the fitness of the equipment with respect to safety aspects as mentioned in the equipment fitness report.
- d. The findings are entered in the equipment fitness report, with a recommendation of whether the vehicle is fit for use or not.
- e. Only that equipment's, which are found to be FIT, are allowed for deployment.
- f. Equipment's which were found UNFIT are rejected for deployment. This equipment shall be checked for fitness once again after necessary rectifications are carried out.
- g. SSC maintains a record of Equipment Fitness Certificate issued.

Records

1. Equipment Fitness Report – Cranes
2. Equipment Fitness Report – Vehicle and Earth Moving Equipment

Retention

- 1 year or till the end of project
 1 year or till the end of project

4.11 INSPECTION CHECKLISTS

4.11.1 Scaffolding Checklist

Note : Tick () for yes and (x) for no.

Sr No	<u>Points</u>	Observations	
		Yes	No
1.	Does each scaffold and scaffold component support (without failure) its own weight and at least 4 times the maximum intended load?		
2.	Are all working levels on scaffolds fully planked or decked between the front uprights and the guardrail supports?		
3.	Are scaffold platform spaces 25 mm or less between adjacent units and the uprights?		
4.	Are all scaffolding platforms at least 450 mm wide?		
5.	Is the distance between the front edge of the scaffold platform and the face of the work 350 mm inches or less, unless guardrail systems are put along the front edge, or personal fall arrest systems are used?		
6.	Does the end of each scaffold platform extend over the centerline of its support at least 150 mm unless cleated or otherwise restrained by hooks or equivalent means?		
7.	If the scaffold platform is 3 Meter or less in length, does the end of the scaffold platform extend 3.5 Meter or less over its support?		



8.	On scaffolds where platforms overlap to form a long platform, does the overlap occur over supports? Is the overlap at least 300 mm unless the platform is nailed together or otherwise restrained to prevent movement?		
9.	At points of a scaffold where the platform changes direction, is this procedure followed?		
10	Are supported scaffolds with a height to base width ratio of more than 4 to 1 restrained from tipping by guying, tying, bracing, or equivalents?		
11	Are supported scaffold poles, legs, posts, frames, and uprights placed on base plates and mudsills or other firm foundation?		
12	Are footings level, sound, and rigid? Can they support the loaded scaffold without settling or displacement?		
13	Are supported scaffold poles, legs, posts, frames, and uprights plum and braced to prevent swaying and displacement?		
14	Are ladders, stairs, ramps, or walkways provided to access scaffold platforms more than 1 Meter above the point of access?		
15	Do stairway-type ladders have slip-resistant treads on all steps and landings?		
16	Do ramps and walkways 1.8 meter or more above lower levels have guardrails?		
17	Do employees have fall protection if integral prefabricated scaffold access frames with rungs less than 300 mm are used as work platforms?		
18	During erecting and dismantling of supported scaffolds , does a competent person provide and evaluate safe means of access?		
19	Are scaffolds and scaffold components loaded below their maximum intended loads or rated capacities (whichever is less)?		
20	Does a competent person inspect scaffolds and scaffold components for visible defects before each work shift, and after any occurrence that could affect a scaffold's structural integrity?		
21	Are parts of a scaffold that are damaged or weakened immediately repaired, replaced, braced, or removed from service until repaired?		
22	Are proper clearances (as shown in Tables 1 and 2) between scaffolds and power lines always maintained?		
23	Are scaffolds erected; moved, dismantled, or altered only under the supervision and direction of a competent person qualified in scaffold erection, moving, dismantling, or alteration?		
24	If swinging loads are hoisted onto or near scaffolds, are tag lines or equivalent measures used to control the loads?		



25	Is working on scaffolds during storms or high winds prohibited unless a competent person has determined that it is safe for workers to be on the scaffold and workers are protected by a personal fall arrest system or wind screens?		
26	Is debris removed from platforms?		
27	Are makeshift devices, such as boxes and barrels, prohibited on scaffold platforms for increasing the working level height?		
28	Is it prohibited to use ladders on scaffolds to increase the working level height?		

4.11.2 LADDER USE CHECKLIST

	YES	NO
1. Are ladders being used where other means of access would be safer or more economical?		
2. Are the ladders in use properly suited to the task?		
3. Are bases on firm footing such as compacted soil or mud sills?		
4. Are bases secured against slippage?		
5. Are ladders tied off at the top, blocked, secured or held by a second worker when in use?		
6. Are areas around the top and bottom clear of material, debris or obstruction?		
7. Are metal ladders being used where electrical contact is possible near electrical equipment or wires?		
8. Are ladders being used horizontally or for some other wrong purpose?		
9. Are workers 3 metres (10 feet) or more off the ground and using both hands for the work tying off with a safety belt and lanyard to a structurally safe means of support?		
10. Are ladders inspected before being used?		
11. Do the side rails of straight ladders extend at least 914 millimeters (3 feet) above the landing level?		
12. Are the job-built wooden ladders properly constructed?		
13. Are all personnel familiar with the ladder safety policies of the company?		
14. Are straight ladders being erected at the proper angle?		
15. Are ladders being used in passage-ways where they can be affected by adjacent activities?		
16. Unless the ladder is a job-built, double-width ladder, is more than one person on a ladder at a time?		
17. Are ladders being stored and transported by methods that avoid damage?		



- 18. Are workers carrying tools, equipment or materials in their hands while climbing up or down ladders?
- 19. Do workers face the ladder when ascending, descending or working from it?
- 20. Do personnel use fall-arresting devices when climbing up or down long vertical ladders?
- 21. Are ladders being supported on their rungs?
- 22. Are two or more people used to erect long or heavy ladders?

4.11.3 CRANE / VEHICLE / EARTH MOVING EQUIPMENT INSPECTION REPORT

Name of Site: _____ Job No.: _____

Inspected by : _____ Date : _____

Sl. No.	Identification / Registration Number	Make / Model	Unsafe conditions / Deficiencies observed	Action by	Close out Date	Remarks

Site Safety Co-ordinator

P & M Engineer / Site Engineer



4.11.4 EQUIPMENT FITNESS REPORT FOR VEHICLE & EARTH MOVING EQUIPMENT

Name of Site: _____ Make / Model: _____

Job No.: _____ Identification / Reg. No.: _____

Date: _____ Asset code (if applicable): _____

Inspected Team: _____ Owned by: _____

Sl. No.	Check Points	Observation	Remarks
1	Engine condition		
2	Clutch / Brake		
3	Hydraulic system		
4	Guards / Covers / Doors		
5	Fastener lock pins / Keys		
6	Horn / Reverse horn / Lights		
7	Indicators / Wiper blades		
8	Operators fitness		
9	Tyre pressure		
10	Condition of Battery and Lamps		
11	Operating levers / steering		
12	Gauges & warning devices		
13	Fire extinguisher provided		
14	First Aid Box		
15	Swing Alarm provided		

This Vehicle / Earth Moving Equipment has been checked for the above points and

Found FIT for deployment

Found UNFIT for deployment

(P & M Engineer)

(Site Safety Co-ordinator)



4.11.5 EQUIPMENT FITNESS REPORT FOR CRANES

Name of Site: _____

Make / Model: _____

Job No.: _____

Identification / Reg. No.: _____

Date: _____

Asset code (if applicable): _____

Inspected Team: _____

Owned by: _____

Sl. No.	Check Points	Observation	Remarks
1	Hook and Hook latch		
2	Over-Hoist Limit Switch		
3	Boom-Limit Switch		
4	Boom Angle indicator		
5	Boom-Limit cut-off switch		
6	Condition of boom		
7	Condition of Ropes		
8	No. of load lines		
9	Size and condition of the sling		
10	Swing Brake & Lock		
11	Propel Brake & Lock		
12	Hoist Brake & Lock		
13	Boom Brake & Lock		
14	Main clutch		
15	Leakage in hydraulic cylinders		
16	Out riggers fully extendible		
17	Tyre pressure		
18	Condition of Battery and Lamps		
19	Guards of moving and rotating parts		
20	Load chart provided		
21	Number & position of pendant ropes		
22	Reverse horn		
23	Load test details		
24	Operators fitness		
25	First Aid Box		
26	Swing Alarm Provided		
27	Fire Extinguishers in operators cabin		

This Crane has been checked for the above points and

Found FIT for deployment

Found UNFIT for deployment

(P & M Engineer)

(Site Safety Co-ordinator)



CHAPTER 5

PLANT AND MACHINERY

5.1 TOOLS

HAND TOOLS:

- 5.1.1 All hand tools shall be kept in good condition and used only for the purpose for which designed.
- 5.1.2 Tools having mushroomed/heads, spilt or defective handles, worn parts, or other defects that will impair their strength or render them unsafe for use, shall be removed from service and shall not be reissued until the necessary repairs have been made.
- 5.1.3 All sharp tools shall be kept in sheaths, shields, tool chests, or other containers when not in actual use, to protect the tools, the workers and other persons.
- 5.1.4 Tools shall not be left on scaffolds, ladders or overhead working spaces when not in use. When work is being performed overhead on scaffolds or ladders, containers shall be used to hold tools and prevent them from falling.
- 5.1.5 The practice of throwing tools from one location to another, from one employee to another or dropping them to lower levels shall not be permitted. When it is necessary to pass tools or material under the above conditions, suitable containers and / or ropes shall be used.
- 5.1.6 Sharp-edged or pointed tools shall not be carried in workmen's pockets.

5.1.8 PNEUMATIC AND POWER TOOLS:

- (a) Hands tools and portable power tools should be inspected frequently for worn-out parts and connections. The sudden cessation of operation or the Kicking or bucking or such a tool may cause a serious accident especially when the operator is at an elevation exposed to the danger of falling.
- (b) In using heavy tools, it is best to support them where possible from some detached object or support in order to safeguard the operator's feet.
- (c) Operators of portable electric drills, reamers, etc should never wear loose clothing with free ends. Neither should gloves be worn. Smooth overalls should be worn with the jumper tucked in.
- (d) All tools should be laid flat when not in use. They should never be kept standing on the nozzle or cutting edge.

PNEUMATIC TOOLS:

- 5.1.9 Pneumatic tools shall be used only by employees familiar with and properly instructed in their use.



- 5.1.10 Pneumatic tools shall be kept in goods operating condition thoroughly inspected at regular intervals and particular attention given to control and exhaust valves, hose connections, die clips on hammer, and the chucks of reamers and drills.
- 5.1.11 Safety clips or retainers shall be installed on pneumatic impact tools to prevent dies and tools from being accidentally expelled from the barrel.
- 5.1.12 Pressure shall be shut off and exhausted from the line before disconnecting the line from any tool or connection.
- 5.1.13 Safety lashing shall be provided at connection between tool and hose.
- 5.1.14 Air hose shall be suitable to safely withstand the pressure for which it is intended. Leaking or defective hose shall be removed from service.
- 5.1.15 Hose shall not be laid over ladders, steps, scaffolds or walkways in such a manner as to create a tripping hazard.
- 5.1.16 The use of compressed air for blowing direct from hands, face or clothing is prohibited.

POWER TOOLS:

- 5.1.17 Only persons who have been trained and instructed in their safe use shall use Power actuated tools.
- 5.1.18 Such supervision and safeguards as are necessary to prohibit their use by unauthorised persons shall be provided.
- 5.1.19 In electrically operated tools, a three conductor cord shall be used so that a ground wire may be taken off and tool. Even a slight electric shock may result in a sudden jump on the part of the operator resulting in a bad fall or a severe bump or fracture.
- 5.1.20 Connecting cord should have oil resistant rubber insulation. Protection against kinking should be provided by the use of the short-coiled steel spring or rubber protecting tube securely fastened in place at the motor end. Care should be taken to see that strain on the wires is not transmitted to the connection at the terminal or binding post.
- (i) Never oil an electric motor to excess. This oil may prove harmful to cord insulation.
 - (ii) When a motor is in storage, coil the cord in a free coil, not around the motor.
 - (iii) Inspect cord frequently.
 - (iv) Do not lay cord on oily or chemically saturated floor while the tool is in use.
 - (v) Never pull on the cord when it is kinked or pinched.
 - (vi) Do not lower or lift the tools with the cord; use a small rope.
 - (vii) Do not leave the cord where a car or truck might run over it.
- 5.1.21 Premature starting of the motor presents a major hazard. Wherever possible, select tools those are equipped with safety devices to guard against this danger.



5.1.22 The use of Power actuated tools is prohibited in explosive or flammable atmospheres.

JACKS:

5.1.23 Maximum working load shall be permanently marked on a jack and it shall be provided with a positive stop to prevent over travel unless this is impracticable in which case the jack shall carry a warning that a stop has not been provided. Every jack shall be thoroughly examined at suitable intervals depending upon service conditions.

STORAGE BATTERY:

5.1.24 Care shall be exercised in handling acids.

5.1.25 When preparing electrolyte the acid must be added slowly to the water until the solution has the proper specific gravity. Never bring an open flame near or allow sparks to shower on a storage battery, as the gases produced are explosive under certain conditions.

