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Sub: Standards and Safety Provisions of Diesel Equipment for using in belowground coal and metalliferous mines.

1.0 General design and Construction

Every diesel equipment to be used in underground mines shall be of good construction, suitable material, of adequate strength, free from visible defect and shall be properly maintained. The diesel equipment and each accessories thereof, except the tyres (which shall be of anti-static material), shall so far as is practicable be constructed of non-inflammable material and any inflammable material, if used, shall be shrouded with a substantial non-inflammable covering.

1.1 Ergonomic and anthropometric requirements for operator and passenger compartments in the diesel equipment

- 1.1.1 All diesel operated equipment shall be provided with cabin/canopy for operator, of sound construction, suitable material and adequate strength. Such operator cabin shall be provided with 'Falling Object Protective Structure' (FOPS) and "Roll Over Protective Structure" (ROPS) in accordance with ISO – 3449:2005 and ISO – 3471:2008 respectively or its revised versions or any internationally accepted standards.
- 1.1.2 Passengers' compartment shall be of sound construction, suitable material and adequate strength so that the passengers would not be injured in case of dangerous occurrence or accident.
- 1.1.3 Protection shall be provided to avoid possible ingress of material/objects from the surroundings of the equipment into the operator's and passengers' compartments.
- 1.1.4 Safe access to the operator and passenger compartments shall be provided. The entrance to any compartment shall be designed to prevent personnel being thrown - out of the equipment.
- 1.1.5 All diesel operated equipment with closed cabin shall be provided with an emergency exit.
- 1.1.6 The operator and passengers compartments shall be designed to prevent any part of a person's body projecting outside the envelope of the compartment, or coming into accidental contact with the roof, side of the roadway or with moving parts of the equipment.
- 1.1.7 The design of the operator's space must allow for free movement and comfortable operating postures for the operator. Any manoeuvres necessary for the operation of the equipment should be able to be performed safely and without fatigue or discomfort. Sufficient leg space both vertically and horizontally is essential for comfort and safety in the operation of foot controls.
- 1.1.8 The operator seat shall be ergonomically designed to permit safe operation. The design of the seat (s) shall have provision for horizontal, vertical and/or swivel adjustment to accommodate operator(s). Compartment space shall be sufficient to allow for the full range of adjustment required to operate the equipment safely and comfortably. The seat(s) shall be covered and padded so as to minimise discomfort.
- 1.1.9 The seat and its suspension shall be so designed to reduce vibration transmitted to the operator to the lowest level that can be reasonably achieved.

1.1.10 Seat belt(s) shall be fitted to every operator and passenger's compartment of the equipment.

1.2 Noise: The operator and passengers shall not be exposed to noise level that exceeds an eight hour equivalent continuous sound pressure level of 85 dB(A) and wherever it exceeds 85 dB(A), Personnel Protection Equipment (PPE) of adequate strength shall be used by the operators and passengers.

1.3 Visibility: The operator's field of view shall comply with the acceptance criteria specified in ISO 5006.3:2006 when tested in accordance with ISO 5006.1:2006 and evaluated in accordance with ISO 5006.2:2006 or its revised versions or any internationally accepted standards.

1.4 Vibration: The vibration exposure limits of the operator and passengers shall comply with the acceptance criteria specified in ISO 2631:2014 or its revised version or any internationally accepted standards.

1.5 Controls and display system at operator cabin

1.5.1 Controls shall be laid out and designed to allow easy and safe operation based on the principle that a given direction of movement of any control produces a consistent and expected effect. The surfaces of frequently used pedals shall be fitted with skid resistant type materials.

1.5.2 Marking of all controls shall be indelible and illuminated to enable the operator to see gauges necessary for safe driving without the use of a cap lamp.

1.5.3 The distance between control levers, adjacent foot pedals, knobs, handles, operator's body and other machine parts shall be sufficient to allow unhindered operation without unintentional actuation of adjacent controls.

1.5.4 The controls shall be of suitable design and construction and arranged so that they are able to be operated with ease from the operator's seat and within the operator's force limits.

1.6 Guards and Shields

1.6.1 Shields shall be fitted to all vital components of the equipment to prevent its damage.

1.6.2 Guards or shields shall be provided in the vicinity of exhaust and turbocharger to prevent fuel or oil spraying on hot surfaces.

1.6.3 All dangerously exposed moving parts of the equipment shall be provided with suitable guards of substantial construction to prevent injury to personnel.

1.6.4 All pipes and hoses of fuel oil and lubricants shall be covered so that oil from any leakage cannot contact any exposed metal surface where the temperature exceeds 120°C under any condition of the equipment.

2.0 General safety provisions

2.1 Braking system

2.1.1 Efficient braking systems shall be provided for every movable equipment.

2.1.2 The following brakes shall be provided in the every equipment conforming to the standard ISO 3450: 2011 or its revised version or any internationally accepted standards:

- a) Service brake - to be used as the primary braking system during normal operation of the equipment.
- b) Emergency brake - to be applied by the operator in the event of a failure of the service brake.
- c) Parking brake - used to prevent movement of stationary equipment.

Provided that at least one of the brakes shall be "fail safe", i.e. the spring applied-hydraulically released (SAHR).

2.1.3 The brakes should be activated automatically if:

- a) Cabin door is not fully closed, if door is provided
- b) Engine oil pressure is low,
- c) Hydraulic brake pressure is low,
- d) Steering control valve fault is active, if provided
- e) Engine is shut down, and
- f) Whenever transmission comes to neutral position inadvertently.

2.2 Warning Devices

2.2.1 All diesel equipments shall have an audio warning device of giving adequate audible warning signal and provided at suitable location conveniently near to the operator.

2.2.2 All equipments shall be fitted with suitable pre-start warning alarm. A mechanically operated device, like gong hammers, of giving adequately audible warning signal, in addition to any other type of horn, shall be provided.

2.2.3 All equipments shall be fitted with audio visual alarm (AVA). In case of coal mines, the AVA shall conform to DGMS Tech. Circular (Electrical) Approval No. 21, dated 05.10.2015 or its revised version.

2.2.4 A warning device shall be provided in the operator's cabin, to indicate when the rear dump body is elevated.

2.2.5 In case of lifting equipment, audio warning device shall be provided to give warning during lifting and lowering of platform.

2.3 Lighting

2.3.1 Efficient and suitable headlights capable of showing any obstruction in the roadway atleast upto 60m away from the equipment shall be provided.

2.3.2 A suitable cabin light shall be provided, so that all controls and instruments are visible to the operator.

2.3.3 A cap lamp shall be provided in the operator's cabin for emergency.

2.3.4 Equipment normally operated in both directions shall be equipped with headlights for both directions. The reversing lights shall get switched ON automatically when the equipment engages in reverse gear.

