Safety

PV-271D / PV-291D

Original Instructions
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Epiroc

Table of Contents

Revision History

Revision No.	Date	Revision
001	May 2019	Original release
002	April 2020	Editorial changes
003	May 2022	Updated Safety Functions section. Updated lightning content. Added Abbreviations section.
004	October 2022	Added PV-291D to title.
005	December 2024	Removed data plate information. Removed fire suppression information. Made editorial changes throughout. Updated Signs chapter.

1 Introduction

1.1 Purpose of the Safety Manual

This safety manual contains important information that must be followed to prevent accidents and property damage while working with and around the machine. The manual is designed to do the following:

- Provide information about the identification and prevention of hazardous situations.
- Provide information about safe, correct, and economical use of the machine and related equipment.
- Provide information about the risks involved and the hazard zones.
- Provide information about safety equipment and the safety signs on the machine.
- Provide information about environmental regulations.

This manual is part of the complete machine delivery and its related equipment.

This manual does not replace the necessary training that is necessary for the handling of the machine and its related equipment.

The information in this manual and all applicable local regulations must be followed.

1.2 Target Group

The information in this publication is intended for everyone that is involved in the application, operation, and maintenance of the machine and related equipment. All readers are expected to possess basic competence of the mining methods, construction methods, and the machines used for that kind of operation.

1.3 Safety and Health Statement

Every employer should have a safety and health philosophy based on the following statements:

- We believe that our employees are our greatest asset.
- We are committed to providing a safe and healthy workplace for all our employees.
- We believe that injuries and accidents are preventable and that the well being of all our employees can be protected in the work environment.
- We believe that safety is number one. Safety is not sacrificed for production.
- We believe that housekeeping is an integral part of our safety program and the protection of our employee’s health.
- We believe that all of our employees are responsible for the safety of their coworkers. Each of us has the duty to listen, watch, and act upon hazards that might injure another.
- We believe that good safety training is necessary to assist employees in completing their assigned tasks in a safe manner.
- We believe that safety is a team effort. Safety is an integral part of every individual’s job responsibility. Every employee must be committed to these beliefs and must work in a manner that demonstrates that commitment.

1.4 Qualified Personnel

Work done on and with the machine must be done by qualified personnel. Statutory minimum age limits must be observed.

To operate, maintain, and work on Epiroc equipment, the worker must be:

- Physically competent to react correctly and quickly to avoid accidents.
- Mentally competent to concentrate on the job to be done and understand and apply all established rules, regulations, and safe practices.
- Emotionally competent to withstand stress and prevent mistakes.
- Trained in the operation and maintenance of Epiroc equipment:
  - They must read and understand the machine manuals and know the specifications and capabilities of the machine they are using.
  - They must understand hand signals.
  - They must understand the meanings of symbols on instruments, controls, and specific parts of the machine.
  - They must be trained in safety procedures and controls.
- Licensed, if required by law.

The duties of the personnel responsible who operate, setup, and maintenance the machine should be stated clearly:

- Define the machine operator's responsibility to observe site traffic regulations.
- The operator should have the authority to refuse instructions by third parties that are contrary to safety.
- Do not let personnel being trained, instructed in the operation, or maintenance of the machine do work without permanent supervision by an experienced person.

Failure to obey instructions and warnings could result in injury or death.

If you have any questions about the safe use or maintenance of your machine, ask your supervisor or contact your nearest Epiroc distributor for assistance.

1.5 Personnel Safety

- All personnel must watch for hazards during operations and must alert the operator of potentially dangerous situations, such as the presence of other personnel, equipment, unstable ground, or overhanging obstacles.
- All personnel who work around the machine must make sure that any unsafe conditions and practices are corrected or reported to the machine operator and supervisor.
- All personnel who work around the machine, including the support and maintenance personnel, must obey all warning signs and must make sure of their own safety and the safety of others.
- With careful planning, most accidents can be avoided. To minimize risk of accidents:
  - Have a clear understanding of the work to be done.
  - Consider potential dangers or hazards.
  - Develop a plan to do the job safely.
  - Explain the plan to all personnel concerned.
- This Safety Manual cannot cover every possible situation. All personnel are expected to exercise good judgment and common sense when operating, servicing, or working near Epiroc machines.