5.1.26 Ordinary baking soda will prevent skin and eye burns, if used with water immediately after contact with the acid or electrolyte. If soda is not available, a weak solution of ammonia or plain clear water can be used.

5.2 DRILLS:

5.2.1 All drilling equipment shall be kept in good working order. Safe handling and lifting methods should be used.

5.2.2 Drills shall be stopped before greasing the machinery or moving parts.

5.2.3 Crown blocks shall be mounted securely and should be inspected frequently for loose connections.

5.2.4 Drillers should be required to block all finished drill holes over 10 cms in diameter before moving to a new location.

5.2.5 When using compressed air drills as well as other compressed air driven equipment, the hose connections should be made only after the pressure has been released.

5.2.6 Electrically operated drills and all other electrically driven equipment should be provided with specially insulated power transmission cables with waterproof connections.

5.2.7 The use of gas engine or petrol engine driven drills under ground shall be prohibited. If used on open-air work, the engine shall be kept in good operating condition and the operator shall be trained in the use of the tool, including necessary precautions to avoid burns from the engine. The engine shall be stopped while filling the fuel tank.



5.3 ROPES, CHAINS AND SLINGS:

5.3.1 The use of ropes, cables and chains shall be in accordance with the safe usage recommended by the manufacturer.

5.3.2 No chain or rope shall be used unless:

- (a) It is of good construction, sound material, adequate strength and free from patent defects.
- (b) Safe working load is plainly marked on it or an identification number is marked on it and the safe working load corresponding to this number is entered in a register maintained by the person-in-charge.

CHAINS:

5.3.3 All chains in continuous use shall be inspected once a month. Each chain shall be measured for length at each inspection. If a stretch of 2.7 cms in 1 meter is found, it shall be inspected for cracks. Any link that shows evidence of a crack or cross-section reduction by wear, nicks or cuts shall be removed. The reduced link section shall never be less than two-thirds of the original section.

5.3.4 No chain shall be used which has been broken and mended with a bolt, nor shall the end of the chain be bolted to the chain to form a loop.

5.3.5 Chains shall never be knotted, nor shall they be shortened by twisting the chain.

5.3.6 Before any strain is put on the chain, it shall be inspected to see that all links are lined up so that the pull is through the long diameter of the link.

5.3.7 All chains except those mentioned below shall be annealed once a year (6 months for 12mm bar chains and below) when in continuous use. This work shall be attempted only by competent men having the proper facilities for such work. The particulars of annealing or heat treatment and tests shall be entered in the register maintained for the purpose. It is recommended that all chains be returned to the manufacture for annealing. Chains that need not be annealed are:

- (i) Bridle chains attached to derricks or masts;
- (ii) Chains made of malleable cast iron;
- (iii) Plate link chains
- (iv) Chains of steel and
- (v) Pitched chains

FIBRE ROPES:

5.3.8 Manila, sisal or hemp ropes are commonly used. For all normal use pure manila rope which is hard but pliant should be used. Sisal rope is 2 to 3 times as strong as manila rope, but its fibres are hard and stiff and have a tendency to splinter. Hemp ropes are as strong as manila ropes, but they are softer.



5.3.9 The weight, breaking strength and safe working strength with a factor of safety of 8 of standard manila rope (3 strand) are given in the table below. (The values are only suggestive).

Diameter (mm)	Weight per foot (kg)	Strength (kg)	
		Breaking	Working
6	.97	270	35
12	.110	1200	150
18	.250	2500	310
25	.400	4080	510
32	.625	6100	770
40	.890	8400	1050
50	1.610	14060	1760
65	2.485	21090	2630
75	3.600	29030	3630

When a table of strengths is not available, an approximation of the working strength of rope may be obtained by squaring the numerator of the diameter in eights and multiplying by 13. This gives strengths somewhat lower than those given in the table (e.g. if the dia of rope is $\frac{3}{4}$ the dia in eights will be $\frac{6}{8}$ and working load will be found to be $(\frac{6}{8})^2 \times 13$ lbs. OR 468 lbs.)

5.3.10 Fiber ropes should be regularly inspected for wear and tear while in use to make sure that they are in good condition.

5.3.11 Fiber ropes should be protected from abrasion by padding when drawn over square corners or sharp rough surfaces. Frozen rope or wet rope subjected to acids or excessive heat should not be used. Ropes having dark or pinkish brown coloration on them due to exposure to acids shall not be used.

5.3.12 Suitable care should be taken while uncoiling, using and storing the fiber ropes. Sheaves should have diameter not less than 36 times the diameter of the rope.

5.3.13 Wire ropes have almost superseded fiber ropes and chains for hoisting and haulage purposes.

(a) Standard hoisting rope consists of 6 by 19 wire strands and a fiber core made of iron, cast steel, mild plow steel, plow steel or special plow steel.

(b) The breaking strength of standard wire hoisting rope is shown in the following tabulations The values are only suggestive:

Breaking Strength (Tons)

(Factor of Safety = \div for working out safe working strengths).

Dia (mm)	Weight (kg/m)	Iron	Cast Steel	Mild Plow Steel	Plow Steel	Sp. Plow Steel
1	2	3	4	5	6	7
6	.115	...	2.1	2.3	2.5	2.9



10	0.36	2.05
12.5	0.60	3.57	7.7	8.5	9.4	10.8
25	2.40	13.70	29.5	33.0	36.5	42.00
37.5	5.40	29.70	65.0	72.5	80.5	92.5
50	9.60	51.80	114.0	127.0	140.0	161.0

- (c) Extra flexible hoisting rope, for use with smaller sheaves and drums, such as are usually found in derricks, consists of 8 by 19 wire strands and one fiber core. The breaking strength of this rope is approximately 87 percent of the standard wire hoisting rope given in the preceding tabulations.
- (d) Special flexible hoisting rope consists of 6 by 37 wire strands and one fiber core. It is extremely flexible and is specially adapted to high-speed service on cranes or where sheaves are small. The breaking strength of special flexible hoisting rope is approximately the same as that of standard wire hoisting rope.

- 5.3.14 Wire rope or cables shall be inspected by a competent person at the time of installation and once each week there after when in use.
- 5.3.15 No wire shall be used in hoisting or lowering if in any length of 8 diameters the total number of visible broken wires exceeds 10 per cent of the total number of wires or the rope show signs of excessive wear, corrosion or other defect which in the opinion of the person who inspects renders it unfit for use.
- 5.3.16 Wire rope removed from service shall be plainly marked or identified as being unfit for further use on cranes, hoists or other load carrying service and stored separately.
- 5.3.17 Wire rope should be carefully uncoiled; coiled or used to prevent kinking; kinked strands damage the rope permanently. Even slight burning of rope reduces its load capacity because of drying out of lubrication.
- 5.3.18 Thimbles of proper size should always be used when a loop is formed at the end of a wire rope.
- 5.3.19 Socketing, splicing and seizing of cables shall be performed by qualified persons.
- 5.3.20 Connections, fittings, fastenings, parts etc. used in connection with ropes and cables shall be of good quality and of proper size and strength and shall be installed in accordance with recommendations of the manufacturer.
- 5.3.21 Drum sheaves and pulleys shall be smooth and free from surface defects such as cracks, kinks, de-strands etc. Drums, sheaves or pulleys having eccentric bores or cracked hubs, spoke or flanges shall be removed from service.
- 5.3.22 The ratio between rope diameter and sheave diameter should never be less than 27. Good practice favors a ratio of 45. Grooves of sheaves or drums should be 2mm larger than nominal rope diameter.



- 5.3.23 Running lines of hoisting equipment located within 2 meters of the ground or working level shall be boxed off or otherwise guarded, the operating area restricted.
- 5.3.24 Hooks, shackles, rings and pad eyes, U Bolts and other fittings shall be of proper size and those showing excessive wear or that have been bent, twisted or otherwise damaged shall be removed from service.
- 5.3.25 Slings, their fittings and fastenings, when in use shall be inspected daily by a qualified person for evidence of overloading, excessive wear or damage. Slings found to be defective shall be removed from service.
- 5.3.26 Slings shall be of proper construction and size for the load to be hoisted. Slings should not be attached to load as to provide an angle of less than 60° between sling leg and the horizontal. The efficiency varies with the angle of sling as follows:

Angle (Degree)	Efficiency (Percent)	Angle (Degree)	Efficiency (Percent)
90	100	50	76
80	98	45	71
70	94	40	64
65	91	35	57
60	87	30	50
55	82	5	8.5

- 5.3.27 Single legged and reeve slings shall be avoided as far as possible except for small or unyielding leads under competent supervision.
- 5.3.28 Slinging should be done only by a crew trained for the purpose. Accidental over loading, out of ignorance, is frequently the cause of fatal injuries. For all normal practice 2 or 4 part sling should be used.
- 5.3.29 Suitable protection shall be provided between the sling and sharp unyielding surfaces of the load to be lifted.
- 5.3.30 The maintenance, repair and testing of slings shall be done only by qualified persons. Proper storage shall be provided for slings while not in use.

5.4 CONVEYORS AND CABLEWAYS

- 5.4.1 All conveyors shall be regularly inspected repaired and maintained.

BELT CONVEYORS:

- 5.4.2 Belt conveyors shall not be overloaded to the point where material fall off the belt. The walkway along the belt shall be kept free of materials. Where the walkway is one meter or more above the ground, a standard guardrail shall be installed.



5.4.3 Oilers shall never attempt to clean rollers while the belt is in motion. All oil and grease cups shall be so located that the oiler can service the cups without exposing himself to danger.

5.4.4 Following are the maximum allowable speeds of conveyor belts carrying sand, gravel and earth:

Width of Belt	SPEED
40 or LESS	80
40 to 60	130
60 or MORE	180

If the materials includes abrasive lumps such as crushed rock, the speed should be reduced by 15 metres per minute on narrow belts and by 30 meters per minute on wide belts of 60 cms or more in width.

5.4.5 Where trippers are used to control the discharge from the belt, a device for throwing the propelling mechanism into neutral gear shall be installed at each end of the runway.

5.4.6 Whenever the belt crosses over a traveled way, either public or private, trays shall be installed to catch all spillage from the belt. The trays and their supports shall be of ample strength to support a heaped load of wet materials and the estimated weight of the cleaning crew. The trays shall not be so allowed to fill and patrolmen shall be particularly alert to prevent any spillage on travel ways.

5.4.7 Crossovers or underpasses with proper safeguards shall be provided for passage over or under all conveyors, as necessary. Crossing over or under conveyors except where safe passageways are provided is prohibited.

5.4.8 All conveyors system shall be equipped with such emergency signal devices that will provide reasonable safe control at all times. A system of signals to indicate the stopping or starting of belt shall be installed.

5.4.9 On all conveyors where reversing or runaway presents a hazards “anti-runway” or “backup” stops or other safeguards shall be installed to protect persons and property from injury and damage.

5.4.10 Riding on conveyors shall be prohibited.

5.4.11 Baffles shall be placed across belts installed on steel grades to prevent materials from rolling or bouncing off. The baffles shall be placed at intervals of about 30 meters on level belts.

5.4.12 Where conveyors are operated in tunnels, pits and similar enclosures, ample room shall be provided to allow safe access way and operating space for all workmen. Tunnels, pits and similar enclosures shall be provided with adequate drainage,



lighting, ventilation and emergency controls including escape ways where it is necessary for person to work in or enter such areas.

5.4.13 All openings to hoppers, chutes, bins etc shall be protected to prevent unauthorised entry or persons from stepping or falling into them.

CABLEWAYS:

5.4.14 While all cables shall be carefully inspected everyday. Special care shall be taken in the inspection of the button line at the buttons, where all grease shall be removed and the cable examined for broken wires and abrasions. Button line failures generally occur at the buttons, due to the impact of the carriers, and abrasion caused by the rebound of the carriers when they strike the buttons. Rubber and steel ferrules should be installed on each end of the buttons as shock absorbers.

5.4.15 Breaking of cable occasionally results in fatalities or serious injuries. Jamming of the carriers when the carriage, thus putting more strain on the line than it was designed to withstand, picks them up some times causes Button line failures. On some cableway systems, one end of the button line is anchored to a counter weight, which maintains a constant predetermined tension in the line. Jamming of the carriers causes a lifting of the counterweight. A limit switch can be installed above the normal travel of the counterweight, which will sound an alarm in operator's booth.

5.4.16 In high operations, clearance lights shall be installed on high blocks or other high points under the cableway to assist the operator in maintaining proper clearance over such points.

5.4.17 Hoist rope failures are most serious. Regular inspection and recording of all repairs and performance is extremely necessary. Unloading of buckets should be slow so that the cable does not surge. Heavy surges cause hoist rope to twine around main cable and get excessive grinds. Sometimes the rope slips out of the pulley in the fall blocks and strands get severely damaged.