2.3.5 Red Retro- Reflective Reflectors shall be provided on four sides of the equipment at suitable positions.

2.4 Fire Suppression system

- 2.4.1 All Diesel operated equipment shall be provided with suitable type of Automatic Fire Detection and Suppression System conforming to DGMS (Approval) circular. No.02 of 2013 or its revised version.
- 2.4.2 The fire suppression system shall provide automatic fire detection and suppression for all the following parts of the equipment:
 - (a) The engine, transmission, hydraulic pumps and tanks, fuel tanks, exposed brake units, air compressors and battery areas, as applicable, on all diesel-powered equipment; and
 - (b) Fuel containers and electric panels or controls used during fuel transfer operations on fuel transportation units.
- 2.4.3 The fire suppression system shall include a fire alarm and system fault annunciator that can be seen and heard by the equipment operator.
- 2.4.4 The fire suppression system shall provide for automatic engine shutdown when the alarm alerts the operator. Engine shutdown and discharge of suppressant agent may be delayed for a maximum of fifteen seconds after the fire alarm annunciator alerts the operator.
- 2.4.5 Manual actuators: At least two manual actuators shall be provided with at least one manual actuator at each end of the equipment. If the equipment is provided with an operator's compartment, one of the manual actuators shall be located in the compartment within easy reach of the operator. For stationary equipment, the two manual actuators shall be located with at least one actuator on the stationary equipment and at least one actuator at a safe distance away from the equipment, and in intake air.

2.5 Control devices and instruments

Every equipment shall be provided with the following control devices and instruments including gauges for safe operation. The controls shall be arranged in the operator cabin so as to be within easy reach of the operator from his operating position.

2.5.1 Controls

- a) Engine throttle control.
- b) Engine start-stop control.
- c) Forward-reverse control.
- d) Brake controls including emergency brake.
- e) Emergency stop function.

2.5.2 Instruments and gauges

- a) Engine hour meter
- b) Engine lube oil pressure gauge
- c) Engine coolant temperature gauge
- d) Fuel level indicator
- e) Transmission oil temperature gauge
- f) Transmission oil pressure gauge
- g) Hydraulic oil temperature gauge
- h) Exhaust outlet temperature gauge (for equipment used in coal mines)
- i) Air pressure gauge for brake system, wherever applicable
- j) Filter clog indicators for air and oils

- k) Engine RPM meter
- l) Audio-visual signals or panel lights for:
 - i. Low engine oil pressure
 - ii. Coolant temperature high

2.6 Electrical safety provisions

The following safety provisions shall be provided in all Diesel equipments:

- 2.6.1 All electrical components and accessories shall be Flame proof/Intrinsically safe or both conforming to relevant IS/ IEC standards for use in below ground coal mines.
- 2.6.2 Suitable Ingress Protection shall be provided to prevent ingress of dust and water/ moisture entering into the interior of the electrical apparatus.
- 2.6.3 The circuit voltage for remote control and electrical interlocking of apparatus shall not exceed 30 Volts.
- 2.6.4 Necessary protection against over-current and short circuit shall be provided in all electrical circuits/individual apparatus.
- 2.6.5 All cables shall comply to the provisions of the DGMS Tech. Circular (Electrical) No. 12, dated 25.05.2015 and corrigendum issued vide DGMS Tech. Circular (Electrical) Approval No. 01, dated 19.02.2016 in addition to the special requirement, if any, specifically for safe operation of the equipment or its revised version, for use in below ground coal mines.
- 2.6.6 Strapping of electrical harnesses to hydraulic and fuel lines is not permitted.
- 2.6.7 The battery shall be housed in a compartment that provides adequate clearance between the battery terminals and any lid. The cover provided over battery terminals shall be insulated underside. Battery compartments shall be properly ventilated and located so that it does not form part of an access pathway or platform during maintenance.
- 2.6.8 Equipment shall be provided with a clearly identified lockable isolation switch as close to the battery as practicable, which shall isolate the battery and shut down the engine when switched off as required under DGMS Circular No. 2 of 2017, dated 15.6.2017, issued on "Lock out and Tag out- energy shut down procedures".
- 2.6.9 To avoid risk of ignition due to electrostatic charge during use, maintenance or cleaning of the equipment, the selection of material and area of exposure shall be within the limits as per the relevant recommendations, such as ISO 10605:2008.
- 2.6.10 No part of the equipment/machine shall be made of light metals or its alloys which causes incendive sparking due to impact or friction.

2.7 Additional safety provisions for all tyre mounted equipments

- 2.7.1 Articulation safety lock shall be provided in articulated steering equipment. All articulated equipment shall be equipped with a safety bar or a device which can readily be fitted without special tools to prevent movement of the articulation joint during maintenance work in the vicinity of this joint.
- 2.7.2 Load locking valve/hose fail check valve shall be provided on all lifting cylinders to keep Bucket/dump body/lifting platform or any other lifted object stationary in the event of pressure loss of hydraulic oil. During maintenance underneath the extended cylinder, an additional mechanical locking device shall be provided.

- 2.7.3 There shall be provision for installing wheel chocks on the equipment.
- 2.7.4 Every equipment shall be provided with emergency steering, which can allow the operator to safely steer the equipment in case of emergency.
- 2.7.5 Towing arrangements of equipment
- a) The following arrangements shall be provided for towing of the equipment in case of the equipment is inoperable/breakdown:
 - i. a suitable rigid towing points on both sides, i.e. front and rear
 - ii. a means of releasing emergency brakes.
 - iii. a means of steering or guiding the equipment.
 - b) The equipment towing attachment including coupling pins and other associated components shall be designed and tested to a minimum factor of safety 3 (three) times the maximum tractive effort of the equipment.
- 2.7.6 Wheel rims shall be of heavy duty to operate equipment on the uneven load conditions, rough roads and corrosive environment present in mines.
- 2.7.7 Pressure check points shall be provided to measure brake system pressure in case of hydro-static braking.
- 2.7.8 Brake operation indication lights shall be provided at suitable locations.

2.8 Additional safety provisions for Personnel Carriers

- 2.8.1 Personnel carriers shall be equipped with emergency buzzer in the personnel compartment in order to warn the operator to stop the equipment in case of emergency. The buzzer shall give audible alarm in the operator cabin.
- 2.8.2 The Personnel carrier shall be provided with downhill, uphill, neutral and/or hydrostatic braking system.
- 2.8.3 Deadman's control switch shall be provided in the operator's cabin to automatically shutdown the equipment, if the operator becomes incapacitated.
- 2.8.4 Steps, rungs, ladders, platforms and walkways shall be provided with non-slip surfaces, and shall minimize rock and soil retention. Hand holds shall be provided inside the compartment for personnel.
- 2.8.5 Personnel compartment shall have adequate ventilation and illumination.
- 2.8.6 Personnel carrier shall be provided with lockable gate.
- 2.8.7 Provision shall be made for transportation of an injured person on stretcher in all personnel carriers.

2.9 Additional safety provisions for Lifting Equipment

Every Lifting equipment shall have-

- i) an emergency stop button on platform to quickly stop the motion of the mobile elevating platform
- ii) supporting legs, wherever required
- iii) railings and work platform gates with locking provision
- iv) an additional mechanical locking device for work underneath elevated platform
- v) load lock valve/check valves in all lifting cylinders
- vi) limit switches for lifting and lowering of platform.

