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8 EXPLOSIVE AND BLASTING


8.1 SCOPE OF WORK

- i) The specifications described herein under relate to supply, transportation, handling, storage and use of explosives. All operations shall be carried out by the contractor as per Indian Explosives Act and any other Act, Regulation or Rules concerning storing, handling, safety and use of explosives.
- ii) The contractor shall, in due time, apply for a permit/license which allows him to buy, store and use the explosives required for the works. He shall acquaint himself with all applicable latest laws and regulations concerning storing, handling, safety and use of explosives. The Project Manager may issue modifications, if required and the contractor shall comply with the same without these being made a cause for claim, whatsoever, against the Employer.
- iii) Contractor shall be responsible for non-compliance of provisions of Indian Explosive Act or any other Govt. Rule/Regulation regarding transportation, use and storage of explosives by contractor or his representative. Employer or Project Manager shall not be responsible for such act of contractor or his representative, whatsoever.

8.2 Submittals

- i) At least 60 days prior to the commencement of the excavation Works, the contractor shall submit to the Project Manager for approval, the details relating to transportation, storage and use of materials such as explosives, detonators, fuse coils, tamping materials etc.
- ii) The Project Manager reserves the right to ask any additional information deemed necessary to be included in the submitted documents.

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8.3 Standards

- i) Transportation, handling, storage and use of explosives shall conform to the following Indian Standards (latest revision) or, where not covered by these Standards, to equivalent International Standards:

Act: Indian Explosives Act

IS: 4081 Safety code for blasting and related drilling operation underground excavation in rock.

IS: 6609 Methods of test for commercial blasting explosives and accessories.

IS: 10081 Terms relating to Commercial Explosives, Pyrotechnics and Blasting Practices.

IS: 7526 Detonating fumes-Specification.

IS: 7632 Specification for Detonators.

IS: 5878(Part-II) Code of Practice for Construction of Tunnels –

Part II: Underground Excavation in Rock –

Section 1 Drilling and Blasting

Section 2 Ventilation, Lighting, Mucking and Dewatering

IS: 15447 Commercial blasting explosive Specification-Nitro glycerine based (Part-1)


IS: 14881 Method of blast vibration monitoring-Guidelines.

- ii) In case of conflict between the above standards and the specifications given herein, the specifications shall take precedence.

8.4 Supervision

Before taking up blasting operation, contractor shall carry out studies or get the studies done (through reputed institutions having expertise in the area such as NIRM, CSMRS, CMRI or any other institute of repute as approved by Project Manager, based on actual field trials), covering blasting pattern, minimum safe charge, vibration control/monitoring etc. for various classes of

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rock mass likely to be encountered during HRT and other excavation and submit report to the Project Manager. Such study/report shall have to be got updated/improved periodically during the excavation period.

Excavation by blasting shall be permitted only under the supervision of competent, trained & certified blastman who are fully experienced in the Work and who have received adequate instructions. The contractor shall make sure that his blasting crew is fully conversant with the rules and regulations concerning storing, handling and use of explosives.

8.5 Transportation and Handling

- i) Explosives shall not be transported to the site of operations 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) Suitable explosive vans, duly approved by the Project Manager, shall be used for transportation of explosives and detonators. The following rules shall be observed for use of Explosive Van:
 - a) Detonators and ignitors shall not be carried in the same vehicle with explosives.
 - b) Besides the driver, only one helper shall be accommodated in the explosive van. The vehicle carrying the explosives shall not be used to transport workmen or other materials to workspots although there may be enough space for men or materials.
 - c) Drivers shall not leave the vehicle unattended while transporting explosives.
 - d) All vehicles transporting explosives shall be marked or placarded on both sides and ends with the word 'EXPLOSIVES' in bold


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letters. All explosive boxes shall bear explosive's Lot No., Mfg. Date, Expiry date etc. clearly on them.