5.4.18 Hoist ropes must be replaced immediately on damage.

5.4.19 Carriers should be of such design that they do not slip.

5.4.20 Where any cableway passes above any place on a site of operation where persons employed habitually work or pass and are liable to be injured by object falling from such cableway, appropriate screens shall be provided or other steps shall, so far as is reasonably practicable, be taken to protect such persons from being so injured.

5.5 LIGHT EQUIPMENT

WORKING MACHINERY:

5.5.1 Safe means shall be provided for the removal of sawdust, chips and shavings from all woodworking machinery.



- 5.5.2 A mechanical or electrical power control shall be provided on each machine, in a protected position, to prevent accidental starting and to enable the operator to cut off the power without leaving his position at the point of operation.
- 5.5.3 Circular rip saws shall be provided with hood guard, splitter and anti - kickback device. All circular saws shall be provided with hood guards.
- 5.5.4 The peripheral length of circular saws and cutters beneath tables shall be guarded on sides of table enclosed.
- 5.5.5 All planers and jointer shall be guarded and have cylindrical heads with throats in the cylinder.
- 5.5.6 All swing cut off and radial saws or similar machines, which are drawn across a table shall be equipped with limit stops to prevent the cutting edge of the tool from extending beyond the edge of table.
- 5.5.7 Band saw blades shall be fully enclosed except at point of operation.
- 5.5.8 The use of cracked, bent or otherwise defective parts such as saw blades, cutters and knives is prohibited.
- 5.5.9 A push stick, block or other safe means shall be used in all close operations on saws, jointers and other machines having high speed cutting edges.

GRINDING WHEELS:

- 5.5.10 All grinding wheels shall be protected by hoods.
- 5.5.11 New wheels must be inspected carefully to see that they have not been damaged in transit. Suspending the wheel and tapping it with a light wooden mallet will reveal any cracks.
- 5.5.12 New wheels should be carefully fitted on the spindles.
- 5.5.13 Wheels should be tested frequently for balance and out of round if any, shall be 'turned-up' by a competent workman. If after being 'turned-up' a wheel is still out of balance, it shall be discarded for use as a power operated wheel.
- 5.5.14 Wheels used in wet grinding shall never be left standing in water as the water-soaked portion may throw the wheel out of balance.
- 5.5.15 Wheels designed for hand operation shall never be used on power operated grinders.
- 5.5.16 Grinding on the site of the wheel is hazardous and shall not be permitted.



- 5.5.17 Direct current motors shall not be used for operating grinding wheels unless equipped with some approved device to prevent over speeding if the shunt field circuit should be accidentally broken.
- 5.5.18 When any person is wholly or mainly employed on a grinding wheel and substantial quantities of dust are given off during grinding, such grinding shall not be performed without a hood or other appliance so constructed, arranged, placed and maintained as substantially to intercept the dust throw off and a duct of adequate size arranged as to be capable of carrying away the dust by means of a fan or other efficient means.

METAL WORKING MACHINERY:

- 5.5.19 Lathes, punch presses, drills, shapers, milling machines and other metalworking tools shall be fully shielded or guarded.
- 5.5.20 Point of operation guards shall never be made in-operative by plugging the switch buttons or otherwise interfering with the operation of the guards.
- 5.5.21 Chain hoists or other power lifting devices shall be provided to lift heavy objects to the operating table of the machine.
- 5.5.22 Cleaning the hands with cutting oil or compound is dangerous and should be prohibited as small particles of metal in the oil may penetrate the skin.
- 5.5.23 Operators shall never wear gloves, loose clothing, loose sleeves or ties.
- 5.5.24 Articles made of celluloid or other flammable material shall not be worn.
- 5.5.25 Every machine shall have a brush conveniently placed for the operator to brush shavings or bits or metal from the machine. The bare hand should never be used for this purpose.
- 5.5.26 Goggles suitable for the work shall be worn and safety shoes are recommended.

5.6 LIFTING APPLIANCES

- 5.6.1 Every lifting appliance and every part thereof including all working gear and all plant or gear used for anchoring or fixing such appliances shall:
- (a) be of good mechanical construction, sound material, adequate strength and free from patent defects;
 - (b) be properly maintained; and
 - (c) as far as construction permits, be inspected at least once every week by a competent person and a report of the result of inspection entered in a register maintained for the purpose.



- 5.6.2 Every lifting appliance or part thereof during the course of erection, dismantling shall be properly supported and all the fixing and arrangements shall be adequate and secure. working or anchoring

TRAVELLING:

- 5.6.3 When lifting appliances with traveling and showing motion are used, there shall be 2 metres clear distance between any part of the appliance in its extreme position and any guardrails or fencing or other fixtures; provided and if it is impracticable to maintain this distance, all reasonable steps shall be taken to prevent the access of any person to such guardrail, fencing of fixture.
- 5.6.4 Where minimum clearance of 2 metres from nearby structures is not possible, suitable warnings like peal of gongs should be sounded before crane commences to move.
- 5.6.5 A Minimum distance of 2 metres must be maintained between the boom and all power lines or feed during the traveling operation of a mobile crane.
- 5.6.6 Under no circumstances, an attempt should be made to raise electric wires by a person other than the employee of the Electricity Department.
- 5.6.7 Platforms for persons driving or operating the cranes or for signalers shall be provided with safe means of access and the floors of such platforms shall be close planked or plated and be of sufficient area for persons employed thereon.
- 5.6.8 The driver of every power driven lifting appliance shall be provided with a suitable cabin for protection from the weather and it should be so constructed as to afford ready and safe access to parts of the lifting appliances in the cabin which required periodic inspections and maintenance and it shall not be so placed that it prevents the driver from having clear and unrestricted view of all lifting operations outside the cabin.

DRUMS:

- 5.6.9 Every chain or rope which terminates at the winding drums of lifting appliances shall be properly secured thereto and at least two turns of such chain or rope shall remain on the drum in every operating position of the appliance.
- 5.6.10 Drums or pulleys of lifting appliances shall be of suitable diameter in relation to the sizes of chains or wire ropes used around them.

BRAKES, CONTROLS AND SAFETY DEVICES:

- 5.6.11 Every crane, crab and winch shall be provided with an efficient brake, or brakes and dogs or pawls or other safety devices which will prevent the fall of the load when suspended, and by which load can be effectively controlled whilst being lowered.



- 5.6.12 While a load is suspended from a crane, hoist or derrick, the operator shall not leave his position at the control until the load has been lowered to the ground.
- 5.6.13 Side pulls shall not be made with cranes or derricks. The crane or derrick boom shall be directly over the load to be lifted.
- 5.6.14 Riding on loads, hooks, hammers, materials hoists, or buckets shall not be permitted. Loads, booms and buckets shall not be swung over the head of the workmen.

CRANES WITH DERRICKING JIBS:

- 5.6.15 On every crane having a derricking jib, there shall be provided and maintained an effective interlocking arrangement of sound construction between the derricking clutch and the pawl sustaining the derricking drum except where:
- (a) The hoisting drum and the derricking drum are independently driven, or
 - (b) The mechanism driving the derricking drum is self-locking.

STABILITY:

- 5.6.16 Mobile lifting appliance shall not be used on soft or uneven surface or on a slope in circumstances in which the stability of appliance is likely to be affected unless adequate precautions are taken to ensure its stability.
- 5.6.17 No fixed crane shall be used unless it is securely anchored or adequately weighted as to secure stability.
- 5.6.18 Every traveling jib crane on rails shall be provided with guards to remove any loose material from the track, which shall be provided with effective stops at the end.
- 5.6.19 When the stability of the crane is secured by means of removable weights, a diagram or notice indicating the position and amount of such weights shall be fixed on the crane where it can readily be seen.

COMPETENT PERSONS FOR OPERATION:

- 5.6.20 Lifting appliance shall not be operated except by a person trained and competent to operate that appliance except that for the purpose of training it shall be permissible for any person to operate the appliance provided such a person is under the direct supervision of a competent person. Operators shall have the following additional qualifications:
- i) Be able to read and understand the signs, notices, operating instructions and signal code used.
 - ii) Be not less than 21 years of age.



- iii) Must have had a physical examination within one year to determine that they have no deficiencies of eyesight or hearing or they are not subject to epilepsy, heart failure or similar ailments that would be detrimental to safe operation of equipment.
- 5.6.21 If the person operating a lifting appliance has no clear view of the load, there shall be appointed signallers to give signals to the operator.
- 5.6.22 The crane operator should recognize signals from only one person designated as signalman.
- 5.6.23 Every crane operator and rigger should be made familiar with the rules and regulations for crane operations and standard crane signals for the safe operation of the crane.

TESTING AND EXAMINATION:

- 5.6.24 All lifting appliance shall be tested and thoroughly examined once in every period of four years and thoroughly examined once every year by a competent person.
- 5.6.25 Any lifting appliance, to which any substantial alteration has been carried out, shall not be taken into use unless it is tested and thoroughly examined by a competent person.
- 5.6.26 Results of all tests and through examinations shall be entered in a register to be maintained by the occupier.

MARKING OF SAFE WORKING LOADS:

- 5.6.27 The safe working load or safe working loads and a means of identification shall be plainly marked:
- i) upon every crane, crab and winch; and
- ii) upon every pulley block, gin wheel, shear legs or derrick pole or mast used in the raising or lowering of any load.
- 5.6.28 Every crane fitted with a derricking jib shall
- i) have plainly marked upon it the safe working loads at various radii of the job and the maximum radius at which the jib may be worked; and
- ii) be fitted with an accurate indicator, clearly visible to driver, showing the radius of the job at any time and the safe working load corresponding to the radius.
- 5.6.29 No jib crane with fixed or derricking jib shall be used unless it is fitted with an automatic load indicator which gives an efficient sound signal when the load lifted is in excess of safe working load at that radius, provided that if the requirements of clauses 27 and 28 are complied with, fitting of an automatic load indicator shall not be required.



5.6.30 The lifting appliance, shear legs or derrick pole or mast or any part thereof shall not be loaded beyond the safe working load except for the purpose of testing when it may be loaded to such amount as may be decided by a competent person for carrying out such test.

SCOTCH, GUY OR TOWER DERRICK CRANES:

5.6.31 No scotch derrick, guy derrick or tower derrick shall be used in any work unless:

- (a) It is of good construction, sound material, and adequate strength and free from any defect that will endanger life of any work.
- (b) All parts including anchorage have been thoroughly examined before erection and thoroughly examined and tested after erection by a competent person and results of such examination and tests are entered in a register maintained for the purpose by the occupier, tests load shall be 25 per cent above the maximum load to be lifted.

5.6.32 Maximum load to be lifted by the crane shall be marked on the crane in a position where it can readily be seen by the crane driver.

5.6.33 The jib of a scotch derrick crane shall be erected between the back stays of the crane.

5.6.34 No load which lies in the angle between the back stays of a scotch derrick crane shall be moved by the crane.

5.6.35 No crane shall be used for lifting a load which is in excess of Maximum load marked on the crane.

5.6.36 In Scotch and Tower Derrick cranes, appropriate measures shall be taken to prevent foot of king post being lifted out of the socket while it is in use, and in Guy Derrick crane, guys shall be suitably spaced to ensure stability of the crane.

5.6.37 The crane operator should test the brake for full load capacity, at least, once a week while the crane is in use. Such testing every day, before the work is started, is recommended.

5.7 RAIL TRACKS, LOCOMOTIVES AND HAULAGE TRUCKS:

RAIL TRACKS AND LOCOMOTIVES:

5.7.1 Every rail track shall rest on a firm and even foundation and at each end it shall be provided with adequate stop blocks or buffers.

5.7.2 In any line of rails on which locomotive truck or wagon moves, there shall be adequate clearance so that persons are not liable to be crushed or trapped between walls, fixed structures, fencing or stack of materials, and a passing locomotive truck or wagon or any part of load thereon and where such clearance is not reasonably practicable, suitable recesses at a distance of not less than 6 metres along the lines



shall be provided and effective arrangements for warning any person of the danger, of being liable to be crushed or trapped, shall be made.

- 5.7.3 Every locomotive truck or wagon shall be fitted with effective brakes and a sufficient number of suitable springs or scotches shall be provided for the use of persons employed on the movement of trucks or wagons which shall be in good condition and used, whenever necessary.
- 5.7.4 Where any person is likely to be endangered by the movement of locomotive truck or wagon:
- (a) the locomotive shall be fitted with an effective warning device;
 - (b) the person in charge of movement of locomotive truck or wagon shall see that adequate warning is given before the locomotive truck or wagon is moved ; and
 - (c) when the locomotive truck or wagon is approaching any crossing, blind spot or any place where the driver of the locomotive is unable to see clearly a sufficient length of the track, the driver shall given adequate warning by means of a suitable sound signal.
- 5.7.5 Except where adequate handholds and footholds are provided, no person shall be required to be permitted to ride on a buffer or on a running board or in any locomotive truck or wagon.
- 5.7.6 No person shall be required or permitted to remain on any vehicle or on any truck or wagon during the loading of loose material by means of grab, excavator or similar appliances if he is endangered by so remaining.
- 5.7.7 Where hauling locos have to work to dangerous limits, the travel of the loco beyond the safety limit should be arrested by stops of adequate height and strength.