1.6 Safety Messages in Publications

Safety messages in publications declare hazards and the related measures to avoid the hazards in that particular situation. Safety messages contain signal words (Danger, Warning, Caution, and Notice) that relate to the consequences of those specific hazards. The information in safety messages must be obeyed.

Safety messages consist of:

- A signal word to determine the degree of the hazard.
- A type of hazard states the potential source of a hazard. For example: Moving parts, Hot surface, and so on.
- The consequence of the hazard, if not avoided.
- A method to avoid the hazard.

The following are examples of safety message structures.

DANGER

Hazard

The signal word "DANGER" indicates a hazardous situation which will result in death or serious injury if not avoided.

▶ The method to avoid the hazard is written here.

WARNING

Hazard

The signal word "WARNING" indicates a hazardous situation which could result in death or serious injury if not avoided.

▶ The method to avoid the hazard is written here.

CAUTION

Hazard

The signal word "CAUTION" indicates a hazardous situation which could result in minor or moderate injury if not avoided.

▶ The method to avoid the hazard is written here.

NOTICE

Hazard

The signal word "NOTICE" contains information that is not related to bodily injury yet considered important. In a "NOTICE" the damage is related to machines, components, or systems.

▶ The method to avoid the hazard is written here.

1.7 Emergencies

Emergencies are situations where there is personal injury or property damage, or when there is an imminent threat of personal injury or property damage. It is important for everyone to know how to respond to emergency situations to minimize injury and damage.

Each operator must have a plan to contact emergency services or some other form of help, such as fire or medical emergency services, immediately. These plans must be known to everyone around the machine in case someone is injured.

Local Emergency Number: _____

Mine Site Number: _____

Emergency Frequency Number: _____

1.8 Customer Acknowledgment

Use only Epiroc original parts. Damage or breakdown that is caused by non-original spare parts are not covered by the warranty or product liability.

Epiroc is not responsible for damages that are caused by unauthorized modification of the machine and its associated equipment.

The manufacturer is not liable for damage that is caused by inappropriate use.

The following damages are not included in the customer warranty policy:

- Damage from substandard repairs.
- Injury to personnel from unresolved repairs.
- Damage to equipment from unresolved repairs.

Always refer to the customer warranty policy.

Performance specifications are based on maximum computed values and are subject to revisions without notification. Nothing in this instruction extends any warranty or representation expressed or implied, regarding the products described. Any such warranties or other terms and conditions shall be in accordance with Epiroc standard terms and conditions of sale for such products, which are available upon request.

Specifications represented herein are calculated values at 100% efficiency. Epiroc is constantly striving for product improvements and enhancements. Accordingly, Epiroc reserves the right to make such changes in specifications and design as the company considers in conformity with this policy or due to unavailability of materials or assemblies.

1.9 Feedback and Contact Information

At Epiroc, we work actively to develop and continuously improve our products and associated documentation. We value customer feedback and do our best to promptly answer questions. To provide feedback, contact your local supplier at Epiroc.com, under **CONTACT**.

> ***NOTE:*** *If you give feedback via email, make sure that you use a valid email address to be able to receive and reply.*

Postal Address:

Epiroc Drilling Solutions, LLC

2100 North First Street

Garland, Texas 75040 - USA

1.10 Product Warranty

The product must be used and maintained in accordance with the technical documentation that is provided by Epiroc. The warranty is only valid if the product is strictly used for its intended purpose.

- Read and understand the contents of the Epiroc warranty policy.
- Read and understand the technical documentation that is provided by Epiroc before using the product.
- Use only Epiroc genuine parts. Damage or breakdowns caused by using parts other than Epiroc genuine parts is not covered by the warranty.
- Epiroc is not responsible for any damage caused by unauthorized modification of the product and its associated equipment.
- Epiroc is not liable for damage caused by misuse of the product.
- Technical warranties cover all defects caused by substandard materials or poor workmanship.
- Any damage caused by substandard repairs is not covered by the warranty.