- e) A motor vehicle carrying explosives shall not be refuelled except in emergencies and that too only when motor is stopped and other precautions taken to prevent accidents. Such vehicles shall invariably have at least two fire extinguishers placed at convenient points.
- f) Vehicles transporting explosives shall never be taken into a garage, repair shop, parked in congested areas, or in a public garage or similar building.
- g) Explosives shall not be transported on a public highway during hours of darkness except in extreme emergency and that too only with the written approval of the Project Manager.
- h) Explosives shall not be transported in any form of trailer, not shall any trailer be attached to a motor truck or vehicle hauling explosives.
- i) No transfer of explosives from one vehicle to another shall be made on any highway except in case of emergency.
- j) Persons employed in the transport or handling of explosives shall not carry with them or in the vehicles, matches, loaded fire arms, petrol or any flame-producing devices.
- k) All explosives shall be adequately protected against theft. (m) Smoking shall be prohibited during handling and transport of explosives.
- l) The speed of the vehicle shall not exceed 25 km. per hour on rough roads and 40 km. per hour elsewhere.
- m) The interior of the body of the vehicle shall not have any exposed metal parts except those of copper, brass and other non-sparking metals and shall be preferably lined with wood.

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- iv) Motor vehicles used for transporting explosives shall be carefully inspected daily to ensure that:
 - n) Filled and serviceable fire extinguishers are in position;
 - o) The electric wiring is well insulated and firmly secured;
 - p) Chassis, engine and body are clean and free from surplus oil and grease;
 - q) Fuel tank and feed lines are not leaking;
 - r) Lights, brakes and steering mechanism are in good working order; and
 - s) Vehicle is in proper condition in all respects for the safe transportation of explosives.
- v) Boxes of explosives shall not be handled roughly or allowed to fall.
- vi) Containers of explosives shall be opened only by means of non-sparking tools or instruments.
- vii) 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.
- viii) Containers for detonators shall always be used only for storing detonators.
- ix) Explosives and detonators shall be carried in separate containers.
- x) The driver of the vehicle carrying explosives shall be trained in use of fire extinguishers on his vehicle.
- xi) If any fire occurs on a vehicle carrying explosives, the driver shall take all practicable steps to ensure that all other traffic is stopped at least 300 m from the vehicle and that all persons in the vicinity are warned of the danger.
- xii) Loading, unloading and handling of explosives shall be supervised by qualified personnel. At the time of loading or unloading of explosives, no electric switch shall be operated.

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- xiii) Explosives shall not be placed where these may be exposed to flame, excessive heat, sparks or impact.
- xiv) 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.
- xv) Explosives shall not be carried in the pockets or folds of clothing by any person.
- xvi) Primers shall not be made up in a magazine, or near excessive quantity of explosives, or in excess of immediate needs.
- xvii) Nothing shall be inserted in the open end of a blasting cap except fuses.
- xviii) 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.
- xix) No attempt shall be made to soften hard set explosives by heating over a fire or by rolling the explosive on the ground.
- xx) 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.
- xxi) 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 for this.
- xxii) The contractor shall make all necessary arrangements for the security of the explosives during transportation. However, the Project Manager, upon a request by the contractor, may arrange protection by the Govt. security forces for large quantities of explosives.

8.6 **Storage**


- i) The contractor shall provide/arrange a magazine of approved type for storing the explosives at a suitable and safe place.

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- ii) The magazine shall, at all times, be kept scrupulously clean. High explosives like dynamite shall be stored in a dry, clean, well-ventilated and fire-proof building constructed in accordance with the Indian Explosives Act, on an isolated Site. The area around the magazine for a distance of 8 m 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 to prevent loss or theft of explosives.
- iii) Explosives, detonators and fuse coils shall be stored separately.
- iv) The contractor shall maintain a record of storage and withdrawal of all explosives. This record shall be made available to the Project Manager or concerned government authorities. The Project Manager and concerned government authorities shall be promptly notified of any loss or theft of explosives.
- v) Explosives shall be stored and used chronologically to ensure that the ones received earlier are used first. There shall be sufficient space between the stacks.
- vi) A “make up house” shall be provided at each working place in which cartridges shall be made up by experienced men as required
- vii) Unauthorized persons shall not be allowed at any time to enter the magazine.
- viii) The person-in-charge of the magazine shall, at all times, ensure that the magazine is well and securely locked.
- ix) The magazine, on no account, is to be opened during or on the approach of a thunderstorm and no person shall remain in the vicinity of the magazine during such storm. Sufficient number of lightning conductors shall be provided on top of the magazine.
- x) Magazine shoes, without nails, shall be kept at all times in the magazine, and a wood tub or cement trough, about 30 cms high and 45 cms in diameter, filled with water shall be fixed near the doors of the magazine.