HAULAGE TRUCKS:

- 5.7.8 Vehicles shall be maintained in good mechanical condition. Special attention should be given to brakes, horns, tyres, steering mechanism and signaling devices. Drivers of motor vehicles should be on the alert to observe defects and report them to take further appropriate action for their correction. Drivers shall operate vehicles with regard to proper protection of the mechanism thereof:
- 5.7.9 Constant attention, concentration and alertness shall be exercised by the driver while operating a motor vehicle. Driving will not be undertaken under fatigue, or drowsiness and drunkenness as they impair driving ability to a high degree until the condition causing the impairment has been relieved.
- 5.7.10 Every vehicle should carry notices of warning pasted in at a conspicuous place, containing the following instructions:
- (a) Persons traveling in the vehicle, on duty should sit at a safe place in it.



- (b) they should not stand in the vehicle or sit on the top of side planks of the body.
 - (c) No person should get down from or get into the vehicle when it is in motion.
- 5.7.11 The log book of every vehicle should have a fly leaf containing the following instructions to the driver and the crew:
- (i) No person should be allowed to enter in the vehicle or travel in it except under written orders of the concerned Executive Engineer or any other officer-in-charge or his subordinate duly authorized in this behalf. Any infringement of this rule shall render the driver and the cleaner liable for punishment.
 - (ii) They should be prohibited from standing in the vehicle or sitting on the top of the side planks of the body.
 - (iii) No person should be allowed to get down from or get into the vehicle while it is in motion.
 - (iv) The cleaner should act as the conductor of a transport bus and should look after the safety of the crew and others traveling in it.
- 5.7.12 No driver of a truck shall back up a truck unless assisted by a signal man who shall have clear view of the driver and the area behind the truck during each backing up operation.
- 5.7.13 As far as possible, load trucks should not be backed on gradients. Stumbling blocks must always be put in place to prevent the truck from moving down a gradient.
- 5.7.14 In slopes, it should be ensured that very heavily loaded trailers are not used behind light hauling units.
- 5.7.15 The driver should not drive too fast, should avoid distractions and drive defensively. The driver should not attempt to overtake another vehicle unless he can plainly see far enough ahead to be sure he can pass safely ; proper horn signal should be given before passing.
- 5.7.16 Before crossing rail-road-track, the driver should reduce speed, look in both directions along track and proceed track only if it is safe to do so.
- 5.7.18 Workmen shall not be transported standing in the truck with their heads above the cab where they are liable to be injured by low hanging wires, tree branches etc.
- 5.7.19 Loaded haulage trucks shall not be allowed to carry labourers on the top of their load.
- 5.7.20 Where any vehicle is used for tipping material into any excavation or pit or over the edge of any embankment or earthwork, adequate measures, such as the provision of suitable blocks, shall be taken where necessary so as to prevent such vehicle from overrunning the edge of such excavation, pit embankment or earthwork.

5.8 BOILERS AND COMPRESSORS:



BOILERS:

- 5.8.1 All steam boilers shall comply with provision of Boiler Regulations.

UNFIRED PRESSURE VESSELS:

- 5.8.2 Other pressure vessels shall comply with the provisions of rules framed under section 31 of the Factories Act, 1948.

AIR COMPRESSORS:

- 5.8.3 Air compressors should not be operated at speeds greater than those listed by the manufacturer, as explosion of compressors are sometimes due to excessive speeds.
- 5.8.4 Compressors should be securely anchored to firm foundation as the sudden and frequent variations in load cause considerable vibration and impose severe shocks upon the equipment.
- 5.8.5 At a pressure of 8 kgs per square cms as the temperature in an air cylinder may reach 200 degree C., which is sufficient to volatilize. The lubricating oil shall, therefore, have high flash points.
- 5.8.6 Every air compressor shall be equipped with an automatic mechanism so arranged that the compressor will automatically stop its air compressing operation before the discharge pressure exceeds the maximum safe working pressure allowable on the weakest portion of the system to which the compressor is attached.

AIR RECEIVERS:

- 5.8.7 Under no circumstances should air receiver be installed without a pressure gauge, and a relief or safety valve so proportioned and adjusted that the pressure will never exceed the maximum allowable working pressure of the tank by more than six percent.
- 5.8.8 A drain pipe should be installed at the lowest point of every compressed air tank or receiver.
- 5.8.9 No stop valve should be placed in the air line between the compressor and the air receiver unless spring loaded safety valves are installed between the compressor and the stop valve.
- 5.8.10 Gauge and valves shall be regularly inspected.
- 5.8.11 Air receiver shall be drained and cleaned of oil and water every six months or more often if so specified by State laws.
- 5.8.12 The manhole or hand hole shall be opened every six months and the inside of the receiver checked.



5.8.13 When operating under dusty conditions, the relief valve shall be checked at least every month.



CHAPTER 6

FIRE PREVENTION AND PROTECTION

6.1 FIRE PREVENTION:

- 1) All construction areas and storage yards should be kept clean and well arranged.
- 2) A clear space of 15 metres around the outer boundary of saw mill and lumber storage area may be provided. All lumber should be stored in sections with fire breaks with a distance of 15 metres between consecutive sections.
- 3) All combustible waste materials, wood scaling, soiled rags etc. shall be removed daily and burned in suitable burning area. The saw mill and lumber yard shall be kept free from accumulation of combustible debris.
- 4) Fires, welding flame cutting shall in general not be permitted in combustible areas. Fires and open flame devices shall not be left unattended.
- 5) Smoking shall be prohibited in all flammable material storages viz. carpentry, paint shops, garages, service stations etc. “No Smoking” signs should be used on all such areas.
- 6) Accumulations of flammable liquids on floors, walks etc. should be prohibited. All spills of flammable liquids shall be cleaned up immediately.
- 7) Smoke pipes from Diesel Engines passing through roof of combustible material e.g. in compressor stations, at dam site and quarry shall be insulated by asbestos. All joints of smoke pipe should be rivetted, welded or otherwise securely fastened together and supported to prevent accidental displacement or separation. The joints should not be leaky.
- 8) Flammable liquids, lubricants etc. should be handled and transported in safety containers and drums which can be kept tightly capped.
- 9) Petrol or other flammable liquids with a flash point below 100⁰F shall not be used for cleaning purposes.
- 10) Oxygen cylinders shall not be stored with combustible materials.
- 11) All electric installation should be properly earthed. Repairs should not be made on electrical circuits until the circuit has been de-energized.

6.2. FIRE FIGHTING ARRANGEMENTS:

1. Fire extinguishers and fire buckets, painted red shall be provided at all fire hazardous locations viz. Batching and Mixing Plant, Winch Houses, Workshops, Store yards, Saw-Mill, Switch Gear Room compressor Station, Office establishments etc. The extinguishers shall be inspected, serviced and maintained in accordance with manufacture’s instructions. The inspections shall be evidenced by notations on tag attached to the extinguisher.
2. Where building and establishment are located in or near cities or towns, definite arrangements shall be made to ensure protection by the established municipal fire department. In more isolated locations, it will be necessary to provide and install



- complete fire fighting facilities including provision for fire tenders commensurate with the number, size and importance of buildings, equipments, or supplies to be protected.
3. Full reliance should never be placed on portable hand extinguishers as all of these have a very limited capacity. Water, in a ample amount and under adequate pressure, should always be available for fire fighting.
 4. Where a group of buildings are located beyond the range of protection from a public water supply, the installation of a water system for private fire protection may be warranted. The following design factors should be considered in the planning of a private water supply:

The standard fire stream is recognized as 1155 litres per minutes. Multiple streams of 1155 litres must be provided for protection of important groups of buildings. While the daily domestic consumption is the basis used in the design of a domestic type of water system, additional capacities should be provided for use during fire emergencies.

For examples, two standard fire streams (2310 litres per minute) discharged for ½ hours amount to 69.300 litres of water. Therefore, additional water storage for fire use must be provided. A loop system of hydrants from two directions with a reduction of friction losses and a resultant higher water pressure should be provided for fire-fighting purposes. No underground pipes that are a part of the system should be smaller than 15 cms. in diameter and valves should be provided for shutting of the domestic connection outside of all buildings served. Hydrants should not be over 120 metres apart and so located that not less than two hose streams can be concentrated on any building. Hydrants in cold climate should be designed and installed to prevent freezing. Two 60mm. outlets with standard 5 hose thread should be used for all private hydrants. It is good practice to provide hose houses at hydrants in a private water supply system. The houses should be equipped with a minimum of 60 metres of 60 mm. house and accessories, including axes, spanner, wrench and other tools.

5. Excavation facilities and fire exit may be provided at al locations featuring fire hazards.
6. Siren or other suitable fire alarm arrangement shall be made on all projects. Warning sings may be posted at all locations having fire hazards.
7. All staff shall be conversant with the use of all types of fire extinguishing apparatuses.
8. Demonstrations and training in fire fighting shall be conducted at sufficient intervals to ensure that sufficient personnel are familiar with and are capable of operating fire fighting equipment.

6.3 PREVENTION FROM DROWNING:

1. Where adjacent to the site of any operation there is water, into which a person employed, in the course of his employment is liable to fall with risk of drowning, suitable rescue equipment shall be provided and maintained in an efficient state and steps shall be taken for the prompt rescue of any such person in danger of drowning.



2. The rescue equipment shall include life saving skiffs properly maintained with life vests and life buoys of approved type with 16m metres of 10mm rope attached.
3. Life preservers, vests or belts shall be worn by all persons while working:
 - (a) On floating pipeline, pontoons, rafts, float stages etc;
 - (b) On open deck-floating plant not equipped with bulwarks, guardrails or other life lines;
 - (c) On structures extending over or adjacent to water except where proper guardrail or safety belts and life lines are provided;
 - (d) Working alone at night where there are potential drowning hazards regardless of other safeguards provide and;
 - (e) In skiffs, small boats or launches except when inside of enclosed cabin or cockpit.
4. Life preservers or work vests shall have a buoyancy of at least 7.5 kgs when new and shall



CHAPTER 7

ELECTRICAL SAFETY MEASURES (Do's and Don'ts)

Electricity is a versatile energy but highly dangerous when it is not properly handled or used. Failure to take proper precautions against electrical hazard may result in major accidents and loss of lives and property. Unlike mechanical hazards, electrical hazards are very fatal and voltages in the ranges of 30 to 35 volts can even cause of death. Therefore extreme care shall be taken in connection with electrical works. Control of electrical hazards is neither difficult nor very expensive but ignoring them may lead to serious accidents. Only qualified persons should undertake electrical works / repairs. Some safety precautions (Do's and Don't instructions) are given here for strict implementation to prevent chances of such electrical accidents.

7.1 Power Transmission

High Voltage Distribution – Overhead

1. Power circuits and electrical equipment shall be de-energized before work is done on such circuits and equipment except for trouble shooting or testing.
2. No electrical work shall be performed on electric distribution circuits or equipment, except by qualified person or by a person trained to perform electrical work and to maintain electrical equipment under the direct supervision of a qualified person.
3. Disconnecting devices shall be locked out and suitably tagged by the person who performs such work. Only the persons who installed them or, if such persons are unavailable, by persons authorized shall remove locks or tags by the operator or his agents.
4. Electric equipment shall be frequently examined, and properly maintained by a qualified person to assure safe operating conditions.
5. Transformers shall be of the totally enclosed type, or shall be placed at least 1.5m above ground, or installed in a transformer house, or surrounded by a substantial fence at least 1.8m feet high and at least 1m from any energized parts or casings.
6. Transformer stations shall be enclosed to prevent persons from unintentionally or inadvertently contacting energized parts. Transformer enclosures shall be kept locked against unauthorized entry.
7. Suitable danger signs shall be posted at all major electrical installations.
8. Dry wooden platforms, insulating mats, or other electrically nonconductive material shall be kept in place at all switchboards and power control switches where shock hazard exists. However, metal plates on which a person normally would stand and



which are kept at the same potential as the grounded, metal, non-current carrying parts of the power switches to be operated may be used.

9. Overhead high-voltage lines will be appropriately marked and signed indicating minimum clearance of 3m of power lines rated up to 50KV, each site will clearly address overhead power lines locations and proper clearance
10. All road crossings at site shall be posted to warn crane operators of power line height, voltage and not be within 3m of power lines rated up to 50KV and 4.5m from 50KV to 220KV.
11. A lineman must be accompanied by a groundman when working in the air.