2.10 Additional safety provisions for Fuel bowzers

- 2.10.1 The Fuel bowser shall have approved license from Petroleum and Explosives Safety Organization (PESO), where ever applicable.
- 2.10.2 Fuel tank of the bowser shall be mounted on the chassis by means of fabricated M.S. saddles.
- 2.10.3 Fuel bowser compartment(s) shall be fitted with discharging faucet ending in a common manifold and heavy duty shut off valve located inside the tank, as per recommendations of PESO.
- 2.10.4 Opening lever of the valves of the bowser shall be housed in a control box at the rear part of the tanker with locking arrangement.
- 2.10.5 Top filling pipe of the bowser shall be drawn near to the bottom of the tank with spill proof device complete with leak proof connector with filling hose, and provided with suitable cap with chain.
- 2.10.6 Internal bulk heads of the bowser shall be stiffened to take care of surge pressure.
- 2.10.7 The bowser shall have filters with air eliminator for correct meter reading.
- 2.10.8 Tank of the bowser after completion of fabrication, shall be properly cleaned and treated with two coats of zinc chromate red oxide primer and finished with two coats of synthetic enamel paint.

2.11 Additional safety provisions for Explosive Carrier

- 2.11.1 Every Explosive Carrier shall have valid license from PESO.
- 2.11.2 The equipment shall not be used for transport of explosives unless it is in a fit condition and complies with the Explosives Rules, 2008.
- 2.11.3 All electrical wirings shall be protected with a conduit. An isolation switch for battery shall be located in an accessible position.
- 2.11.4 The equipment shall not be used for carrying passengers
- 2.11.5 Before the equipments are serviced, an authorized person shall inspect and certify that the equipments are free from explosive residues and the same shall be recorded in soft/hard copy and kept available at mine office.

2.12 Additional safety provisions for Explosive charging Equipment

- 2.12.1 Ammonium Nitrate Fuel Oil (ANFO) loading tanks shall be located so that they are not liable to potential impact damage from uncontrolled movement of the charging unit. Any spillage which may occur during loading does not fall onto any electrical connections, hot surfaces, flammable fluid tanks or filling points.
- 2.12.2 The hoses used for pumping of explosives shall be fire resistant and anti-static (FRAS).
- 2.12.3 Storage areas for packaged explosives shall be located so that they are not liable to be potential impact damaged from uncontrolled movement of the charging machine.
- 2.12.4 If an operator is required to work outside his compartment, the working point shall have-
 - (a) provisions for stopping and starting the engine.
 - (b) provisions for activating the fire suppression system.

2.13 Additional safety provisions for Diesel Locomotives

Diesel Locomotives shall conform to IS 9999:1981(Reaffirmed 2009) or its revised version along with DGMS - governing conditions for use of Diesel Locomotives in underground mines.

3.0 Construction and safety provisions of diesel engine to use in belowground mines

3.1. Design of the engine

The engine shall have following requirements-

- 3.1.1. good intake air cleaning system
- 3.1.2. fuel filtration system and water separators
- 3.1.3. well maintained engine cooling system
- 3.1.4. turbochargers and after coolers, if required
- 3.1.5. efficient high pressure fuel injection system
- 3.1.6. minimum engine emissions and Diesel Particulate Matter (DPM).

3.2. Engine Compartment

Engine compartment shall comply with the following:

- 3.2.1 The location of systems such as fuel, hydraulic oil, lubricating oil, other oils, and electric power within the engine compartment should be avoided wherever possible. It shall be shielded from hotspots and against possible damage. Fire wall or a barrier shall be installed to separate the engine compartment from the hydraulic components.
- 3.2.2 All hoses shall be fire resistant type and be routed away from hot engine surfaces. All pipes and hoses should be covered so that leaked oil cannot contact any exposed heated metal surface under any condition of equipment use. If this is not possible, the exposed metal surface shall be shrouded or heat shielded to reduce the temperature.
- 3.2.3 The transmission belts used in the diesel engine shall be fire resistant and anti-static (FRAS) type.
- 3.2.4 All engine exhaust systems shall be installed such that flames or glowing particles shall not be emitted from the engine compartment under any condition of equipment use.
- 3.2.5 The discharge from any engine breather shall be directed away from external surfaces of the engine system, so that it will not foul such surfaces with oil.
- 3.2.6 The temperature of any surface of the engine that comes into contact with the mine atmosphere shall not exceed 150°C under any condition of operation.

3.3. Cooling System

- 3.3.1. Every engine shall be provided with efficient cooling system.
- 3.3.2. Radiator caps provided for cooling systems shall be fitted with a means of safely relieving pressure to prevent scalding of personnel. Radiator caps shall be guarded against damage by foreign objects.

3.4. Fuel System

- 3.4.1. All fuel lines shall be heat resistant, corrosion resistant double braided hoses or metal pipes. All fuel lines shall be properly secured.
- 3.4.2. Fuel filter elements shall be enclosed within suitable containers.

- 3.4.3. All fuel tanks shall be substantially constructed and protected against damage by collision.
- 3.4.4. All fuel tanks shall be fitted with non-leaking caps which shall be effective irrespective of the inclination of the equipment and the caps shall be secured to the tank.
- 3.4.5. For high capacity equipment, diesel dispensing shall be of high volume diesel transfer facility, which includes fuel receiver with non-return valve, breather and other related accessories, to avoid spillage of fuel.

3.5. Engine protection system

- 3.5.1. The engine shall be equipped with suitable sensors to monitor and control engine performance, temperature and level of coolant and lube oil pressure, etc. When the sensor value differs from the preset parameter value limit, the engine protection system shall force the engine to decrease torque and warn the operator.
- 3.5.2. Every engine shall be provided with suitable sampling points for monitoring of engine lubricating oil pressure, engine speed, engine coolant temperature, inlet manifold vacuum, exhaust back-pressure and gas stream emissions both before and after exhaust treatment, temperature of emissions, etc.

3.6. Intake System

- 3.6.1. The location and installation of intake filter housings shall be situated away from heat sources (like exhaust) and dust sources (like tires).
- 3.6.2. Every underground diesel engine shall be equipped with a two-stage intake filter system.
- 3.6.3. Engine intake filter choke indicators shall be provided and located suitably for its easy monitoring by operator.

3.7. Exhaust System

- 3.7.1. Exhaust system shall consist of exhaust pipe from the exhaust manifold, exhaust conditioner, flametrap, spark arrester, exhaust cooling/dilution system and silencer. The exhaust system shall be provided with monitoring and shutdown devices. If any existing equipment is not having exhaust cooling/dilution system, within 12 months of issue of this standard, the equipment shall be incorporated with the exhaust cooling/dilution system.
- 3.7.2. The exhaust pipe shall be double walled construction to reduce exhaust surface temperature and manufactured with stainless steel to resist corrosion.
- 3.7.3. The exhaust conditioner/catalytic convertor shall be capable to dilute and render the exhaust gases harmless.
- 3.7.4. The final diluted exhaust gases shall be discharged in such a manner that they are directed away from the operator's compartment and also away from the breathing zones of persons.
- 3.7.5. The temperature of the cooled/diluted exhaust gases discharged in to atmosphere shall not exceed 85°C. In case of metalliferous mines, the temperature shall be measured at 1 m away from the discharge point.

3.8. Testing of Engines

- 3.8.1. Type testing of diesel engine shall be conducted by OEM at any Government approved test house or NABL accredited laboratory subject to confirmation of its ability to

conduct such tests or International accredited laboratory/recognized laboratory of country of origin, conforming to BS-III emission norms of Construction Equipment Vehicles (CEV) or its revised versions issued by the Government of India from time to time or its equivalent standard of the country of origin. The test certificate of the same shall be kept available at mine office.