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- xi) (xi) Persons entering the magazine shall 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.
- xii) 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.
- xiii) A brush or broom shall 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.
- xiv) No matches shall be allowed in a magazine.
- xv) No person having articles of steel or iron on him shall be allowed to enter a magazine.
- xvi) Oily cotton rags, cotton waste and articles liable to spontaneous ignition shall not be taken into a magazine.
- xvii) No tools or implements other than those of copper, brass, gun metal or wood shall be allowed inside the magazine. Tools shall only be used with great gentleness and care.
- xviii) Boxes or explosives shall not be thrown down or dragged along the floor and shall be stacked on wooden trestles. Where there are white ants, the legs of the trestles shall rest in shallow copper, lead or brass bowls, containing water.
- xix) Packages containing explosives shall not be allowed to remain in the sun.
- xx) Empty boxes shall not be stored in the magazine nor let any packing material lie loose.
- xxi) Blasting caps and electric blasting caps shall never be stored in the same box, magazine or building with other explosives.
- xxii) The following shall be hung 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 lightning conductor.

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xxiii) Adequate fire fighting equipment shall be provided in the magazine.

xxiv) Signboards reading “DANGER HIGH EXPLOSIVES”, “PROTECTED AREA”, “NO SMOKING” etc. shall be conspicuously displayed in front of the magazine.

xxv) If nitro-glycerine from deteriorated explosives has leaked down onto the floor of explosive magazine, the floor shall be desensitized by washing thoroughly with an agent obtained before hand from the supplier of explosives. For this purpose, desensitizing agents and the instructions for using them shall always be obtained alongwith the supply of nitroglycerine.

xxvi) No explosives shall be stored in the tunnels, galleries, caverns or shafts.


8.7 Disposal of Deteriorated Explosives

All deteriorated explosives shall be disposed off in an approved manner. The quantity of deteriorated explosives, to be disposed off, shall be intimated to the Project Manager and appropriate government authority prior to its disposal.

8.8 Drilling

- i) The position of all holes to be drilled shall be marked out with paint.
- ii) All holes shall be of greater diameter than the diameter of the cartridges of explosives used.
- iii) Loading and drilling shall not be carried out at the same time in the same area.
- iv) A drill, bit, or pore shall not be inserted in butts of old holes even if examination fails to disclose explosives.
- v) Drilling shall not be resumed after blasts had been fired until a thorough examination has been made to make sure that there are no unexploded charges which the drills may strike.
- vi) Drilling shall not be started until all remaining butts of old holes are examined for unexploded charges.

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- vii) Rock drillers shall be provided with approved respirators in siliceous dusty atmosphere arising out of drilling operations.

8.9 Loading/Charging

- i) The holes shall be cleared of all debris before a cartridge is inserted.
- ii) In loading the holes, tamping shall be done with a wooden mallet having no exposed metal parts.
- iii) Primed cartridges shall be seated by even steady pressure only.
- iv) All loaded holes or charges shall be checked and definitely located before firing.
- v) When holes are sprung, ample time shall be left between spring shots for the holes to cool, and also between the last springing shot and the loading of the main charge.
- vi) When practicable, no more cartridges shall be primed than are required for a round of blasting.
- vii) Detonators shall be inserted only in a hole in the end of a cartridge prepared specially for that purpose.
- viii) Holes in cartridges shall be made with a sharpened wooden stick.
- ix) All charges, before being fired, shall be covered with blasting mats where blasting is done in the vicinity of structures likely to be injured by flying debris.
- x) Detonating cord shall be cut from supply reel before attaching to explosive or tamping in hole. Use of the short pieces of fuse shall be prohibited for detonation purpose.
- xi) No welding shall be done inside the tunnel/cavity at the time of loading of the face, till the blast has been taken.
- xii) Naked flames and lamps shall be kept away at the time of the loading of holes.
- xiii) Such of the electrical lines as could constitute danger for Work of loading/charging shall be removed from the Site.