Assured Grounding

1. All portable electric tools, drop cords, extension cords, and similar items will be visually inspected daily before being put to use. Any items showing signs of possible damage will not be used until repaired as indicated or tested.
2. All portable electric tools, extension and drop cords, fixed temporary wiring and receptacles will be tested for continuity of the grounding conductor and for its connection to the exposed frame in the case of tools. This test can be made by either an ohmmeter or a battery powered test light.
3. Tests will be made at the following times:
4. Before first using of any item.
 - After repairing any item, before it put back into service.
 - After any incident which might have caused damage.
 - At intervals not to exceed 3 months, except that temporary wiring and receptacles fixed in a position where they are not subject to damage will be tested at intervals not to exceed 6 months.
5. Any item, which has not passed the above tests, will not be made available to any employee for use. It will be taken out of service and tagged out.

Batteries and Battery Charging

- Batteries of the unsealed type shall be located in enclosures with outside vents or in well ventilated rooms and shall be arranged so as to prevent the escape of fumes, gases, or electrolyte spray into other areas.
- Ventilation shall be provided to ensure diffusion of the gases from the battery and to prevent the accumulation of an explosive mixture.
- Racks and trays shall be substantial and shall be treated to make them resistant to the electrolyte.



- Floors shall be of acid resistant construction unless protected from acid accumulations.
- Face shields, aprons, and rubber gloves, shall be provided for workers handling acids or batteries.
- Facilities for quick drenching of the eyes, and body shall be provided within 7.5m of battery handling areas.
- Facilities shall be provided for flushing and neutralizing spilled electrolyte and for fire protection.

Charging

- Battery charging installations shall be located in areas designated for that purpose. Appropriate signage shall be used.
- Charging apparatus shall be protected from damage by equipment.
- When batteries are being charged, the vent caps shall be kept in place to avoid electrolyte spray. Vent caps shall be maintained in functioning condition, i.e., Clear of mud, muck or dirt.

WORKING AROUND HIGH VOLTAGE

High voltage power will be present throughout the construction work area(s) including overhead lines, site utilities, and within the shaft and tunnel. Work on high voltage lines or equipment requires specific safety precautions and mitigation measures to prevent any risk associated with working around these facilities.

High Voltage Rooms

Whenever any high voltage rooms or areas are unlocked and de-energized the following is required:

1. All personnel working on or near these areas shall place their lock and tag on the junction box that is disconnected or at the gate on the appropriate substation or disconnected gutter box.
2. Multiple lock-outs will be used so that each employee has a lock and tag in position.

High Voltage Lines and Equipment

When a high voltage line is to be worked on it must not be considered de-energized until a qualified person determines that the high voltage line has been de-energized and grounded. Such qualified persons shall:

1. Determine that the disconnecting devices on the high voltage circuit are in the open position.



2. Ensure that each ungrounded conductor of the high voltage circuit, upon which work is to be done, is properly connected to the system ground medium.

Whenever work is to occur in or around the location of overhead high voltage power lines, Contractor must ensure the following:

1. Minimum clearance height of power lines is posted at all road crossings at site under power line.
2. A lineman must be accompanied by a safety watch person when working in the air.

High Voltage Circuits

High voltage circuits will not be energized until:

1. All work on the high voltage circuit is completed and inspected.
2. All personnel have been cleared from the high voltage area and notified that the circuit will be energized.
3. All protective grounding installed has been removed from the ungrounded conductors.
4. The high voltage area has been secured and locked.

7.2 MAINS AND APPARATUS:

1. Before replacing a lamp or repairing an electric apparatus, make sure that the supply is switched off.
2. Use correct size and quality of fuse wire when renewing blown fuse.
3. When removing fuse, pull out the supply end first and when replacing the supply end should be put in last.
4. Place sign 'men working' or other warning boards on main switch before commencing work.
5. Before working on any circuit or apparatus, make sure that the controlling switches are opened and locked or the fuse holders withdrawn.
6. Always treat circuit as alive until you have proved them to be dead, the insulation of the conductors may be defective.
7. Before working on motor or other rotating machine, make sure that it cannot be set in motion without your permission.
8. Cultivate the habit of turning your face away whenever an arc or flash may occur.
9. Guard against arcs as well as high voltage; remember that burns from arc may be very severe.
10. See that all splices and connections are securely made. Use extreme care when breaking an inductive circuit, as dangerously high voltage is likely to result.
11. Thoroughly discharge to earth all cables before working on the cores.
12. Test rubber gloves periodically.
13. Place rubber mats in front of electrical switch boards.
14. Prevent accumulation of gases in unventilated manholes. Varnishes emit flammable vapour.



15. Do not connect single pole switch or fuse in a neutral circuit, but always connect in the live or phase wire.
16. Do not renew a blown fuse until you are satisfied as to the cause and have rectified any irregularity.
17. Do not use copper wire as substitute for fuse wire.
18. Do not close any switch, unless you are familiar with the circuit, which it controls and know the reason for its being opened.
19. Do not touch or tamper with any electrical gear or conductor, unless you have made sure that it is dead and earthed. High voltage apparatus may give leakage shock or flashover even without touching.
20. Do not work in live circuits without the express orders of the person-in-charge. Make certain that all safety precautions have been taken and you are accompanied by a second person competent to render first aid and artificial respiration.
21. Do not disconnect Earthing connections or render ineffective the safety gadgets installed on mains and apparatus.
22. Do not tamper with the meter boards and cutouts, unless you are authorized to do so.
23. Do not expose your eyes to an electric arc. Painful injury may results even with short exposure.
24. Do not close or open a switch or fuse slowly or hesitatingly; do it quickly and positively.
25. Do not turn your face and then grope for switch or fuse.
26. Do not use metal case flashlight around apparatus, which is energized.
27. Do not place any part of your body in circuit either to round or across the terminal when making a connection or operating.
28. Do not use wires with poor insulation.
29. Do not touch an electric circuit when your hands are wet, or bleeding from a cut or an abrasion.
30. Do not work on energized circuits without taking extra precautions, such as the use of rubber gloves and wooden handles.

7.3 PORTABLE LAMPS AND APPLIANCES:

1. Ensure that all portable appliances are provided with 3-pin plug and socket connections and the metal work of the apparatus is effectively earthed.
2. Always use portable hand lamps of the insulated safety type and provided with a rubber, plastic or wooden handle and wire guard.
3. Do not use a lamp in a metal holder fixed to the end of a loose flexible wire as a portable hand lamp.
4. Do not disconnect a plug by pulling the flexible cable or when the switch is ON.
5. Do not use kinked or perished cables for portable lamps and appliances.
6. Do not plug in any portable lamp or apparatus before making sure that the switch is OFF and that the wall plug is properly inserted in the socket.

7.4 FIRE

1. Disconnect the supply immediately in case of fire on or near electrical apparatus.
2. Make sure, when using water hose that the jet of water does not come into contact with live apparatus.
3. Keep flammable material only in special containers and in fireproof rooms.
4. Be sure that your men are familiar with the location of fire fighting apparatus.



5. Organize precautionary fire drill.
6. Have sufficient number of fire extinguishers located in strategic position, so that they may be available for immediate use in various areas.
7. Check fire-fighting apparatus periodically.
8. Wipe up oil as soon as possible; use sand to cover oil spots.
9. Do not use fire extinguishers on electrical equipment, unless it is clearly marked as suitable for that purpose.
10. Do not throw water on live electrical equipment in case of fire. It is dangerous to you.

7.5 ELECTRIC SHOCK

1. Remove the casualty, from the cause, render first aid and send for doctor or take the casualty to a hospital or dispensary.
2. Report all accidents, whether minor or major, non-fatal or fatal, immediately to the person-in-charge.
3. Study carefully and practice first aid treatment for injured persons.
4. Study carefully and practice regularly the instructions for resuscitation (artificial respiration) after electric shock, displayed at every major electrical installation.
5. Do not take unnecessary risk with electricity. Low voltage, under certain circumstances, can be more dangerous than high voltage.
6. Do not leave the casualty in contact with live apparatus. Switch off current immediately.
7. Do not attempt to disengage a person in contact with a live apparatus, which cannot be switched off immediately. Insulate yourself from earth by standing on rubber mat, or dry board before attempting to get him clear.
8. Do not touch his body. Pull him by clothes if they are dry or push him clear with a piece of dry wood.
9. Do not discontinue artificial respiration until recovery or death is certified by doctor. It may take even more than 2 to 3 for recovery.

7.6 GENERAL SAFETY PRECAUTIONS

1. Preach and practice safety at all times. Good work can be spoiled by an accident.
2. Work deliberately and carefully. Haste cause many accidents, be sure of what you are doing.
3. Examine before use all safety appliances, such as rubber gloves, mats, ladders, goggles, insulated pliers, etc. for their soundness.
4. Always add the acid or soda to water and not vice versa when mixing sulphuric acid or caustic soda and water.
5. Always report immediately to the person-in-charge or to any other proper authority any dangerous condition or a dangerous practice, which you may observe.
6. Always be cautious while lifting or removing a heavy apparatus or material. Warn others when they seem to be in danger near live conductor or apparatus.
7. Always be careful and take no chance against any possible accident.
8. Always obey the safety instructions given by the person-in-charge.
9. Do not wear loose clothing, metal watch straps, bangles or finger rings while working on electrical appliances.
10. Do not hand clothes and such other things on electrical fittings.



11. Do not work on a pole or other elevated position if there is a live part on it without safety belt and rubber gloves, and unless a competent person stands on the ground nearby to direct operations and give warning.
12. Do not use a ladder without a lashing rope; otherwise the ladder should be held firmly by another person.
13. Do not go carelessly near running belts on machines.
14. Do not remove danger notice plates or other signs or interfere with safety barriers or go beyond them.
15. Do not bring a naked light near battery. Smoking in the battery room is prohibited.
16. Do not allow visitors and unauthorized persons to touch or handle electrical apparatus or come within the danger zone of high voltage apparatus.
17. Do not enter excavations, which give out obnoxious smell, or work in badly lit, badly ventilated and congested areas.
18. Do not touch a circuit with bare fingers or hand or other makeshift devices to determine whether or not it is alive.

* * *



CHAPTER 8

HOUSEKEEPING AND WORK ENVIRONMENT CONTROL AND OCCUPATIONAL HEALTH MEASURES

8.1 Housekeeping:

Purpose

Housekeeping method has been developed to ensure that all workplaces and storage areas are better maintained not to cause hazards / danger to the life of humans as well as equipments and a means to improve the safety, effectiveness and efficiency of the work place. It also provides the necessary guidance on the storage, handling, inspection and maintenance procedure that has to be followed during the usage of specific items like cement, Diesels / Oils etc at site.

Scope

Housekeeping is to be used by members of the site management, staff, supervisors and sub contractors who supervise and control activities at site. It is to ensure “Safe place for everything and everything in its safe place”.

Reference

IS 4082:1996 –“Stacking and Storage Construction materials and Components at site – Recommendations”.

Responsibilities

Project Manager:

- a) He has overall responsibility for ensuring that provisions are made for the implementation of safe systems of work.
- b) Implementation of Housekeeping procedure shall be the joint responsibility of the project manager and the Project safety Engineer with full assistance from the Storekeeper, Site Engineers and Sub Contractors personnel.

Safety Engineer:

- a) To arrange the necessary awareness and training for all persons involved in Entry, Storage and handling of Building Materials as well as its sustenance.
- b) Inspect the material storage areas at site and handling of the same for complying with statutory requirements and ensure things are being carried out in accordance with this method.

Site Engineers:

- a) Ensure that all persons involved in handling of materials have been suitably trained and are fully aware of the safe handling, stacking and upkeep procedures.
- b) Regularly inspect the working areas for compliance with requirements of it.

Storekeeper:



- a) Ensure all materials are stored at site as per this method.
- b) Ensure availability of MSDS along with the hazardous material being received at site and comply with the MSDS.
Sub Contractors:
 - a) Sub contractor or his authorised representative shall also be responsible to ensure that the handling and storage of Building materials are as per this method.

Housekeeping Procedures

- a) Stacking of Cement, Bricks, Lime tiles, timber, steel and other Building materials and its storage facilities must be in accordance with the IS 4082:1996.
- b) Bricks must be stacked up to a maximum height of 5 feet not only to prevent its fall but also to ensure safe handling of the same.
- c) Any material must not be stacked nearer to the excavation i.e. a least distance of 1.5 meters to be maintained from the edges of the excavation. It should be kept in such a way that it does not block the access ways or blocks the approach to any facilities like First aid center, Fire Extinguisher, Electrical distribution Boards etc.
- d) All the Diesel / Oil shall be stored separately away from direct sunlight as below
 - 1) Area is leveled off and a plastic / polyethylene sheet is laid.
 - 2) Sand is spread over the plastic / polyethylene to a thickness / height of not less than 2”.
 - 3) A concrete bund is made for a height of minimum 150 mm around the spreader area.
 - 4) An all-purpose fire extinguisher is kept at a visible accessible location near the storage area.
 - 5) Suitable warnings posters shall be displayed at the storage facility.
- e) A MSDS of the stored fuel should be displayed at the storage area with emergency contact numbers in case of any emergency.
- f) In case of storage of Hazardous materials, warning poster / caution notice shall also be displayed to warn the tress passers that the area is hazardous.
- g) All the site engineers must ensure that the access ways are clear of materials and also no material is stacked at the edge of the floor.
- h) A separate gang of 5 persons per block will be exclusively allocated to the site Incharge of that area and will be taking care of the access areas, loose materials etc.
- i) Apart from regular housekeeping works, every Saturday shall be observed as a Housekeeping day and two persons from all the contractors will be nominated for carrying out the Housekeeping activities.
- j) All materials in bags, containers or bundles stored in tiers shall be stacked, blocked, interlocked, and limited in height so that it is stable and otherwise secured against sliding or collapse.
- k) Inflammable liquids and grease shall be stores in a ‘NO SMOKING’ area and properly separated from other stores materials.
- l) Used lumber shall have all nails withdrawn before it is stacked for storage.
- m) In withdrawing sand, gravel, and crushed stone from frozen stock piles, no overhanging shall exist at any time.
- n) Material dumped against walls or partitions shall not be stores to a height that will endanger the stability or exceed the resisting strength of such walls and partitions.