3.8.2. A specification plate shall be provided for each diesel engine system, permanently affixed either to the system or, if impracticable, adjacent to the system in an easily seen position. The specification plate shall include the following information:

- a) Engine system protection rating
- b) Designation and year of the standard followed
- c) Name of the diesel engine system manufacturer
- d) Date of manufacture of the diesel engine system
- e) Serial number of the diesel engine system
- f) Maximum compound, transverse and longitudinal angles of operation
- g) Maximum concentrations of undiluted exhaust gas emissions measured during type testing.

3.8.3. The diesel engine system manufacturer shall supply the following documents to each purchaser alongwith consignment:

- a) The general arrangement drawing
- b) A letter of compliance for explosion protection and Standards followed- in case of coal mines.
- c) Make and model of the engine
- d) Serial number of the engine
- e) Date of the routine assessment and the letter of compliance. A summary of results from routine testing, including gas testing.
- f) Details of maintenance requirements, specifications and any other drawings/documentation necessary to maintain the diesel engine system in compliance with this Standard.

3.8.4. Wherever required, warning labels shall be fitted to each diesel engine system, at clearly visible locations, to identify major hazards that may cause injury to persons. Labels shall be permanently fixed and indelibly marked.

4.0 Additional construction and safety provisions for diesel engines used in underground coal mines and metalliferous mines in which Regulation 142 of Metalliferous Mines Regulations, 1961(or as amended from time to time) is applicable

4.1 Every diesel engine system used in underground coal mines shall be designed conforming to National standard (when formulated) or any internationally accepted standard for Explosion-protected diesel engine and shall be approved by Chief Inspector of Mines under Regulation 208(3) of Coal Mines Regulations, 2017 or as amended from time to time.

4.2 The diesel engine used in underground coal mines shall be Explosion-protected, i.e., designed, manufactured and maintained such that it will not propagate or generate flame or sparks, which could initiate an explosion of the surrounding inflammable atmosphere, if any.

- 4.3 The engine shall be compression ignition, diesel-fuelled and water-cooled type. It may be naturally aspirated, turbo-charged and/or super-charged. The diesel engine systems shall also be designed for a limited time safe operation in atmospheres containing up to 1% methane.
- 4.4 The equipment shall be fitted with at-least one automatic methane detector to detect the general body concentration of methane around the vehicle. The detector shall automatically activate a visual alarm to warn the operator when the concentration of methane exceeds 0.5% and shall shut off the engine when the concentration of methane exceeds 0.75%.
- 4.5 In case of such shutdown and if the equipment is required to be retrieved to a safe location, Manager shall frame suitable SOP for its retrieval.
- 4.6 All rotating components external to the engine (e.g., fan hubs, fan blades, pulleys) shall not be made of light metal and its alloys (which is incensive to sparking) and the use of non-metallic materials for external components of a diesel engine system shall be kept to a minimum (where such materials are used, they shall be shielded and routed away from heat sources). Cooling fans and rotating parts shall be guarded.
- 4.7 Air inlet systems shall be fitted with an inlet flametrap, an air filter assembly and an inlet manifold vacuum monitor.
- 4.8 The flametraps provided at the inlet and exhaust shall be capable of preventing the propagation of an explosion. Where a water-based flametrap is fitted, tests shall be conducted to ensure the engine exhaust system remains explosion protected at all angles of inclination during operation.
- 4.9 The ignition system of the diesel engine shall be of either pneumatic or hydraulic or any other explosion-protected system. The system shall be readily available all the times. A suitable standby portable type of such system shall be made available.
- 4.10 Compressors forming part of a diesel engine system shall be water cooled. Hoses that are attached to a compressor delivery port shall be of Poly tetra fluoro ethylene (PTFE) steel-wire reinforced braided construction or equivalent heat-resisting material. There shall be no valves between the un-loader and the compressor.
- 4.11 The following Safety shutdown systems for fail-to-safety, shall be provided:
 - i. Low oil pressure
 - ii. High coolant temperatures
 - iii. Loss of engine coolant
 - iv. Manual fuel shut-off
 - v. Exhaust gas temperature
 - vi. Low-water level device
 - vii. Sensing device for a fume dilution system
 - viii. Spark arrestor sensing device
 - ix. Device to ensure the safe operation of a particulate filter, and
 - x. Emergency stop system.

In case of shut down of the engine due to any of the above safety shutdown systems, the engine shall not be able to be restarted until the fault is rectified, except for the allowed automatic override features, like, low oil pressure and low coolant pressure. Where the automatic override is provided, period of override shall not exceed the engine manufacturer's specifications.

- 4.12 Warning labels shall not be manufactured from light metal and its alloys (which is incensive to sparking).
- 4.13 Undiluted exhaust gas emissions of equipment after treatment shall not contain more than—
- (a) 0.010% (100 PPM) by volume of NO₂;
 - (b) 0.09% (900 PPM) by volume of NO;
 - (c) 0.11% (1100 PPM) by volume of CO; and
 - (d) 0.20% (2000 PPM) by volume of CO, while 1% CH₄ is injected into the intake.

5.0 Specifications of diesel fuel and lubricants

Diesel fuel of proper quality shall be used for satisfactory engine performance, longevity of the engine and acceptable exhaust emission levels.

5.1 Quality of diesel fuel

- 5.1.1 Specifications of diesel fuel used in the diesel equipments shall conform to Bharat Stage III- Construction Equipment Vehicular Emissions Norms or its revised versions issued by the Government of India from time to time.
- 5.1.2 The supplier of the fuel oil shall certify in writing that the diesel fuel supplied by him meets the requirements mentioned under para 5.1.1 above and shall provide a copy of the certificate to the user with every consignment.
- 5.1.3 User shall ensure that the diesel fuel received at the mine is free from water content. Before using the diesel fuel in the equipments, user shall ensure that the diesel fuel conforms to the above mentioned standards and obtain certificate from the supplier to this effect.
- 5.1.4 The user and supplier shall jointly collect the samples of the fuel oil once atleast in every three months and get it tested at any Govt. approved or NABL accredited laboratory. The fuel oil shall not be used unless it meets the requirements of above mentioned standards/norms.

5.2 All the lubricants used in the diesel equipment shall conform to relevant National/International standards.

6.0 Emission Pollutants and Limitations

6.1 Permissible Limits of Exposure to Diesel Particulate Matter

The owner, agent or manager of every mine shall take such steps as necessary for minimising of emission of diesel particulate matter (DPM) from the exhaust of every diesel engine and for the dispersal and dilution of DPM which enters the air at any work place belowground and for ensuring that the exposure of workers to DPM is limited to an extent that is reasonably practicable but in any case not exceeding the limits described below:

- a) A miner's personal exposure to diesel particulate matter (DPM) in an underground mine shall not exceed an eight-hour time weighted average (TWA) airborne concentration of 100 micrograms of Elemental Carbon per cubic meter of air (100_{EC}µg/m³).

Provided that the allowable limit of TWA of EC in DPM may be $120_{EC}\mu\text{g}/\text{m}^3$ for a period of one year from the date of coming into force of this standard.