1.11 Owner's or Lessee's Responsibility Toward the Product

The owner or lessee must make sure that:

- The user is provided with relevant Epiroc product training and safety training before using the product.
- The user is not under the influence of alcohol or drugs.
- The user has the relevant technical documentation provided by Epiroc.
- The user knows about the local laws and regulations and that they are obeyed.
- The user knows about the product capabilities and limitations, and that the limitations are not exceeded.

- The product is kept in good condition and maintained according to the maintenance intervals, where applicable.
- The product is discarded in accordance with the local environmental regulations for discarding of waste and recycling. Discard waste and recycle products and components in a way that the percentage of recyclable material is maximized and the negative environmental impact is minimized.

1.12 Abbreviations

Abbreviation	Definition
DEF	Diesel Exhaust Fluid
DHD	Down-Hole-Drill
EWL	European Waste List
FOPS	Falling Object Protective Structure
ISO	International Organization for Standardization
MOL	Machines Online
NFPA	National Fire Protection Association
OEM	Original Equipment Manufacturer
PPE	Personal Protective Equipment
RRC	Radio Remote Control

2 Product Liability

The owner or lessee is responsible for:

- Using the machine only for intended purposes
- Knowing the limitations of the machine and not exceeding the design limits
- Following the instructions in the relevant machine documentation
- Using the machine only when it is in good condition and fully-maintained
- Providing safety training and making sure that all local regulations are obeyed
- Obtaining and distributing the relevant documentation to operating personnel, maintenance personnel, and other relevant personnel.

3 Risks and Hazards

3.1 Stored Energy Hazard

Before operating the machine, personnel must be aware of the following information regarding the dangers from stored energy.

- Personnel must be aware of how the hydraulic components can move.
- Personnel must be aware of how the hydraulic system controls components.
- Personnel must be aware of how related control circuits affect the hydraulic components.
- Personnel must prevent movement of any component that could cause personal injury and property damage.
- Personnel must make sure that no part of the body is in a position where component movement can cause physical injury.
- Personnel must be aware of situations where component movement cannot be prevented, such as:
  - If the hydraulic system fails
  - If the hydraulic system disengages
  - If the hydraulic system receives a control signal resulting in component movement
- Personnel must release all sources of potential energy.
- Personnel must make sure that any possible component or machine movement is mechanically prevented.

3.2 Hydraulic System Hazard

Improper operation, maintenance, or service of the hydraulic system can cause severe injury or death.

To minimize the risk:

- Always use cardboard or paper when you do a high-pressure hydraulic leak check.
- Keep hands and body away from the leak.
- Obey approved procedures for releasing the hydraulic pressure before you loosen the hoses and open any component in the system.
- Always depressurize the system before you do maintenance on the hydraulic system accumulators.

3.3 Explosion Hazard

Use only water in the water injection system tanks. Using additives can cause an explosion when the system is heated.

3.4 Burn Hazard

There is a risk of burn injuries while working with and around the machine. This must be considered when:

- Working with parts that get hot during operation - for example, the engine, transmission, or hydraulic pumps.
- Working on a part that can get overheated due to bearing or bushing defects - for example, starter bushing.

To minimize the risk:

- Keep away from the engine during operation.
- Always wait for the engine, transmission (if equipped), or hydraulic pumps to cool before you start any maintenance work.
- Keep away from the particle filter and the exhaust pipe during regeneration.
- Release all pressure in air, oil, or cooling systems before any hoses, fittings, or related items are disconnected or removed.

3.5 Electric Shock Hazards

There is a risk of electric shock while working with the machinery. This must be considered when:

- Connecting or disconnecting a power supply to and between machines.
  - Turn off the power supply before you plug the connectors in or out.
  - Avoid water around the cables.
- Cleaning the equipment or doing maintenance around electrical cabinets, connectors, and cables.
  - Only authorized personnel can do work involving cables, electrical cabinets, and connectors.
  - Do not use high-pressure cleaning methods for electrical components.

3.6 Slipping Hazard

Substances such as ice, lubricant, and oil can cause surfaces to become slick and increase risk of slipping.