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- xiv) Highly insensitive caps shall be used in case parasite electric current are anticipated within the ground and if lightning is frequent.

8.10 Type of Explosives & Accessories


8.10.1 Explosives

- i) Explosives, banned/restricted in any form by the Govt. of India shall not be used for the purpose for blasting.
- ii) Only class-2 explosive shall be used. These explosives shall be of safe to handle and use, exhibit water resistance and liberate low volumes of noxious gases.
- iii) Manual Mixing of chemicals to form any explosives shall not take place and such explosives shall not be used.
- iv) Any Explosives having shelf life less than 6 months shall not be used.
- v) Explosives being used shall be capable of performing in low temperatures.

8.10.2 Detonators

- i) Priming of the explosives shall be done only with Non-electric detonators with shock tube containing fine spray of around 13-16 mg/m HMX/AL powder.
- ii) The detonators shall be truly Non-electric in nature.
- iii) The shock tube shall be of the nature that the color of the tube remains unchanged post blast and can be located easily for misfires etc.
- iv) Identification tag and J-hook shall be placed at the end of the tube for identification and easy connectivity respectively.
- v) Ultrasonic seal shall be provided at the end of the tube to make it water proof.
- vi) Shelf life of the detonators shall be a minimum of 1 year.

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- vii) Non-electric detonators shall be safe against stray currents, static electricity, Radio-frequency energies and accidental initiation by impact, shock, friction and time as per the standards fixed by the appropriate authority.
- viii) The delay range of detonators should comprise of a minimum 0-15 delays firing completely in not less than 8000 ms for long period detonators.
- ix) Short delay series shall contain a nominal delay interval of 25 ms.
- x) Electric detonators shall not be used except for the initiation of Detonating Fuse.


8.10.3 Detonating Fuse/Safety Fuse

- i) Detonating Fuse shall be used for connecting Non-electric detonators.
- ii) Nominal Weight of PETN shall be 10 gm/m.
- iii) Detonating Fuse shall be able to get initiated by no. 6 detonators.
- iv) Water resistance shall be excellent.
- v) Safety fuse shall be used only to initiate the plain detonators.

8.11 Wiring

- i) All electric caps in a blast shall be of the same manufacture.
- ii) Each electric blasting cap shall be tested with an approved galvanometer before and after tamping in a hole to determine whether it will carry the current. All testing shall be done away from the heading face.
- iii) After testing the leg wires of electric blasting caps, they shall be short circuited by twisting the bare ends together and shall remain so twisted until ready to be connected into the circuit prior to connecting to the firing line.
- iv) Unless, the power supply is heavy, it is recommended that all electric blasting caps shall be wired in series and the firing line shall not be smaller than No.14B and S-gauge copper wire.

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- v) The number of electric blasting caps used in a circuit shall not exceed the tested capacity of the blasting machine.
- vi) The circuit, including all caps, shall be tested with a circuit tester or galvanometer, operating accurately, before being connected to the firing line.
- vii) Cartridges shall not be primed nor holes loaded during the approach of a thunderstorm or while it is in progress. If a charge has been primed or holes loaded, every person shall be ordered to a safe distance until the storm is over.
- viii) Blasting circuit wires shall never touch other wires carrying electric current.
- ix) Blasting operation control shall consist of two switches, a safety switch and a firing switch located at least 2 meters apart, the connection between the switches to be made by a 'Plug-in' jumper which may be permanently attached to the safety switch. The 'Plug-in' jumper is so made that it cannot be plugged into or connected to the firing switch until the firing switch is unlocked, and the jumper must be disconnected from the firing switch before the firing switch can be locked.
- x) Both the safety switch and the firing switch shall be of the locking, double pole, double throw type which, when opened and locked in downward position short circuit and ground the leading wires.
- xi) Both the switches shall be locked immediately after firing the shot and before any person is allowed to return to the area. Keys to the switches shall remain in the possession of the starter at all times.