- b) The airborne concentration of DPM shall not exceed 3 times the TWA value (i.e. $300_{EC}\mu\text{g}/\text{m}^3$) for more than 30 minutes and shall never exceed 5 times the TWA value (ie, $500_{EC}\mu\text{g}/\text{m}^3$) at any place in an underground mine.

6.2 Monitoring of Diesel Particulate Matter (DPM)

- 6.2.1 The owner, agent or manager of every mine shall once at least in every three months or whenever the Regional Inspector so requires by an order in writing, monitor full-shift personal exposure of all workers exposed to diesel particulate matter(DPM), under actual mining conditions.

provided that, if any measurement of DPM shows the concentration in excess of fifty percent or seventy five percent of the allowable concentration as specified in Para 6.1 above, the subsequent measurements shall be carried on at intervals not exceeding one month or fifteen days respectively;

provided further that, such measurements shall also be carried on immediately upon the commissioning of equipment or machinery or upon any major alteration in ventilation that is likely to bring about any substantial change in the level of DPM.

- 6.2.2 The DPM shall be measured by a person authorised for the purpose with a suitable instrument capable of measuring concentrations of elemental carbon (EC) in near real-time, which replicates NIOSH 5040 or equivalent or by collection of samples and the samples shall be analysed at any Govt. approved or NABL accredited laboratory following a procedure equivalent to NIOSH 5040. The samples drawn shall as far as practicable be representative of the levels of DPM exposure of work-persons.
- 6.2.3 When the DPM monitoring results have established that the permissible limit of EC concentrations being exceeded at any place, immediate steps shall be taken to minimize the emission of DPM and to notify the Regional Inspector. If however, the average concentration of DPM in a series of 2 samples in successive working shifts exceeds the "permissible limits" the relevant operation causing excessive DPM shall cease. The operation(s) shall not be resumed until improvements have been made in the generation and dilution/removal of DPM and fresh sampling carried out immediately on resumption of the said operation(s) has established that such improvements have reduced the DPM concentration below the "permissible limit".
- 6.2.4 The measurements shall be recorded and maintained in the form of soft copy or a register kept for the purpose, signed and dated by the person taking measurements and counter signed by the Manager.

7.0 Ventilation requirements

- 7.1** No diesel equipment shall be operated in any work place :

- i. where the velocity of air current is less than 45 m/min,
- ii. where presence of inflammable gas in the general body of air at any point of the roadway exceeds 0.1% in case of I degree gassy coal mines and any metalliferous mine in which Regulation 142 of Metalliferous Mines Regulations, 1961 is applicable or 0.75 in case of II and III degree gassy coal mines,
- iii. whenever the ventilation therein interrupted for any reason whatsoever,

- iv. where the concentration of any noxious gas at any point in the roadway exceeds the concentration given in the table below:

Sl. No.	G a s	Maximum Allowable concentration	
		% age by volume	PPM
1	Carbon Dioxide	0.5	5,000
2	Carbon Monoxide	0.005	50
3	Nitric Oxide (NO)	0.0025	25
4	Nitrogen Dioxide (NO ₂)	0.0005	5
6	Sulphur dioxide (SO ₂)	0.0005	5
7	Hydrogen sulphide (H ₂ S)	0.0005	5
8	Aldehydes	0.001	10

- v. where wet bulb temperature at any place therein exceeds 33.5⁰C. provided that, if the wet bulb temperature at any place in the roadway exceeds 30.5⁰C, arrangements are made to ventilate the same with a current of air moving at a speed of not less than 1 meter per second.

7.2 Owner, Agent or Manager of the mine shall ensure that adequate quantity of air shall be maintained in each workplace in which a diesel equipment is operated to dilute the engine exhaust gases to the lowest practicable levels, and this volume flow shall not in any case be less than the minimum quantity of air specified in this standard.

7.3 Additional quantity of air required for each diesel equipment shall not be less than 0.06 cubic meters per second per kilowatt of the maximum rated engine output specified by the manufacturer.

7.4 If more than one diesel equipment is operated in any ventilation circuit of a mine at the same time, the total quantity of air in that circuit shall not be less than the aggregate of the volume requirement for the individual diesel units.

7.5 Examination of roadways for adequacy of Ventilation

7.5.1 (a) At least once in every shift during the diesel equipments are in normal operation, the atmosphere of the roadways, in which the equipments are operated, shall be tested for the presence of the noxious and inflammable gasses. The tests for noxious gasses shall be carried out in the roadways approximately at 1.5 m above the floor level and 1 m from the diesel equipment exhaust on the return side.

- (b) Such tests shall also be done in the roadways at following places;
- i. At each end of the roadway, or part thereof, in which equipments are operated; and
 - ii. At other points, as may be fixed by the manager.

7.5.2 The above measurements shall also be taken whenever any alteration is made in the quantity of air circulating in the roadway or part thereof.

7.5.3 The measurements shall be recorded and maintained in the form of soft copy or a register kept for the purpose, signed and dated by the person taking measurements and counter signed by the Manager.

7.5.4 During any such examination, if the percentage of inflammable or the noxious gasses are found more than the limits specified above, the person making the inspection,

shall immediately report the fact to the official in charge of the district, who after confirming the presence of the gas as above, shall discontinue the use of any diesel equipment in that roadway. After the said discontinuance, no equipment shall be re-operated in the roadway unless the manager, after satisfying himself and certifying in writing that the content of gas in the roadway or part thereof has been reduced below the specified limits.

- 7.5.5 Every such discontinuance shall be recorded in the form of soft copy or a register kept for the purpose and signed and dated by the Manager.
- 7.5.6 During any such examination, if the concentration of the noxious and inflammable gasses in general body of air, is found to be more than prescribed limits, steps shall be taken to dilute the said concentration below the said limits.
- 7.5.7 In II and III degree gassy coal mines, presence of inflammable gas in the general body of air shall be monitored continuously with suitable systems and the diesel equipment operating therein shall be shut down by the systems automatically or give audio-visual warning in the event of concentration of the gas exceeds the prescribed limits.

7.6 Air Sampling

- 7.6.1 Once at least in every week, samples of the general body of air shall be taken-
 - i. at a point at the end of every road in which any diesel equipment is operated;
 - ii. at such other suitable points as may be fixed by the manager;
 - iii. at any place and time, as may be specified by Regional Inspector.
- 7.6.2 Every sample, taken as above, shall be analysed, within 4 days of taking thereof (without taking into account any rest day or day of general holiday) to determine the percentage of noxious and inflammable gasses therein. Particulars of every such analysis shall be recorded in the form of soft copy or a register kept for the purpose.

8.0 Safe operation of diesel equipment

8.1 Transport Rules

- 8.1.1 Transport rules shall be framed with regard to the operation of diesel equipment in the mines. The transport rules, inter alia, shall contain:
 - i) Code of safe practices and standard operating procedures of the diesel equipments used in the mine.
 - ii) The minimum required width and height of the roadways in the mine in which the equipments may be operated.
 - iii) The permissible maximum load to be carried by the equipments.
 - iv) The areas in the mine, in which speed restrictions on equipment shall apply.
 - v) The roadways, in which person to be transported and the material to be carried and the type of the equipments to be used for the purpose, etc.
 - vi) Traffic rules of the equipments.
- 8.1.2 Copies of the Transport Rules shall be circulated to all operators of the equipments, concerned supervisors and officers of the mine. The traffic rules, permissible maximum load and speed of the equipments shall be posted at all conspicuous places along the route, in which the equipment is operated, transfer/ loading points, garage, charging stations and miners' station.