- o) Persons working in hoppers or on high piles of loose material shall be equipped with life lines and safety belts.
- p) For persons engaged in handling of corrosive materials, adequate equipment shall be provided.
- q) Where in connection with any grinding, cleaning spraying or manipulation of any material, there is given off any dust or fume of such character and to such extent as is likely to be injurious to the health of persons employed, all practical measures shall be taken by securing adequate ventilation or by the provisions and use of suitable respirators or otherwise to prevent inhalation of such dust and fume.
- r) Men below the age of 18 years and women should not be employed on the work of painting with products containing lead in any form. Wherever men above the age of eighteen years are employed on the work of lead painting, the following precautions should be taken:
 - 1) No paint containing lead or lead products shall be used except in the form of paste or ready made paint.
 - 2) Suitable face masks should be supplied for use by the workers when paint is applied in the form of spray or a surface having lead paint dry rubbed and scrapped.
 - 3) Overalls shall be supplied to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.
 - 4) White lead, sulphate of lead, or product containing these pigments shall not be used in painting operation, except in the form of pastes or paints ready for use.
 - 5) Cases of lead poisoning and suspected lead poisoning shall be immediately notified, and shall be subsequently verified by a member appointed by the competent authority of project.
 - 6) Instructions with regard to special hygienic precautions to be taken in the painting trade shall be distributed to working painters.
 - 7) Lead compounds shall not be used in form of a spray in the interior painting of the structures.

Awareness and Training

It is the responsibility of the safety engineer to organize training and awareness programs on safe handling, storage and maintenance of building materials. Site engineer should facilitate the safety engineer by allocating people for training.

Pep talks should also be given at regular intervals to educate the workmen on safe handling, storage and maintenance of fuel, oil and compressed gas cylinders.

Safety engineer shall help in identification and training of workmen to carryout regular housekeeping works.

Inspection Procedure

Housekeeping will be the first priority to be inspected during the safety walkabout and inspection should be conducted every Friday. Storekeeper, safety engineer and site engineers should jointly conduct it. Non-conformity would be treated with memo to the concerned violators.



8.2 WORK ENVIRONMENT CONTROL AND OCCUPATIONAL HEALTH MEASURES

Concerned contracting agency shall take responsibility to implement the work environment control and occupational health measures to provide for a safe working environment, as well as to provide safety and health protection to the construction workers.

A. GENERAL REQUIREMENTS

- a. When hazardous substances such as dust, fumes, mists, vapour or gases exist, or are produced in the course of construction (such as excavation, drilling, blasting, demolition, handling of cement, corrosive material, stone crushing, batching, grinding, shotcreting, loading & unloading of materials etc.), all reasonably practicable measures shall be taken to prevent inhalation, ingestion or skin absorption of these hazardous substances. Suitable engineering control measures like exhaust system, water spray etc, shall be implemented wherever feasible. Respiratory protective equipment shall be provided to the workers and shall be used wherever necessary.
- b. Adequate working facilities shall be provided for workers engaged in the application of paint, coating, herbicide or insecticide, or in other operations where contaminants may be considered harmful to enable workers to remove such harmful substances from their hands & body before leaving the worksite.

B. DUST ELIMINATION:

- a. In case of haul and access roads, the road surfaces shall be kept moist.
- b. In case of concrete batching & mixing plant and in places where the handling of cement is done manually, respirators / dust masks shall be provided to the workers.

C. PROTECTION FROM HIGH NOISE:

- a. Suitable engineering controls wherever practicable, shall be arranged / utilized to minimize the hazard, where the noise levels are exceeding the prescribed limits.
- b. Workers shall be provided with suitable ear protectors wherever they are exposed to high noise levels.
- c. In construction and related activities, involving the use of sources of ionizing radiations, the pertinent provisions of the Atomic Energy Commission shall be strictly followed.

D. VENTILATION:

- a. In confined spaces workmen shall be provided with ample supply of fresh air to maintain their health and safety at all times. The ventilation system shall be adequate to maintain supply of pure air and if natural circulation is not adequate, artificial ventilation shall be provided.
- b. Oxygen content of the atmosphere in the work area shall be determined by pre-entry and subsequent tests made with approved instrument frequently during the working shift.
- c. Approved breathing apparatus or fresh air hose masks shall be provided to the workers where Oxygen content in atmosphere is below 19.5% by volume.



- d. No person shall be allowed to enter or remain in Oxygen deficient atmospheric working conditions.
- e. In case, presence of dangerous gases as indicated in Table-1, the area shall be examined for dangerous gases within 2-hours before the work is begun and after every 2 hours during the working shift.
- f. Wherever, there is rock / sand fall in the under-ground works, the respiratory protection shall be ensured to the workers apart from the other safety measures.

Table-1: Air shall be considered unfit to breathe if it contains any of the following –

Sl. No.	Name of the gas	% age by volume in atmosphere
1.	Oxygen	Less than 19.5
2.	Carbon dioxide	More than 0.5
3.	Carbon monoxide	More than 0.005
4.	Hydrogen sulphide	More than 0.001
5.	Nitrous oxide	More than 0.002
6.	Oxides of Hydrogen	More than 0.002
7.	Methane	More than 0.5
8.	Flammable gases	More than 1.5
9.	Any other poisonous gas in harmful amounts.	

E. LIGHTING

Construction areas, aisles, stairs, ramps, runways, corridors, offices and shops where work is in progress, shall be adequately lighted with either natural or artificial illumination. Inadequate lighting of working areas is by itself a source of danger, particularly where work is undertaken at night. The minimum illumination intensities as given in the table-2 shall be provided while any work is in progress.

Table-2: Minimum illumination intensities

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 (for example, batch plants, screening plants, mechanical and electrical equipment rooms, carpenter shops, rigging lofts, active store rooms, barracks or living quarters, locker or dressing rooms, mess halls and indoor work rooms).
325	First aid stations, infirmaries and offices.

F. WASTE MANAGEMENT:



- a. General Construction Waste: The contracting agencies to ensure that any waste generated is disposed off in a controlled manner with minimal impact on the environment.
- b. The general construction waste management measures includes –
 - Buying of waste on site is strictly prohibited
 - Spoiled earth and concrete waste shall be carried away to the appropriate area under the responsibility of the contractor or subcontractor who has produced the rubbish. A special area should be earmarked to store reusable material.
 - Waste material originating from on site works (plastic bags, cement bags, packing, rubbish, timber, planks etc.) shall be carried away to an approved area.
 - If any rubbish is stored temporarily in a dedicated area on each contractor's site facilities, this shall be dumped in the appropriate rubbish tip periodically.
 - Earth and mud left by lorries and at the connection of working site roads and public roads shall be cleaned periodically to prevent dust emission and chances for traffic accidents.
- c. Fuel, Lubricants or Chemical products: To minimize the risk of ground contamination and discharge to surface water drains, the following measures shall be followed.
 - All chemical products, paints or solvents are to be stored in properly designed and labeled containers in areas away from watercourses and drains.
 - It shall be the responsibility of each contractor or subcontractor to install his fuel storage tanks correctly within a special retention area to contain any spillage that may occur. This retention area shall be impervious and shall have sufficient capacity to contain the total volume of the fuel tanks.
 - Absorption blankets or granules shall collect minor spillage of oil or fuel.
 - Oil, grease or similar products must not be drained into the ground or drains. Waste oils shall be collected, stored in tight containers and removed from the site periodically.
- d. Recoverable Waste: To conserve resources in order to protect the environment, the following measures shall be observed by the contracting agencies strictly.
 - Recoverable waste such as discarded metals, timber, planks, reinforcement steel bars, paper and cardboard shall as far as is reasonably possible to be kept separate from other non-recoverable waste before reuse.
 - Where possibilities of re-use exist, items shall only be removed from the site with permission of the Engineer In charge.
 - Each contractor must conserve electric power and prevent water wastage in order to have an efficient use of energy and water sources.
- e. Surface and Foul Water Discharge: It is to be ensured so far as is reasonably practicable that no polluting substances are spread on site.
 - The contractor shall treat waste water (by separating oil etc.) and then route it to the river.
 - The Septic tanks established around the construction site and working area should accommodate sewage effluents from common facilities. It is the responsibility of the contractor to install a number of septic tanks and filters for their own accommodations at site and empty them by a specialized waste carrier if necessary.
 - The wastewater from the batching plant shall discharge into the drainage system after passing through a settling tank.

* * *



CHAPTER 9

Miscellaneous

TRADE SAFETY RULES

Laborer / Miner

General

- Always wear hard hats, safety glasses, vests, and work boots.
- Additional eye and face protection is required when chipping, grinding, and any other operation where flying material is a concern.
- Hearing protection is required in mining, chipping, grinding, and compressed-air tool usage operations.
- Wear gloves when handling stripped material, contaminated material, abrasives or sharp metal, lumber/timber.
- Keep work areas clean.
- Wear chaps when operating a chain saw or demolition saw.

Earthwork

- Check the trench or embankment for any cracking or loose material that may fall into the excavation.
- Excavated material, tools or other equipment will not be stored closer than a 1 m distance from the edge of the excavation.
- Ladders will be placed no more than 10 m from employees working in the trench, and must be tied off.
- Before the end of each shift, barricades and ribbon will be put up to protect people and equipment from falling into the open trench or excavation areas.
- Be careful when working around moving equipment – always wear high visibility vests or clothing.

Fall Protection

- 100% tie-off policy at 3 m will be followed.
- Harness and lanyard will be used in all tie-off situations.



- Make sure anchorage is adequate for arrest of a fall.

Concrete Placement

- When working the concrete pour, wear rubber boots and duct tape to pants to prevent concrete from running into the boot.
- Wear rubber gloves and long sleeve shirts.
- Eye protection must always be worn.
- Don't let concrete splash on arms, face or clothing. If this occurs, wash off immediately.
- Check electrical vibrators for cuts in cords and for proper connections.

Small Compaction Equipment

- Use dust masks if material is dry.
- Make sure equipment has automatic shut-off devices.

Chipping or Breaking Concrete

- Eye protection is always to be worn. Wear full-face shield during any chipping or grinding operations.
- Use leather gloves.
- Wear metatarsal shields when striking the foot with the point of the hammer is possible.
- Clean up broken materials to avoid a tripping hazard.

Operator

General

- All operators of ALL equipment will wear hard hats, safety glasses and seat belts at all times.
- Visual inspections of equipment are to be made on a daily basis and given to your foreman. Operators are to notify their foreman of apparent malfunctions, oil leaks or any engine problems.
- Wear hearing protection and dusts masks when necessary.
- Check tail swing for interference on large backhoes and cranes.



- Prior to the start of operation a visual inspection of the operating area will be performed to ensure that no items or personnel are within pinch point area of any equipment that has a rotating superstructure or potential for other pinch point hazards.
- A physical barricade may be required to ensure a 1 m minimum clear distance of rotating equipment.
- Pay attention to people on the ground working around the equipment.
- Keep equipment a minimum of 1 m away from edge of any trench, edge of the embankment or electrical equipment.
- Always maintain a 1m clean area on both sides of a trench during excavation.
- Pay attention to the people working around equipment on the ground.
- Set high rail cars down off rail, on the ground, on its wheels at the completion of its production or shift.
- When handling long sections of rail, make sure that all employees are well clear of the rail before trying to move it.

Driver

General

- Always wear safety glasses, hardhat and vest when out of vehicle.
- Keep your vehicle mechanically sound; report unsafe conditions to your supervisor to insure that they are properly corrected.
- If involved in an accident follow the guidelines on the Accident Procedure Form located in the vehicle.
- Avoid parking on hills, if unavoidable, use tire blocks.
- Report all accidents or damage of your vehicle to your immediate supervisor
- Follow all site and public posted speed limits.