8.12 **Fuse Blasting**

- i) The length of fuse to be used in blasting shall in no case, be less than 75 cm or that required by the Project Manager.
- ii) Blasters or shot firers shall be cautioned always to use sufficient lengths of fuse to permit them to reach a safe place before the first hole is fired.

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- iii) Not more than 12 holes shall be loaded and shot at one time if cap and fuse are used to detonate the charge.
- iv) Mud cap blasting being insufficient and dangerous shall be avoided. Two or more mud caps shall not be placed on one rock except when electrically detonated.

8.13 Firing

- i) Shots shall, so far as practicable, be fired electrically and only apparatus especially designed for the purpose shall be used. Power lines shall not be tapped for the purpose. No shot shall be fired except by a licentiate blaster authorized by the Project Manager.
- ii) The charge shall be fired, successively and not simultaneously.
- iii) Prior to the firing of a shot, all persons in the blasting area shall be warned of the blast and ordered to a safe distance from the area.
- iv) Competent flagmen, equipped with red flags and whistles shall be posted to stop traffic at access points on each possible route of travel, to the vicinity of the blasting area.
- v) Blasting shall be done at fixed hours approved by the Project Manager and the blasting times shall be displayed on a Notice-Board.
- vi) Order to fire shall be given only by the Supervisor-in-Charge of the work after giving three warning signals to enable all the workmen to reach safe shelters.
- vii) Blasts shall not be fired until it is absolutely certain that every person has retreated to a safe distance.
- viii) The person-in-charge of blasting shall be the last one to leave the area to be blasted.
- ix) A siren with a distinctive note shall be used to give warning signals. This bugle shall not be used for any other purpose. All the labour shall be made acquainted with the sound of the bugle and shall be strictly warned to leave their Sites of Work immediately for safe shelters at


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the first warning signal and not to leave the shelters till all clear signal has been given.

- x) An all clear signal shall be given when the blasting is over.
- xi) Definite places of shelter, natural or artificially constructed, shall be assigned to the crew. Workers shall be made to go to these shelters rather than trust each other's judgment about a safe place.
- xii) In special cases, suitable extra precautions shall be taken. The Project Manager may, however, permit blasting for underground excavation without restriction of fixed time provided he is satisfied that proper precautions are being taken and that the Work of other agencies on the Site is not unduly hampered.
- xiii) Only Supervisor-in-Charge shall be responsible for the safe custody of the firing apparatus.
- xiv) For blasts in series, only detonators of the same brand and same electrical resistance shall be used. All detonators shall be checked before use.
- xv) The firing cables shall be with a proper insulating cover to avoid short circuiting due to coming in contact with water, metallic parts or rock.
- xvi) Use of earth as a return line shall not be permitted.
- xvii) The firing cable shall be connected to the source of current only when nobody is in the area of blasting.
- xviii) Mats or rubber tyres tied together with rope shall be used as protection from flying debris to cover the charges where blasting may expose persons or property to injury or damage.
- xix) Blasting shall be permitted only after adequate provisions have been made for the protection of persons, the Works, and public and private property. The Project Manager's approval of any of the contractor's blasting operations shall not relieve the contractor of his sole responsibility for the safety of persons and property. Any damage done to the works or property shall be repaired by the contractor.

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8.14 Inspection after Blasting (Misfire Drill)

- i) Immediately after a blast has been fired, the firing line shall be disconnected from the blasting or other source of power.
- ii) After a blast has been fired, a careful inspection shall be made by the blaster to determine if all charges have been exploded. The blaster shall count the number of the exploding shots in blasting. Misfires in fuse blasting shall not be examined for a sufficient time after its failure to explode.
- iii) 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.
- iv) All wires shall be carefully traced and search made for any unexploded cartridges by the person-in-charge of the blasting operation.
- v) 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.