8.2 Operation of diesel equipment

- 8.2.1 No equipment shall be operated, except for repairs and test, otherwise than by a person who has been authorized by manager to be driver/ operator of the equipment. Provided that, he shall be,-
- a) Trained (preferably by OEM) and certified to be competent in the operation of type of equipment in question.
 - b) provided with full instructions in writing with regard to the permissible haul roads and speed as per transport rules, and
 - c) familiar with all precautions necessary for safe operation of the equipment.
- 8.2.2 Even during the repairs or tests, the equipment shall not be operated, except by a competent person, authorized for the purpose.
- 8.2.3 Starting system of every diesel equipment shall have a suitable locking provision and its key shall always be under the charge of the operator or any authorized person.
- 8.2.4 At the commencement of every shift, the operator of every diesel equipment shall personally carry out necessary pre-start examinations paying special attentions to brakes, steering, accelerator, warning devices, lights, etc. to ensure that it is in safe working order.
- 8.2.5 If any fault is found in the equipment during the above examinations or during its operations/or otherwise, and also, in the event of any irregularity in the running or sound of the engine in particular, any excessive emission of smoke, any open sparking, any stoppage in the circulation of water or any leakage of fuel, the equipment shall be immediately be taken out of service and the same shall be brought to the notice of shift supervisor/officer, and the equipment shall not be put in further use unless it is attended and the fault is rectified to satisfactorily.
- 8.2.6 The result of every such examination, and also of every action taken to rectify the faults or irregularities noticed in the equipments shall be maintained in a soft copy or record kept for the purpose.
- 8.2.7 The engine of a equipment shall not be kept running, when the equipment is stationary except,-
- a) during starting,
 - b) during brief halts,
 - c) while being tested.
- 8.2.8 Any material being transported in a trolley/trailer shall be securely tied to it so that there is no danger of the falling of material.
- 8.2.9 Unless authorized in writing, no person, other than the driver/operator shall be transported in any diesel equipment, trolley, or trailer attached thereto other than a equipment or a carriage duly approved for man-riding.
- 8.2.10 No person shall be allowed to ride over and work on an elevated bucket or any other part of equipment.

8.3 Training

- 8.3.1 Before engaging any person on maintenance, repairs, examinations and tests on diesel powered equipment in the mine, he shall be trained, tested and certified to be competent by OEM and authorised by the Manager for the purpose.

- 8.3.2 The training shall be carried out by OEM or authorised instructor(s) on topics related to safe maintenance of fire-protected and explosion-protected diesel engine systems and gas testing.
- 8.3.3 Similarly, mine workers conducting ventilation related sampling and measurements shall also be trained on related topics.
- 8.3.4 Mine management shall provide refresher training annually to all miners who can reasonably be expected to be exposed to the diesel emissions. The training shall cover the health risks associated with exposure to DPM as well as the methods used in the mine to control DPM concentration and procedures for changing and disposal of DPM filters provided in equipment.
- 8.3.5 Training on the following topics shall be imparted to the concerned persons in the mines:
- a) DPM filters and cleaning of DPM filters, measurement and control of DPM.
 - b) Use of PPE
 - c) Mine environmental monitoring systems and sensors of different gas monitors/detectors.
 - d) Engine fundamentals, which shall include an introduction to the function of a diesel engine and recognition of all major components and their functions;
 - e) Diesel emissions, which shall include an introduction to diesel emissions and their adverse health effects;
 - f) Factors that affect diesel emissions, which shall include a detailed presentation of engine faults and diesel fuel quality, and their effects on emissions, as well as instruction in the preventive actions that can be taken to minimize emissions levels;
 - g) Emissions control devices, which shall include a detailed presentation of the different emissions control devices employed to reduce emissions, and details about actions the equipment operator must take to keep the devices in working order;
 - h) Diagnostic techniques, which shall include a presentation of techniques that can be employed by the equipment operator to assure the equipment is in safe operating condition, and instruction in how to recognize and diagnose certain engine faults that may cause increases in emissions;
 - i) The preoperational inspection, which shall include a presentation of the purpose, benefits, and requirements of the preoperational inspection;
 - j) Ventilation, which shall include an introduction to special ventilation requirements for areas of the mine in which diesel-powered equipment will operate;
 - k) Fire suppression systems, which shall include an introduction to the use and function of fire suppression systems, and when and how to manually activate a fire suppression system;

- l) Safe Operating procedures, which shall include a detailed presentation of the driving rules, safe driving speeds, traffic control devices, and equipment limitations and transport rules.
- m) Emergency procedures, which shall include discussion of emergency situations such as fire, diesel fuel spills, component failure, and loss of ventilation air. This instruction shall also include emergency escape procedures and discussion of the potential use of the diesel-powered vehicle as an emergency escape vehicle in case of a mine emergency situation; and
- n) Record keeping and reporting procedures, which shall include a presentation on required record keeping and reporting procedures for problems or unsafe conditions, high emissions levels, and preoperational inspections made by the equipment operator.

8.3.6 Certificate of qualification: The mine management shall issue to the equipment operator a new certificate of qualification once in every two years on successful completion of training and assessment. The mine management shall keep at the mine site a copy of the most recent certificate of qualification issued and make it available for inspection by Chief Inspector of Mines or any Inspector of Mines.

9.0 Roadways for Diesel equipments

9.1 Construction and Safety provisions of Road ways

- 9.1.1 So far as reasonably practicable, the floor of every roadway, in which any diesel equipment ply, shall be kept even, firm, free from debris/mud, water and not conducive to skidding.
- 9.1.2 Unless exempted in this behalf in writing by the Chief Inspector of Mines/Regional Inspector, track less equipment shall not be operated on any length of roadway of which gradient exceeds 1 in 6 and for track (rail) mounted, the gradient shall not exceed 1 in 15.
- 9.1.3 Floor of roadways should be designed to bear the maximum ground pressure exerted by the heaviest equipment that ply on the roadway.
- 9.1.4 Proper drains shall be constructed along the sides of the roadways so as to keep the floor of the roadway free from water.
- 9.1.5 Man holes shall be provided at an interval of not more than 20 meters on the side of the roadway, if gradient is less than 1 in 6.
- 9.1.6 All the roadways in which diesel equipments ply shall be adequately illuminated.
- 9.1.7 Reflective warning notices and sign boards shall be posted along the roadways at appropriate places, like level crossings, steep gradients, curves and junctions.
- 9.1.8 No person shall be allowed to walk/present in the roadways while the equipments are plying in it.

9.2 Clearances from roof and sides

- 9.2.1 No equipment shall ply in any roadway, where the clear space from roof is less than 300 mm, if the equipment is provided with a canopy/ closed cabin for the operator, or in any other cases, not less than 1.8 m from the footboard of operator.