To minimize the risk:

- Keep work areas, platforms, walkways, scaffolding, and other accessways free of foreign substances.
- Clean any spilled or leaked fluids before you start the machine.

3.7 Entanglement and Shearing Hazard

Moving parts can cause entanglement and shearing.

To minimize the risk:

- Stay away from the machine work area during operation.

3.8 Crushing or Cutting Hazard

There is a risk of crushing or cutting injuries while working with and around the machine.

To minimize the risk:

- Support all equipment and attachments correctly when you work below them.

- Stay clear of all rotating and moving parts. Guards must be in place when maintenance is not being done.
- Keep objects away from moving fan blades. Fan blades can throw or cut objects or tools that fall or are pushed into them.
- Wear protective glasses when you hit objects to prevent injury to your eyes.
- Chips or other unwanted materials can fly off of objects when struck. Make sure that no one can be injured by flying unwanted materials before you hit any object.
- Do not stand in the working area of a floor crane when it is operating with an overhead load.
- Do not stand below an overhead load.
- Do not do adjustments while the engine is operating unless otherwise specified in the operation or maintenance manual.

3.9 Tipping Hazard

Exceeding the slope or grade limitations of the machine and its configuration can cause the machine to tip over.

To minimize the risk:

- Determine the safe operating grade of the machine with the tower in the vertical and horizontal positions before you move the machine into position.
- Do not move the machine with the tower in the vertical position for long distances.
- Refer to the Stability section of this manual for slope and grade limitations for your machine.

3.10 Scalding Hazard

High liquid temperature and hot oil components can cause serious injury.

To minimize the risk:

- Release the pressure before you remove the filler plug on the compressor oil tank.
- Do not service the machine when the fluids or the machine is hot.
- Use working gloves and a face shield, and cover your arms with long sleeves when you work on any hot fluid hoses or components.

3.11 Moving and Rotating Parts Hazard

Moving and rotating parts can cause severe injuries.

To minimize the risk:

- Stay clear of all rotating and moving parts.
- Keep the guards in place when maintenance is not being done.
- Keep objects away from moving fan blades.

3.12 Pressurized Systems Hazard

Leaking fluid systems can cause fluid injection into your skin and the erosion of your skin.

To minimize the risk:

- Make sure that the system is depressurized before maintenance work is started.
- Replace worn hoses.
- Do not replace a high-pressure hose with a hose of lower quality than the original.
- Do not replace a high-pressure hose with a hose that has a removable coupling.

3.13 Hazard Zones

Hazard zones are areas within and around the machine in which a person can be exposed to a hazard. Take the necessary precautions when you work within the hazard zones.

> ***NOTE:*** *Hazard zones are marked with signs. Obey instructions on all warning and information signs on the machine.*

- Rotating drill string hazard zone
- Moving tower hazard zone
- Hot surface hazard zone
- Electrical equipment hazard zone
- Falling equipment hazard zone
- Moving machine hazard zone

3.14 Work Requiring Special Authorization

Only authorized or trained personnel, depending on the type of system, must do all of the diagnosis, repairs, maintenance, and troubleshooting.

- Electrical system
- Climate control unit
- Air and hydraulic system
- Mechanical system
- Machine software
- Crawler tracks
- Diesel particulate filter

4 Safety Precautions

4.1 General Safety Guidelines

- Personnel operating the machine must be trained and knowledgeable about the machine and the dangers involved.
- Obey the safety guidelines and observe warnings provided in the machine documentation.
- Always make sure that the manuals are available to the operator.
- Observe local safety and health regulations.
- Before you start the machine, make sure that all personnel are clear from the machine hazard zones.
- Observe the machine warning signals.
- Do an inspection of the safety equipment and emergency stops before each shift and after you move the machine.
- Step on designated work areas only. Do not step on open hatches.
- Do an inspection of the machine daily. Make sure that the routine maintenance and lubrication are being dutifully done.
- If the machine or a machine system stops because of an indicated fault, use the equipment only when all faults are corrected. Call maintenance personnel.
- Make sure that all controls are working properly.
- Work done with the machine involves impact on the surrounding environment, for example, vibrations and landslides. All work must be done in accordance with the local safety directives.
- Make sure that unnecessary tools and materials are cleared from the work area.
- Supplement all operating instructions with detailed working instructions covering the methodology of the working sequences, all individual job responsibilities, and overall supervisory responsibility.
- Do not modify the machine in ways that could affect safety without having the approval of the manufacturer. This applies to the installation and adjustment of safety devices and valves, as well as to welding work on load-bearing elements.
- Position the machine on a solid, level bench or ground surface with load bearing capacity to adequately support and maintain machine stability while operating. Avoid silt or unstable ground and areas with high water tables.
- Do not provide service or maintenance to your machine unless the machine is on firm, level ground.