8.15 Misfires

- i) Misfired holes shall be placed in the charge of a competent person.
- ii) If broken wires, faulty connections, or short circuits are determined as the cause of a misfire, 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 so fired when the burden has been dangerously weakened by other shots.
- iii) The charge of explosives from a misfired hole shall not be drilled, bored or picked out.
- iv) Misfired charges tamped with solid material shall be detonated by the following method:

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- a) Float out the stemming by use of a water or air jet from hose until hole has been opened to within 60 cm of charge;
 - b) Water shall be siphoned off or pumped out;
 - c) New charge shall be placed and detonated.
- v) Whenever this method is not practicable, then a new parallel hole, not nearer than 60 cms, shall be drilled, loaded and detonated. A careful search shall be made of unexploded material in the debris of the second stage.
- vi) If misfire has been found to be due to defective detonators or dynamite, whole quantity or box from which the defective article was taken must be withdrawn from the work site for return to the manufacturer or destruction as decided by the Project Manager.
- vii) The contractor shall report, in writing, to the Project Manager, all cases of misfire, causes of the same and steps taken in connection therewith.

8.16 Blasting for Underground Works

- i) Only electric blasting shall be adopted for tunnel and underground cavities.
- ii) A separate circuit, independent of power and light circuit, shall be used for blasting.
- iii) No electrically energized circuit shall be installed on the same side of the tunnel, or cavity with the blasting circuits.
- iv) All electric lights or other energized circuits shall be disconnected for at least 70 meters from the point of loading.
- v) All tracks, airlines and vent pipes shall be kept properly grounded.
- vi) For loading purposes, the employees shall be equipped with permissible battery lamps.
- vii) (vii) Switches shall be as specified in Para-4.11(ix) hereof. The safety switch and the firing switch shall be placed on opposite sides of the tunnel/cavity.

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- viii) Only explosives which produce less than 0.005 m³ of poisonous gas (Carbon monoxide and Hydrogen sulphide) per 31.5 mm x 200 mm cartridge shall be used for Underground Works.
- ix) No fire, flame, smoking or open lights shall be allowed within 6 metres from any explosive except for the purpose of firing a charge.
- x) Adequate warning notices shall be given to all persons employed indicating the period of danger at the time of firing and it shall be the duty of the contractor to provide adequate shelters or screens for protection of workers exposed to risk of injury from the explosion or from flying material.
- xi) After the blast takes place in underground works the workmen shall not be allowed to go to the face till all the toxic gases are evacuated from the face.

8.17 Underwater Blasting


- i) Only water resistant blasting caps and detonating cords shall be used in underwater blasting operations.
- ii) (ii) Loading tubes and casings of dissimilar metals shall not be permitted because of possible electrical transient current from galvanic action.
- iii) When more than one charge is placed underwater, a float device shall be attached to an element of each charge in such manner that it will be released by the firing.
- iv) No drilling, digging or excavation shall be permitted until all misfires have detonated or the explosives are removed from the missed holes.

8.18 Monitoring of Blasts

8.18.1 General

- i) The contractor shall supply and operate Seismometer or Seismograph approved by Project Manager at each blasting site to measure 3-components of ground vibration and air blast overpressure. The


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equipment shall have sufficient memory space to store at least 300 events and shall be equipped to measure wide range of ground vibration and airblast overpressure. It shall also be equipped with a microphone attachment, permanent paper trace output with built-in strip chart printer, LCD display and PC retrieval attachment for data to be used as and where directed by Project Manager to monitor blasting work.

- ii) Unless otherwise agreed in writing by Project Manager, trial blasts, initial blasting in general, initial blasts in new areas and blasts adjacent to completed concrete structures and sensitive areas shall be monitored. For structures in the proximity of blasting the peak particle velocity shall be measured at the locations immediately adjacent to the structure nearest to the face being stated or another location where it is necessary to limit vibration. Apart from monitoring on its own the contractor has to provide supports for measurement to other agencies appointed by Project Manager. In tunnel excavation, monitoring shall specially be undertaken with change in rock mass, in shallow cover zone and or as directed by Project Manager.
- iii) The measured vibration results shall be transmitted to Project Manager together with all the useful information concerning the completed information (cut of the face/slope or the cutting face; particle size distribution of the excavated material etc.; drill marks; vibration wave form in three directions-radial, transverse & vertical; air overpressure waveform; print out of Peak Particle Velocity (PPV) and associated predominant frequency in each direction).
- iv) Assistance shall be taken from blasting consultants/experts as specified in Quality Manual document.
- v) In case the defined thresholds be exceeded, blasting operations shall be stopped in order to finalize the new blasting pattern or the choice of another methods of proceeding with the excavations.