Finisher

General

- Always wear rubber boots, rubber gloves and rain gear as needed when in direct contact with concrete.
- Always wear safety glasses, hardhat and vests.
- When using long handled bull floats, be careful the handle does not hit other workers or come in contact with electrical lines or passing traffic.
- When using grinders, be sure to use the correct type of grinding wheel for the material that is being ground.



- Be sure the wheel is rated for the proper revolution per minute.
- Always use the guard that is provided with the grinder and use both hands. Wear gloves when necessary.
- Always wear full-face shields during any grinding operations.
- Use dust masks when necessary.
- Make sure scaffolds have been correctly erected with proper handrails, planks and supports.
- 100% tie-off policy will be followed.

Electrician

General

- Only authorized and qualified electricians are allowed to make electrical connections or repair electrical equipment and wiring.
- Temporary electric cords shall be covered or elevated. They shall be kept clear of walkways and other locations where they maybe exposed to damage or create tripping hazards.
- Damaged or defective electrical tools shall be returned immediately for repair.
- When it is necessary to work on energized lines rubber gloves, blankets, mats, and other protective equipment shall be used as directed by the supervisor.
- Splices in electrical cords shall retain the mechanical and dielectric strength of the original cable.
- Temporary lighting shall have guards over the bulbs. Broken and burned out lamps shall be replaced immediately.
- Energized wiring in junction boxes, circuit breaker panels, and similar places shall be covered at all times. Hazardous areas shall be barricaded and appropriate warning signs posted.
- Electricians are not to leave any job, where exposed wires, etc. could cause injury if touched, until such a job is finished or you are relieved.
- Become familiar with the requirements of the assured equipment-grounding program adopted for this project.
- All electrical work will be performed on de-energized lines; Any “Hot-Work” shall have a completed JHA approved by the Equipment Manager prior to the start of work.
- All high voltage work must be de-energized by a qualified person before any work is to be started.



TOOLS: HAND & POWER PROCEDURES:

- All projects will conduct tool-training specific to job needs.
- Never modify hand or power tools.
- No trigger locks are allowed.
- Inspect all hand and power tools daily.
- All guards must be in place and serviceable per the manufactures specifications.
- All broken or defective tools must be tagged out and either removed from the job or repaired before using them again.
- All hand or power tools must be used in accordance with the manufactures' guidelines.
- All power tools must have twist lock plugs and be assured grounded.
- All hand held power tools must be equipped with a momentary contact or constant pressure "on/off" switch that will shut off the power when pressure is released.
- Mushroomed, cracked or chipped heads and rough, splintered or badly worn handles are unsafe.
- Tools have a proper place. Keep them there when not in use. Do not leave defective tools around where others might use them.
- Use the proper strength tool for each job. Cheaters cause accidents. Come-a-longs are designed to hoist what the manufactured handle can easily lift.
- Power tools shall be hoisted or lowered by a hand line, never by the cord or hose.
- Electric power operated tools shall either be the approved double-insulated type or grounded.
- Do not stand directly in front of, or behind, a man who is swinging an ax, sledge, or other tool.
- When using many tools such as power grinders, metal saws, arc welders or working near others using such tools, personal protective equipment is required. If you have questions about the protective equipment or safety rules, ask your supervisor.
- All pneumatic hose connections shall be fastened securely by whip checks or chain. Whip checks shall be positioned on the hose rather than the fitting - if the hose should break, the fitting may stay connected while the hose will whip around.
- Safety clips or retainers shall be installed on all pneumatic tools to prevent the accidental ejection of the tool from the barrel.



- Caution - Compressed air is extremely dangerous if improperly or carelessly used.
- Never direct it toward yourself or anyone else for any reason. Do not use it to clean clothing. Eye protection is required.
- DUCT TAPE IS NOT TO BE USED FOR REPAIRS ON AIRHOSES.
- Live loads/cartridges must be stored in an approved, locked storage cabinet to meet applicable OSHA regulations. Do not throw explosive charges into trash containers or leave them lying around. Return them to your supervisor.
- Come-a-longs must be sent out to manufacturer or supplier for repair.

Grinders/ Wheels

All abrasive wheels shall be closely inspected and ring-tested before mounting to ensure that they are free from cracks or defects.

Mounted Grinders

- Adjustable work rests shall be provided and kept at a distance not to exceed 3mm from the surface of the wheel.
- Face shields shall be worn while using a bench grinder.
- When safety guards are required, they shall be so mounted as to maintain proper alignment with the wheel, and the guard and its fastenings shall be of sufficient strength to retain fragments of the wheel in case of accidental breakage.

Chain Saws

- All chainsaws shall be equipped with a momentary finger contact or constant pressure “on/off” control switch that will shut off power when the pressure is released.
- When starting a chain saw, place it on the ground, hold the handle with one hand and pull the starter with the other hand. Never start a saw in the air or on your leg.
- Employees using chain saws are exposed to flying debris, dust, and noise. Kevlar fire resistant leg chaps, hard hats, safety glasses and face shields (mesh is acceptable), and gloves are required when working with chain saws. No loose or ragged clothing will be allowed. Additionally, hearing protection must be worn.

Cut-Off Saw

The following will be worn while operating a cut-off saw:

- A hard hat mounted full-face shield in addition to safety glasses.
- Proper hearing protection.



- Proper protection from silica.
- Kevlar fire resistant leg chaps.
- Leather work gloves.

Chop Saws

- Safety glasses and face shield must be worn when using a chop saw.
- Inspect the saw and abrasive wheel prior to each use.
- Use only wheels designed for the saw (rpm rating on blade must meet or exceed that of the saw) and compatible with the material being cut.
- Do not remove the wheel guard.
- Do not cut masonry or wood with a chop saw, and only use correct blade for the items being cut.

Radial Arm Saw

- Where the wearing of gloves creates a possible hazard, they shall not be worn.
- Safety glasses or goggles are mandatory.
- Keep hands well away from saw blades and other cutting tools.
- Never leave the machine with the power on.
- Respiratory protection should be considered if harmful dusts, fumes, or vapours are present.



Annexure 1

DEFINITIONS AND GLOSSARY OF TERMS

(The Definitions given here under are pertains to this document only)

1. Access or Egress means passageways, corridors, stairs, platforms, ladders and any other means to be used by a construction worker for normally entering or leaving the workplace or for escaping in case of danger.
2. Accident means an unintended occurrence arising out of and in the course of employment of a person resulting in injury.
3. Adolescent means a person who has completed his fifteen years of age but has not completed his eighteenth year.
4. Adult means a person who has completed his eighteenth years of age.
5. Base plate means a plate for distributing the load from a standard in the case of metal scaffolds.
6. Bay in relation to scaffolds, means that portion of the scaffold between horizontal or vertical supports whether standards or supports from which the portion is suspended, which are adjacent longitudinally.
7. Brace means a member incorporated diagonally in a scaffold for stability.
8. Bulkhead means an airtight structure separating the working chamber from free air or from another chamber under a lower pressure than the working pressure.
9. Caisson means an air and watertight chamber in which it is possible for men to work under air pressure greater than atmospheric pressure at sea level to excavate material below water level.
10. Cofferdam means a structure constructed entirely or in part below water level or below the level of the water table in the ground and intended to provide a place for work that is free of water.
11. Competent Person means a person so approved by the Central Government, who belongs to a testing establishment in India, possessing adequate qualification, experience and skill for the purpose to testing, examination or annealing and certification of lifting appliances, lifting gear, wire ropes or pressure plant or equipment.
12. Compressed air means air mechanically raised to a pressure higher than atmospheric pressure at sea level.
13. Construction site means any site at which any of the processes or operations related to construction work are carried on.
14. Conveyor means a mechanical device used in construction work for transport of construction material, articles, or packages or solid bulk from one point to another point.



15. Danger means danger of accident or of injury or to health.
16. Dangerous Occurrence means an intended occurrence arising out of failure of structures, heavy equipment resulting in serious destruction in the site whether causing any bodily injury or disability or not.
17. Death means fatality resulting from an accident.
18. Decanting means the rapid decompression of person in a man-lock to atmospheric pressure at sea level followed promptly by their recompression in a decant lock, where they are then decompressed according to the appropriate decompression table in accordance with approved decompression procedures.
19. Demolition work means the work incidental to or connected with the total or partial dismantling or razing of a building or a structure other than a building and includes the removing or dismantling of machines or other equipment.
20. Disabling Injury means an injury causing disablement extending beyond the day of shift on which the accident occurred.
21. Detonator means a small tube of aluminum or copper or other materials approved by Chief Controller of Explosives.
22. Explosive means any substance whether a single chemical compound or a mixture of substances, whether solid or liquid or gaseous, as approved by the Chief Controller of Explosives, used with a view to produce a practical effect by explosion or pyrotechnic effect.
23. Excavation means the removal of earth, rock or other material in connection or demolition work.
24. False works means the structural supports and bracing for formworks or forms.
25. Flashpoint means the minimum liquid temperature at which a spark or flame causes an instantaneous flash in the vapour space above the liquid.
26. Frame or modular scaffold means a scaffold manufactured in such a way that the geometry of the scaffold is pre-determined and the relative spacing of the principal members are fixed.
27. Guardrail means a horizontal rail secured to uprights and erected along the exposed sides of scaffolds, floor openings, runways and gangways to prevent persons from falling.
28. Hazard means danger or potential danger.
29. Hazardous substance means any substance which due to its explosiveness, inflammability, radio-activity, toxic or corrosive properties, or other similar characteristics, may cause injury; or affect adversely the human system, or cause loss of life or damage to property on work-environment, while handling, transporting or storing.
30. High-pressure air means air used to supply power to pneumatic tools and devices.



31. Independent tied scaffold means a scaffold, the working platform O1 which is supported from the base by two or more rows of standards and which apart from the necessary ties stands completely free the building.
32. Ledger means a member spanning horizontally and tying scaffolding longitudinally and which acts as a support for putlogs or transoms.
33. Lifting appliance means a crane, hoist, derrick, winch, gin pole, sheer legs, jack, pulley block or other equipment used for lifting materials, objects or, building worker.
34. Lifting gear means ropes, chains, hooks, slings and other accessories of a lifting appliance.
35. Lock attendant means the person on charge of a man-Lock or medical lock recompression or decompression of persons in such locks.
36. Low pressure air means air supplied to pressurize working chambers and man-Locks and medical locks.
37. Magazine means a place in which explosives are stored or kept, whether above or below ground, as approved by the Chief Controller of Explosives.
38. Man-Lock means any lock, other than a medical lock, used for the compression or decompression of persons entering or leaving a working chamber.
39. Material hoist means a power to manually operated and suspended platform or bucket operating in guide rails and used for raising or lowering material exclusively and operated & controlled from a point outside the conveyance.
40. Materials lock means a chamber through which materials and equipments pass from one air pressure environment into another.
41. Medical lock means a double compartment lock used for the therapeutic recompression and decompression of persons suffering from the ill effects of decompression.
42. National standards mean standards as approved by Bureau of Indian Standards and in the absence of such standards of Bureau of Indian Standards, the standards approved by the Central Government for a specific purpose.
43. Outrigger means a structure projecting beyond the facade of a building with the inner end being anchored and includes a cantilever or other support.
44. Plant or equipment includes any plant, equipment, gear, machinery, apparatus or appliance, or any part thereof.
45. Pressure means air pressure in bars above atmospheric pressure.
46. Pressure plant means the pressure vessel along with its piping and other fittings operated at a pressure greater than the atmospheric pressure.
47. Putlog means a horizontal member on which the board, plank or decking of a working platform are laid.
48. Reportable accident/injury means any injury causing death or disablement to an extent as prescribed by the relevant statute.



49. Responsible person means a person appointed by the employer to be responsible for the performance of specific duty or duties and who has sufficient knowledge and experience and the requisite authority for the proper performance of such duty or duties.
50. Reveal tie means the assembly of a tie tube and a fitting used for tightening a tube between two opposite surfaces.
51. Right angle coupler means a coupler, other than a swivel or putlog coupler, used for connecting tubes at right angles.
52. Rock bolt means a mechanical expansion bolt used with cementitious or resin-anchoring system, which is set in drilled hole in the arch or wall of a tunnel to improve rock competency.
53. Roofing bracket mean a bracket used in sloped roof construction and having sharp points or other means for fastening to prevent slipping.
54. Safety cartridge means a cartridge for small arms having diameter not exceeding 2.5 cms the case of which can be extracted for the small arms after firing and which is so closed as to prevent any explosion in one cartridge being communicated to other cartridges.
55. Safety fuse means a fuse for igniting charges of other explosives which burn and does not explode and which does not contain its own means of ignition.
56. Safety screen means an air and water tight diaphragm placed across the upper part of a compressed air tunnel between the face and bulkhead, in order to prevent flooding the crown of the tunnel between the safety screen and the bulkhead to provide a safe means of refuge and exit from a flooding or flooded tunnel.
57. Safe working load in relation to an article or lifting gear or lifting appliance, means the load, which is the maximum load that may be imposed on such article or appliance with safety in the normal working conditions as assessed and certified by a competent person.
58. Scaffold means any temporarily provided structure on or from which construction workers perform their and any temporarily provided structure which enables workers to obtain access to or which enable materials to be taken to any place at which such work is performed, and includes any working platform, gangway, runway, ladder or step- ladder (other than a ladder or step-ladder which does not form part of such structure) together with any guardrail, toe board or other safeguards and all fixings, but does not include lifting appliance or a lifting machine or to support other plant or equipment.
59. Segment includes a cast iron or precast concrete segmented structure formed to the curvature of the tunnel cross-section and used to support the ground surrounding the tunnel.
60. Service shaft means a shaft for the passage of workers or materials to or from a tunnel under construction.