4.1.1 Inclement Weather

- Drilling operations must be terminated during an electrical storm, and the complete crew must move away from the machine.
- Although drilling operations can proceed through a wide range of weather conditions, operations must cease if weather conditions are severe enough to create a safety hazard.
- Safety hazards from weather could include, but are not limited to, low visibility for approaching traffic, or the inability for the operator to see, grasp, use or move equipment. Other conditions can create safety hazards and can be decided at the work site.

- The operator has the responsibility to determine if the severity of the conditions warrant stopping the machine operation.
- If you do a task during inclement weather, work deliberately and adjust the work procedures to address the changed conditions.
- Stay away from the machine during electrical storms.

Lightning

Because of the high potential for lightning strikes on the tower of a machine, action must be taken when lightning storms approach within 16 kilometers (10 miles). Workers must take shelter away from the machine during the potential for lightning strikes. Follow local mine site requirements and consider the following:

- Lowering the tower before an approaching storm might reduce the likelihood of a top-down lightning strike. If the tower is not lowered before thunder or lightning storms are near the work area, do not reduce evacuation time to do so.
- Keeping the tower raised might make a strike more likely, but also increases the cab's zone of protection under Lee's Rolling Sphere Principle as described in NFPA 780. The National Fire Protection Association (NFPA) provides free online access to NFPA 780 in read-only format.
- If the tower remains raised during a lightning storm, lowering the drill string to the ground or into the bottom of a drill hole might improve grounding.
- If there is enough time to do so, put the machine on its tracks to provide the lowest resistance possible to a lightning strike.
- If there is time to safely exit the machine, take shelter in a lightning-protected building. If a suitable building is not available, take shelter in a car or truck with a metal roof. Do not take shelter in a cloth-roofed convertible, golf cart, or other similar vehicle. Refer to the owner's manual of any vehicle in which shelter might be sought.
- If lightning can be seen or thunder can be heard, conditions have already become too dangerous to exit the cab. Do the following:
  - Stay in the cab.
  - Shut the doors and windows.
  - Remain seated.
  - Do not touch metal in the cab.
  - Remain seated in the cab until the site has issued an “all clear” signal, or 30 minutes after the last thunder.

Cold Weather

- During freezing weather, do not touch any metal parts of the machine with uncovered skin. Freezing of skin to metal can occur almost instantaneously.
- All air and water hoses and pumps must be drained when not in use if freezing weather is expected. If applicable, the machine must be winterized at the end of each period of use.

4.1.2 Ventilation

Operate internal combustion engines and fuel-operated heating systems only in adequately ventilated areas. Before you start the machine in an enclosed area, make sure that there is sufficient ventilation.

4.1.3 Buried Cables

Observe precautions specified by local electric and gas utility companies when you work in the vicinity of buried gas lines or buried electric power cables.

4.2 Personal Protection

- Always use the following Personal Protection Equipment (PPE) when you work with or near the machine:
  - Hard hat
  - Approved and close-fitting clothing with high visibility
  - Safety shoes or boots
  - Hearing protection
  - Protective safety glasses
  - Protective gloves
  - Seat belt
  - Other necessary safety gear
- Secure long hair.
- Do not wear jewelry.
- Use hearing protection with high noise reduction capacity. For some applications, sound pressure levels can be high even with hearing protection.
- Always use protective safety glasses when you use a hammer, as chips or unwanted material can cause eye injury.
- Use a hammer with a soft face when you insert or remove hardened pins.
- Use a respirator in dusty conditions.
- Make sure that compressed air for cleaning the machine does not exceed 2 bar (30 psi).
- Put on a protective face shield and clothing when you clean the machine or components with compressed air.