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- vi) In general the methods, parameters to be measured and equipment for measurement of vibration shall be in accordance with IS: 14881 unless otherwise specified.

8.18.2 Restriction of Blasting

All blasting works shall be completed before pouring the first structural concrete, unless otherwise specifically agreed by Project Manager in writing. When excavation are carried out using explosives, the contractor shall arrange his excavation and concrete placing programmed so that, as far as practicable, it shall not be necessary to use explosives close to permanent construction.

The contractor shall be responsible for avoiding damage to adjacent structures from fly rock by erecting barricades and/or the use of blast mats or other means by installing shielding device acceptable to Project Manager.


The maximum allowable limit of noise overpressure in blasting shall not exceed 133 dB. It must be measured close to the structure to be protected from blasting.

Ground vibration induced by blasting shall be measured in terms of the Maximum or Peak Particle Velocity (PPV) in mm/sec and predominant frequency of the ground vibration.

The following limits on peak particle velocity are given as a guide and may be modified by Project Manager on the basis of seismograph records and observations during the progress of works.

- i) For structures concreted less than 60 hours before, the peak particle velocity shall not exceed 10mm/second or else no blasting shall be authorized within 30 metres of concrete in place.
- ii) For structures concreted more than 60 hours before, the peak particle velocity shall not exceed 50 mm /second for soil weathered and soft rock and 70 mm /second for hard rock measured at the surface of the material concerned
- iii) For existing structures adjacent to excavation areas, including structures of following types

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- Not forming part of the contract
- belonging to owner and
- not belonging to owner,

the frequency and peak particle velocity dependent safety criteria as per Director General of Mines Safety(DGMS) criteria shall be followed.

- iv) Project Manager may request to limit particle velocity at 10mm / second for high structures, even if they were concreted more than 60 hours ago.

Where circumstances dictate, such as when blasting adjacent to partially cured concrete, the peak particle velocity permitted be reduced by Project Manager.

For specific structures and if requested by Project Manager, the contractor shall fulfil the following criteria:


- at a 20 m radius of the blast, the interstitial velocity, for frequencies inferior to 100 Hertz, shall be limited to 4 centimetres per second (40 mm/sec),
- after blasting, 80% of the bore holes must be visible.
- pre-splitting is mandatory,
- bore holes space is 45 cm maximum

If necessary, Project Manager may require the contractor to restore at his own expense any building, structure, masonry and equipment damaged by blasting, through direct or indirect effects.

8.18.3 Recording Blasting Operations

The contractor shall keep records of all blasting carried out showing the time and location of each blast, the type and amount of explosive used, together with any other relevant data in an agreed format approved by Project Manager.

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During the site works, as mentioned before each blasting pattern shall be submitted to Project Manager for approval at least 24 hours before the blasting operation is due to begin. This shall be in the form of a presentation sheet setting out all the information concerning:

- the type(s) of explosives to be used
- the x,y,z coordinates of each firing holes and the firing polygonal
- the diameter, depth, charge and the packing of each hole
- the method of ignition and the type of detonator for each charge,
- if using a sequential exploder, the connection of the different lines and a plan showing the effective delays of the charges,
- the total quantity of explosives for the firing or the round.

At all times, Project Manager shall be able to interrupt the explosive operation or request the contractor to modify to the blasting patterns and the responsibility and the costs to be borne by the contractor.

8.19 Measurement and Payments

- i) No separate payment shall be made for furnishing safe blast reports & their time to time updation from reputed institution as approved by Project Manager, supply of blasting material, its safe storage, drilling of holes, loading of blasting material, all blasting operations including monitoring etc. which is deemed to be included in the Unit Rate of excavation and other relevant items.
- ii) Any repair work or any indemnities required due to contractor's noncompliance with the safety requirements shall be at the contractor's expense.
- iii) No separate measurement/payment shall be made due to use of extra explosive on account of change in rock type.

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