- 9.2.2 Every roadway, in which only one equipment ply, an unobstructed space of not less than 1.5 m, in addition to the width of the equipment, shall be provided along the width of the roadway.
- 9.2.3 In every roadway, in which more than one equipment ply, crossing points shall be provided at intervals not exceeding 300 m. At every such crossing point, a clear space of not less than 1.5 m along the width shall be provided after allowing clearance for safe crossing of two equipments.
- 9.2.4 Radius of curves and clearances at the junctions of the roadways shall not be less than the minimum required for turning the equipment as recommended by the manufacturer, otherwise the radius of curve shall provide a clear space of not less than 1.5 m over the minimum turning radius required by the equipment.
- 9.2.5 The roadways shall be adequately supported to prevent any roof and side falls.

9.3 Examination of Roadways

- 9.3.1 Every roadway, in which any diesel equipment is operated, shall be placed under sole charge of a competent person, who shall once at least in every 24 hours, examine every such roadway with regard to,-
- a. clearance and free from obstruction
 - b. condition of its roof and sides
 - c. ventilation
 - d. illumination level in roadway
 - e. presence of coal dust in case of coal mines
 - f. condition of track in case of locomotives, monorails, etc.
 - g. general safety.
- 9.3.2 The competent person, making the above examinations shall record the results thereof in a soft form or in a record kept for the purpose, signed and dated by him and counter signed by manager.

10.0 Maintenance and Testing

- 10.1 Suitable maintenance schedules and activity wise SOP's shall be framed and implemented for every diesel equipment by considering the OEM recommendations.
- 10.2 All the repairs, scheduled maintenances and testing shall be carried out by competent person(s) under the supervision of an authorized supervisor/engineer.
- 10.3 Procedures and schedules for inspection, maintenance and testing of all fire suppression systems shall be framed and implemented.
- 10.4 Nitrogen charging in accumulators and suspensions shall be carried out as per the DGMS Technical circular no. 02 of 2012 or its revised version.

10.5 Brake testing

- 10.5.1 Once at least in every 7 days, and also immediately after any repairs or adjustments have been carried out on it, the braking system of every equipment shall be examined and tested by a competent person conforming to ISO-3450:2011 or its revised version.
- 10.5.2 Every person, making any inspection, examination or test, as above, shall forthwith record the particulars thereof in the Test report as per Clause no 7.0 of ISO 3450:2011 or its revised version and shall sign and date the same.

10.5.3 The test shall be conducted as under:

(a) Deceleration Test: When the Diesel Equipment, is in a loaded condition,

(i) By direct mechanical action and

(ii) By every other means provided

Explanation: The declaration test shall be carried out as follows:

Apply the service brake of diesel equipment with load passes a marked point, at a selected speed, the distance travelled in coming rest should be measured and recorded. The maximum permissible distance shall be obtained from the manufacturer.

(b) Stand still tests (Parking Brake)

Explanation: The Stand still test shall be carried out as follows:

When the Diesel Equipment is in a loaded condition and diesel engine of the equipment is at rest with the engine stopped with applied parking brake of any means provided other than direct mechanical action for the period of at least 10 minutes. This is leakage test for air/hydraulic pressure of breaking system.

While seeking this information of normal load and gradient should be furnished to the manufacturer.

- 10.6 Testing of steering function and emergency steering function shall be carried out fortnightly and a record thereof shall be maintained.
- 10.7 Non-destructive testing of all the load carrying members of the equipments, where safety of the persons is involved, and whole body vibrations study shall be conducted for operator comfort, once in every one year conforming to any internationally accepted standards, from any Govt. approved test house or NABL accredited laboratory subject to confirmation of its ability to conduct such tests.
- 10.8 Noise survey shall be conducted conforming to the DGMS circulars No. 18 of 1975 and 5 of 1990 or its revised version and accordingly suitable action shall be taken to reduce the equipment noise.
- 10.9 Inspection and testing of all pressure vessels shall be conducted once in every three years conforming to DGMS circular no. 7 of 2003 or its revised version.
- 10.10 Engine blow-by measurement shall be conducted as per the recommendations of OEM.
- 10.11 Oil sample condition based monitoring (CBM) shall be conducted as per the recommendations of OEM at any Govt. approved Test house or NABL accredited laboratory subject to confirmation of its ability to conduct such tests.
- 10.12 Undiluted exhaust gas monitoring shall be carried-out once atleast in every month conforming to the prescribed values and accordingly preventive maintenance is to be carried-out.
- 10.13 Proper protection equipment shall be used to avoid flying of rim accessories. Person(s) shall be kept away from lifting object trajectory while inflating the tyres. Precautions shall be taken during tyre inflation conforming to DGMS circular Tech. 9 of 1979 or its revised version.
- 10.14 The competent person(s) making the inspection/examination, maintenance and testing aforesaid shall record the results thereof in a soft form or register kept for the purpose, signed and dated by him and counter signed by manager.

- 10.15 All sensors of the diesel engine system shall be regularly tested and routinely calibrated/replaced to ensure correct operation as per the recommendations of OEM.
- 10.16 All electrical items associated with the equipment shall be checked by a competent person authorized for the purpose and the observations shall be recorded daily in a register kept for the purpose or in electronic form with due authentication.
- 10.17 **Additional conditions for Maintenance and Testing of Diesel engines used in underground coal mines and metalliferous mines in which Regulation 142 of Metalliferous Mines Regulations, 1961(or as amended from time to time) is applicable**

Apart from the above mentioned maintenance and testing procedures, the following conditions for maintenance and testing of diesel engine systems used in underground coal mines and metalliferous mines in which Regulation 142 of Metalliferous Mines Regulations, 1961 or as amended from time to time, is applicable, shall be carried out to ensure diesel engine systems remain explosion-protected or fire-protected condition over their life cycle.

- 10.17.1 A safety file (History record) for each Diesel Engine system mentioning its serial number and details shall be initiated by the manufacturer and every maintenance activity shall be recorded and maintained by the user. These safety files shall be kept available at mine office.
- 10.17.2 Hydrostatic testing of all explosion-protected components, testing of shutdown systems and calibration of sensors (other than methane sensors) of the diesel engine, shall be conducted once in every two years conforming to the National standard (when formulated) or AS/NZS 3584.3: 2012 (or its revised version) or internationally accepted standard, at any Govt. approved Test house or NABL accredited laboratory subject to confirmation of its ability to conduct such tests and record thereof shall be kept available at mine office.
- 10.17.3 The service facility in the mine shall be provided with required tools and tackles along with the following measuring apparatus to maintain the fire-protection and explosion-protection properties of the Diesel engine system:
- (i) Straightedges
 - (ii) Feeler gauges
 - (iii) Thread gauges
 - (iv) Inside and outside micrometers
 - (v) Dial gauges
 - (vi) Depth gauges
 - (vii) Callipers, inside and outside
 - (viii) Surface roughness/finish instrument
 - (ix) Diesel engine tachometer
 - (x) Injection timing instrument
 - (xi) Surface temperature thermometer
 - (xii) Coolant temperature thermometer
 - (xiii) Exhaust temperature thermometer
 - (xiv) Manometer—exhaust back-pressure
 - (xv) Manometer—inlet vacuum
 - (xvi) Gauges—lube oil pressure and temperature

- (xvii) Hydrostatic test set with calibrated pressure gauge
- (xviii) Barometer—atmospheric pressure
- (xix) Psycho meter—relative humidity
- (xx) Analysers to measure gaseous emissions and diesel particulate matter (smoke), and
- (xxi) Torque wrenches.