4.3 Tools and Equipment

- Tools, lifting equipment, fastening devices, jacks, and other working equipment must be in safe operational and working conditions.
- Put on safety glasses when insert or remove bolts. Metal splinters may break off and cause injuries.
- When you fit, remove, or change the installation position of equipment or components, use approved lifting equipment or support devices to secure equipment or components against unintentional movement.
- Depressurize systems and units in an appropriate manner before you move them.

4.4 Safety Precautions When Lifting, Installing, and Connecting

- Make sure that only authorized personnel lift, install, and connect the equipment.

- De-energize the machine before you lift, install, or connect equipment or a component to the machine.
- Use only approved tools and methods.
- Use lifting devices for lifting heavy components.
- Use lifting devices that are inspected and approved and that are in compliance with local regulations.
- Only attach lifting devices to specified suspension points.
- Make sure that no personnel are present or working below a suspended load.
- Use only ladders and platforms designed for that specific purpose.

4.5 Safety Precautions When Propelling

! ***NOTE:*** *Machines can be propelled from one drill hole to another drill hole with the tower in the vertical position and tower pinning in the locked position if the ground is stable, level, and there are no obstructions to cause the machine to tip.*

! ***NOTE:*** *If the ground is not level, level the machine and lower the tower onto the tower rest at the rear (non-drilling end) of the machine before propelling.*

- The operator shall be seated with the seat belt securely fastened about them when propelling the machine.
- Do not get on or off the machine when it is moving.
- Obey local traffic regulations.
- Observe that no person or obstruction is present within the machine hazard zone or in the direction of travel.
- Propel the machine drill-end first when possible for increased visibility.
- Impaired visibility can cause a collision risk for the operator and for other machines. Use ground personnel to assist with navigating when visibility is impaired. Always know where your helpers are located. Do not move the machine if they are not in view.
- Know and use proper signals when you move the machine.
- Always examine the ground conditions where the machine is operated. Do not operate the machine on unstable ground. Do not propel through areas of soft mud.
- Adapt the speed to the terrain.
- Make sure that the drill pipe is out of the drill hole before you move the machine.
- Secure all drill pipes and tools before you move the machine.
- Know the height, width, weight, and length of the machine before you move it.
- Use the main pumps to control speed and direction. If a problem with propelling arises, and the system does not respond to controls, return the controls to Drill mode. This action sets the parking brakes and stops the machine.
- If propelling with the tower raised, make sure that all locking pins are in place, and the ground is level and solid. Only propel smoothly and at a low speed with the tower raised.
- Do not move the machine with the tower partially raised, unless it is an angle drill with the proper locking pins in place.

- Do not move the machine with the tower-locking pins removed or unpinned. The tower is not designed to be held up by the tower-raising cylinders alone.
- Lower the tower if moving over rough ground or a long distance. A long distance movement of the machine is considered to be any move other than moving from one drill hole to an adjacent drill hole in any given drill pattern.
- When the tower is down, use caution while cornering to allow for tower overhang. Small changes in direction of the machine are greater at the end of the tower.
- Do not exceed the maximum allowed inclination angles for the machine. Seek an alternate route if the angle of the machine nears the maximum allowed inclination angles.
- Always operate up and down slopes and avoid side-hill travel. If traveling across a hill is unavoidable, travel with the cab on the uphill side of the machine.
- If propelling up or down a grade, index the carousel to the non-drill pipe loading position to prevent the drill pipe from falling.
- Monitor the temperature and brake release pressure when propelling the machine. The roller temperature must not exceed 79 °C (175 °F) anywhere on the roller. Constantly do a temperature check of the bottom rollers. If the rollers become overheated, stop and let the rollers cool.