61. Shaft means an excavation having a longitudinal axis with an angle greater than forty five degree from the horizontal for the passage of workers or materials to or from a tunnel, or leading to an existing tunnel.
62. Shield means a movable frame, which supports the working face or a tunnel and the ground immediately behind it and include equipment designed to excavate and support the excavated areas in tunnel.
63. Sole Plate means member used to distribute the load from the base plate or the standard of wooden scaffolds to the supporting surface.
64. Sound or good construction means construction conforming to the relevant national standards or in case such national standards do not exist, to other generally accepted international engineering standards or code of practices.
65. Standard means a member used as a vertical support or column in the construction of scaffolds which transmits a load to the ground or to the solid construction.
66. Standard safe operating practices means the practice followed in construction activities for the safety and health of workers and safe operation of machineries and equipment used in such activities and such practices conforms to all or any of the following, namely:-
 - i. relevant standards approved by Bureau of Indian Standards;
 - ii. national building code;
 - iii. manufacturer's instruction on safe use of equipment and machinery
 - iv. Code of practice on safety and health in construction industry published by International Labour Organization and amended from time to time.
67. Steel rib includes all steel beams and other structural members shaped to conform to the requirements of a particular tunnel cross section, used for the purpose of supporting and stabilizing the excavated areas.
68. Suspended scaffold means a scaffold suspended by means of ropes or chains and capable of being raised or lowered but does not include a boatswain's chair or similar appliance.
69. Testing establishment means a establishment with testing and examination facilities, as approved by the Central Government for carrying out testing, examination, annealing or similar other test or certification of lifting appliances or lifting gear or wire rope as required under these rules.
70. Tie means an assembly used to connect a scaffold to a rigid anchorage.
71. Toe board means a member fastened above a working platform, access landing, access way, wheel barrow run, ramp or other platform to prevent building workers and materials falling there from.
72. Transom means a member placed horizontally and used to tie transversely one ledger to another, or one standard to another in an independent tile scaffold.
73. Trestle scaffold includes a scaffold in which the supports for the platform are any of the following which are self-supporting, namely: -



- i. Split heads,
 - ii. Folding,
 - iii. Step-Ladder,
 - iv. Tripods, or
 - v. Movable contrivances similar to any of the foregoing.
74. Tubular scaffold means a scaffold constructed from tubes and couplers.
75. Tunnel means a subterranean passage made by excavated beneath the over-burden into which a construction worker enters or is required to enter to work.
76. Underground means any space within the confines of a shaft, tunnel, caisson or cofferdam.
77. Vehicle means a vehicle propelled or driven by mechanical or electrical power and includes a trailer, traction engine, tractor, and road- building machine and transport equipment.
78. Working chamber means the part of construction site where work in a compressed air environment is carried out, but does not include a man-Lock or medical lock.
79. Working platform means a platform, which is used to support building workers or materials and includes a working stage.
80. Working pressure means pressure in a working chamber to which a worker is exposed. Certification of lifting appliances or lifting gear or wire rope as required under these rules.
81. Workplace means all places where construction workers are required to be present or to go for work and which are under the control of an employer.

* * *



Annexure 2

Some Important Indian Standards on Safety

Sr. No.	IS Code	Description
1	IS : 3764	Safety code for excavation work
2	IS : 4014	Code of practice for steel tubular scaffoldings
3	IS : 4081	Safety code for blasting & related drilling operations
4	IS : 4130	Safety code for demolition of buildings
5	IS : 4138	Safety code for working in compressed air
6	IS : 4756	Safety code for tunneling work
7	IS : 4912	Safety requirements for floor and wall openings, railing and toe boards
8	IS : 3696	Code of safety for ladders & scaffoldings
9	IS : 5878 (Part-2/Sec-1)	Precautions for blasting in tunnels & shafts
10	IS : 5878 (Part-2/Sec-2)	Ventilation, lighting, mucking & dewatering in tunnels
11	IS : 807	Code of practice for design, manufacturing, erection & testing of cranes and hoists
12	IS : 5121	Safety code for piling and other deep foundations
13	IS : 5916	Safety code for constructions involving use of hot bituminous materials
14	IS : 7205	Safety code of erection on structural steel work
15	IS : 7293	Safety code for working with construction machinery
16	IS : 7969	Safety code for handling and storage of building materials
17	IS : 8989	Safety code for erection of concrete framed structures
18	IS : 8964	Recommendations for safety conditions for wood working machines - Part 1 to 24
19	SP 53	Safety code for the use, care and protection of hand operated hand tools
20	IS : 13367	Code of practice - Safe use of cranes
21	IS : 9474	Principles of mechanical guarding of machinery
22	IS : 8324	Code of practice for safe use and maintenance of non calibrated round steel lifting chains & slings
23	IS : 2825	Code for unfired pressure vessels
24	IS : 8216	Lift wire ropes, guide for inspection
25	IS : 9944	Recommendations on safe working loads for natural and man-made fiber rope slings.
26	IS : 10291	Safety code for dress divers in civil engineering works
27	IS : 10386 (part-I to X)	Safety code for construction, operation and maintenance of river valley projects
28	IS : 3629	Specifications for structural timber in buildings



Sr. No.	IS Code	Description
29	IS : 3337	Specifications for ballies
30	IS : 13416 (part-I to V)	Recommendations for falling material, hazard prevention, fall preventions, disposal of debris, timber structures, fire protection
31	IS : 8523	Specifications for respirators, canister type gas masks
32	IS : 1991	Safety code for the use, care and protection of abrasive wheels
33	IS : 2148	Flameproof enclosures of electrical apparatus
34	IS : 4051	Code of practice for installation and maintenance of electrical equipment in mines
35	IS : 4357	Methods for stability testing of forklift trucks
36	IS : 5571	Guide for selection of electrical equipment for hazardous areas
37	IS : 6539	Intrinsically safe magnet telephones for use in hazardous atmospheres
38	IS : 8091	Code of safe practice for industrial plant layout
39	IS : 8235	Guide for safety procedures in hand operated hand tools
40	IS : 8241	Methods of marking for identifying electrical equipment for explosive atmospheres
41	IS : 8945	Electrical measuring instruments for explosive gas atmospheres
42	IS : 11016	General and safety requirements for machine tools and their operation
43	IS : 11057	Industrial Safety Nets
44	IS : 11461	Code of practice for compressors safety
45	IS : 2309	Code of practice for the protection of buildings and allied structures against lightning
46	IS : 3043	Code of practice for earthing
47	IS : 5216	Recommendations on safety procedures and practices in electrical works
48	IS : 7689	Guide for control of undesired static electricity
49	IS : 8923	Warning symbol for dangerous voltages
50	IS : 11005	Dust-tight ignition proof enclosures of electrical equipment
51	IS : 6305	Safety code for powered industrial trucks
52	IS : 11006	Flash back arrestor (flame arrestor)
53	IS : 10312	Safety code for powered tow trucks
54	IS : 10311	General requirements for powered platform trucks and their acceptance criteria
55	IS : 7361	Stability tests for pallets stackers and high lift platform trucks (pedestrian and rider controlled)
56	IS : 1260 (part-I)	Pictorial markings for handling and labeling of dangerous goods
57	IS : 1446	Classification of dangerous goods
58	IS : 5931	Handling cryogenic liquids
59	IS : 4607	Classification of hazardous chemicals and chemical products
60	IS : 4015	Guide for handling cases of pesticide poisoning
61	IS : 4155	Glossary of terms relating to chemical and radiation hazards and hazardous chemicals



Sr. No.	IS Code	Description
62	IS : 9964	Recommendations for maintenance and operation of petroleum storage tanks
63	IS : 875	Structural safety of building: Loading standards (part 1-5)
64	IS : 13415	Code of safety for protective barriers in and around building
65	IS : 1905	Structural safety of buildings: Masonry walls
66	IS : 1646	Code of practice for fire safety of buildings (general): Electrical installations
67	IS : 933	Portable chemical fire extinguishers, soda acid type
68	IS : 940	Portable chemical fire extinguisher, water type (gas pressure)
69	IS : 2171	Portable fire extinguishers, DCP (cartridge type)
70	IS : 2190	Code of practice for selection, installations and maintenance of portable first-aid fire extinguisher
71	IS : 2878	Portable fire extinguishers, carbon dioxide type
72	IS : 5490	Refills for portable fire extinguishers and chemical fire engines
73	IS : 10204	Portable fire extinguisher, mechanical foam type
74	IS : 11108	Portable fire extinguishers, Halon 1211 type
75	IS : 2189	Code of practice for selection, installation and maintenance of automatic fire detection and alarm system
76	IS : 1641	Code of practice for fire safety of buildings: General principles and fire grading and classification
77	IS : 1644	Code of practice for fire safety of buildings: personal hazard
78	IS : 2190	Code of practice for selection, installation and maintenance of first aid fire appliances
79	IS : 3016	Code of practice for fire precautions in welding and cutting operations
80	IS : 3034	Code of practice for fire safety in industrial buildings: Electrical generating and distributing stations
81	IS : 5896	Code of practice for selection, operation and maintenance of fire fighting appliances
82	IS : 3594	Code of practice for fire safety of industrial building: General storage and warehousing
83	IS : 9668	Code of practice for provision and maintenance of water supplies for fire fighting
84	IS : 818	Code of practice for safety and health requirements in electric and gas welding and cutting operations
85	IS : 8433	Dissolved acetylene cylinders
86	IS : 3521	Industrial safety belts and harness
87	IS : 4501	Aprons, rubberized, acid and alkali resistant
88	IS : 6153	Protective leather clothing
89	IS : 8095	Accident prevention tags
90	IS : 8519	Guide for selection of industrial safety equipment for body protection
91	IS : 10667	Guide for selection of industrial safety equipment for protection of foot and leg



Sr. No.	IS Code	Description
92	IS : 8520	Guide for selection of industrial safety equipment for eye, face and ear protection
93	IS : 3483	Noise reduction in industrial buildings
94	IS : 7194	Noise exposure during work for hearing conservation purposes, assessment
95	IS : 5182	Air pollution, methods of measurement (Part 1 to 20)
96	IS : 10224	Ergonomic principles in the design of work systems
97	IS : 9457	Code of practice for safety colours and safety signs
98	IS : 8520	Guide for selection of industrial safety equipment for eye, face and ear protection
99	IS : 9167	Ear protectors
100	IS : 1179	Equipment for eye and face protection during welding
101	IS : 5983	Eye-protectors
102	IS : 8521	Industrial safety faceshields: part 1 with plastic visor
103	IS : 8940	Code of practice for maintenance and care of industrial safety equipment for eye and face protection
104	IS : 10592	Industrial emergency showers, eye and face fountains and combination units
105	IS : 1989	Leather safety boots and shoes; part-I for miners & part-II for heavy metal industries
106	IS : 5557	Industrial and safety Rubber knee boots
107	IS : 3976	Safety rubber-canvas boots for miners
108	IS : 10665	Safety rubber ankle boots for miners
109	IS : 2573	Leather gauntlets and mittens
110	IS : 4770	Rubber gloves for electrical purposes
111	IS : 6994	Industrial safety gloves: part-I leather and cotton gloves
112	IS : 8807	Guide for selection of industrial safety equipment for protection of arms and hands
113	IS : 2925	Industrial Safety helmets
114	IS : 4151	Protective helmets for scooter and motorcycle riders
115	IS : 5679	Miner's cap lamps assemblies (incorporating lead-acid batteries)
116	IS : 8522	Respirators, chemical cartridge
117	IS : 8533	Respirators, canister type (gas masks)
118	IS : 9473	Filter type particulate matter respirators
119	IS : 9563	Carbon monoxide filter self-rescuers
120	IS : 9623	Recommendations for the selection, use and maintenance of respiratory protective devices
121	IS : 9937	Portable methanometer (electrical type)
122	IS : 10245	Breathing apparatus: Part-1, closed-circuit breathing apparatus (compressed oxygen cylinder), Part-2, Open circuit breathing apparatus, Part-3, Fresh air hose and compressed air line breathing apparatus, Part-4, Escape breathing apparatus (short duration self contained



Sr. No.	IS Code	Description
		type)
123	IS : 5424	Rubber mats for electrical purposes
124	IS : 6685	Life jackets

* * *