10.17.4 Methane sensor(s) provided on the equipment shall be calibrated and tested for its efficacy with suitable testing kit conforming to DGMS (Tech) circular no.09 of 2002 at any Govt. approved Test house or NABL accredited laboratory subject to confirmation of its ability to conduct such tests.

10.17.5 (a) A person authorized for the purpose shall ensure that the undiluted exhaust gases produced, under all standard conditions of engine speed or load, by the engine of a diesel equipment in underground mine is sampled and analysed —

- (i) at intervals of not more than 500 hours as measured by the diesel unit hour meter, or at intervals not exceeding three months if the unit does not have an hour meter;
- (ii) after any maintenance work is done on the turbocharger or fuel injection system on the engine of a diesel unit (other than cleaning or replacing filters); and
- (iii) when required to do so by an Inspector.

(b) The samples shall be tested at any government approved Test house or NABL accredited laboratory. These reports shall be kept available in the mine office.

(c) The manager of an underground mine shall ensure that if sampling of undiluted exhaust gases from engine of a diesel equipment shows the content of contain carbon monoxide or oxides of nitrogen is more than the quantities prescribed in para 4.13 of this standard, the diesel equipment shall not be returned to service until the exhaust emissions are reduced to levels below those specified and as low as is practicable.

11.0 Precautions while transportation, storage and filling of fuel in underground mines

11.1 Filling station

11.1.1 No equipment shall be re-filled with fuel oil, except at a filling station authorized by the manager.

11.1.2 Underground diesel fuel storage facilities in the filling station shall meet the following general requirements:

- a) Permanently affixed underground diesel fuel storage tanks are prohibited;
- b) The fuel oil shall be stored in a suitable mechanically strong/leak proof, spill proof and non-flammable tank and kept in the filling station and,
- c) The stock of fuel oil stored in underground shall at no time exceed the consumption of the equipments over a period of 48 hours or maximum 1800 litres, whichever is minimum.

11.2 **Location:** An underground diesel fuel filling station shall be located:-

- a) At least 50m away from shafts, inclines/declines, haulage roadways, maintenance workshops and reserve stations;

- b) At least 15 m away from trolley wires, haulage ways, power cables and electric equipment not necessary for the operation of the storage and filling facility; and
- c) In an area that is as dry as practicable.

11.3 Construction: Construction of an underground diesel fuel storage facility in the filling station shall be:

- a) mechanically strong, leak-proof, spill proof and constructed of non-combustible materials;
- b) ventilated directly into the return air course using non-combustible materials;
- c) equipped with an automatic fire suppression system that complies with DGMS general order for the fuel storage tanks, containers, safety cans, pumps, electrical panels and control equipment in fuel storage areas.
- d) Maintained with adequate stock of dry sand/lime stone dust for extinguishing fire;
- e) Marked with conspicuous signs designating as combustible liquid storage.
- f) Audible and visual alarms to warn of fire shall be provided at the protected area and at a surface location that is always staffed when persons are in underground. A means shall also be provided for warning all endangered persons in the event of fire.
- g) Manual actuators: Fire suppression systems shall include two manual actuators with at least one located within the fuel storage facility and at least one located a safe distance away from the storage facility and in intake air.
- h) The fire suppression system shall remain operative in the event of electrical system failure.
- i) Monitoring of system: If it is electrically operated, the system's detection and actuation circuits shall be monitored and provided with status indicators showing power and circuit continuity. If not electrically operated, the system shall be provided with a means to indicate the functional readiness status of the system.
- j) Weekly visual inspection. Each fire suppression device shall be visually inspected at least once every week by a person authorised for the purpose.
- k) Maintenance, testing and record keeping: Each fire suppression device shall be maintained and tested in accordance with the provisions of this standard. Maintenance, testing and inspections of the device shall be recorded in the register kept for the purpose or in soft form.

11.4 Transportation of diesel oil

11.4.1 Diesel fuel shall be transported only in containers specifically designed for the transport of diesel fuel. Any container, other than a safety can, shall be permanently fixed to the transportation unit. The container shall be provided with a device for venting & self-closing cap and shall not exceed a capacity of 1800 liters. Two fire extinguishers shall be provided at each end of the transportation unit. Empty containers shall be returned to the surface as promptly as possible.

11.4.2 No person shall transfer fuel to a diesel engine, except by means of a pump and hose. Safety cans shall be used only for emergency fuelling. Safety can shall be clearly marked, have a maximum capacity of 18 liters, be constructed of metal, and equipped with a nozzle and self-closing valves.

11.4.3 While transferring fuel from one container to another or from a container to a equipment, care shall be taken to prevent spillage, and any fuel, if slipped, shall forthwith be removed by means of a suitable non-inflammable absorbent. All oily and greasy waste shall forth with be deposited in a closed incombustible receptacle, and removed from the mine as soon as possible.

11.4.4 Re-fuelling of any equipment shall not be carried on, and fuel oil shall not be transferred from any container, or handled, while any internal combustion engine is running inside the filling station, or within a radius of 15m thereof.

11.5 General Safety Requirements

11.5.1 The silled floor of the filling station shall drain into a covered sump or sufficient size to hold 1 ½ times the maximum quantity of the fuel and lubricant stored.

11.5.2 No person shall smoke, or use any light or lamp, other than a locked safety lamp, or an electric lamp, adequately protected, in any filling station, or within a radius of 15m of any filling station.

11.5.3 No person shall service any equipment in a filling station.

11.5.4 Welding or cutting shall not be done within 15 m of an underground diesel fuel storage facility. Cutting or welding shall not be performed on or within containers or tanks that have contained combustible or flammable materials until such containers or tanks have been thoroughly purged, cleaned or inerted, and a vent or opening is provided to allow for sufficient release of any built-up pressure before heat is applied.

11.5.5 Diesel fuel shall not be transferred to the fuel tank of diesel-powered equipment while the equipment's engine is running.

11.5.6 Safe Operating Procedures shall be framed and kept posted in the form of a notice, clearly visible, in every filling station.

12.0 General Conditions

12.1 Fire resistant high pressure hydraulic hoses with its end fittings used in mines shall conform to DGMS gen. order No.DGMS/Mech/Tech.Cir.(Approval) No.04, dated 13.02.2015 or its revised version.

12.2 In case of coal mines, fire resistant hydraulic fluid shall conform to DGMS gen. order No.DGMS/Mech/Tech.Cir.(Approval) No.02, dated 13.02.2015 or its revised version.

12.3 Adequate number of competent persons including Fitter, auto-electrician, operator, supervisors and Engineers (Electrical, Mechanical & Mining) etc. shall be appointed in mine to take care of installation, maintenance, testing and safe operation of diesel equipment.

12.4 An engineer shall be authorized exclusively to hold charge of Diesel engine system, and to be responsible for its installation, maintenance and safe working.

12.5 All circulars/General approvals issued by DGMS from time to time, relevant to the equipment shall be complied with.

Chief Inspector of Mines may by an order in writing and subject to such condition as may be specified therein require any modifications or additional requirements to be included in this standard on merit of the case.