4.6 Safety Precautions During Operation

- Make sure that the operator can easily access the pedals and controls before they start the machine. If the controls are not accessible to the operator, the machine must not be operated.
- Keep all doors shut during operation. This prevents the disruption of the flow of cooling air and the reduction of noise suppression. Keep doors open for short periods, only if necessary.
- When you work from the service platform, at least one operator must be present on the ground.
- Turn the rotation off when manually using drill bits and drill pipes.
- Energize the machine functionality of collecting dust (water flushing, water mist, or dust collector) during drilling. Rock dust is created during the drilling process and is harmful to personnel or your health.
- Do not use flammable liquids near hot surfaces, sparks, or an open flame.
- Always use handrails and steps to get on and off of the machine. Always maintain a three-point contact when you get on or off the machine. Watch for slippery surfaces when you get on or off of the machine.
- Do not climb or jump off the machine. Do not stand on components that cannot support your weight. Use an adequate ladder.
- Operate the machine only if all protective and safety-oriented devices, such as removable safety devices, emergency shut-off equipment, sound-proofing elements, and exhausts, are in place and fully functional.
- Do not disable or bypass automatic shut-off circuits. They are provided to prevent personal injury and machine damage.
- Make sure that no one is at danger or risk before you start and set the machine in motion. Personnel can be pinched, entangled, or crushed by moving machinery. While the machine is in operation, crew members must not place any part of their bodies or clothing on or near any rotating machinery, gears, pinions, wire ropes, cables, chains, or wrenches.

- Make sure that accessories are safely stowed and that all leveling jacks are fully retracted before you move the machine.
- Make sure that there is sufficient clearance when you cross underpasses, bridges, and tunnels, or when you operate the machine below overhead lines.
- Always keep at a safe distance from the edges of steep slopes, pits, and quarry faces.
- Always secure the machine against inadvertent movement and unauthorized use before you leave the operator cab.
- Observe the position of the fire extinguishers, and make sure that they are fully charged and inspected regularly.
- Avoid any operational mode that might sacrifice safety.
- Take all necessary precautions to make sure that the machine is used only when in a safe and reliable condition.
- Avoid any operation that might be a risk to machine stability.
- Do a check of the water and oil temperatures during the operation of water and/or lube oil heaters to ensure proper operation.
- Use extreme caution and be very observant when you operate the machine in close quarters or congested areas.
- Do not carry passengers except for when using the buddy seat.
- Do not work in the vicinity of overhanging banks or on grades that could cause the machine to slide or roll over.
- Do not let bystanders, other than authorized persons, stand within the machine's working area when the engine or motor is operating.
- Stow the hoist hook securely to the base of the machine when the hoist is not in use.
- Know the area in which you are working. Familiarize yourself with any and all work site obstructions and any other potential hazards in the area.
- Stay away from the exhaust cleaning unit and the exhaust pipes on exhaust openings. High temperature gases escape from the unit.
- Always start and operate the engine in a well-ventilated area and, if in an enclosed area, vent the exhaust to the outside.

4.6.1 Pre-Start Inspection Precautions

- Do a daily inspection of the machine. Make sure that the routine maintenance and lubrication are being dutifully done.
- Do a check for warning or safety locks and tags on the machine. Operate the machine only when repairs have been made and authorized personnel have removed all of the warning and safety locks and tags.
- Repair or replace any malfunctioning, broken, or missing parts before use.
- Do a check the batteries and wire connections before you start the machine. Tighten terminal clamps, and make sure that all batteries have caps. Loose wires can cause fires and shocks, and spilled fluid can cause burns.
- Make sure that all guards are in place on the machine. Install them if they have been removed for maintenance.
- Make sure that the propel, steering, signaling, and lighting systems are fully functional.
- Before you start or propel the machine, look inside, outside, and below the machine for people and obstructions.

- Keep work areas, platforms, walkways, scaffolding, and other access ways free of materials, dust, and substances, such as ice, lubrication, or oil, that could cause surfaces to become slick or otherwise hazardous.
- Know the location of the emergency stop if the machine is so equipped.
- Do a check for conditions that could be dangerous, such as unstable ground conditions, tree limbs, low-hanging wires, or an overhanging rock face.
- Clean any foreign material from the operator's platform to reduce the danger of a slip or a fall.
- Always know the capabilities and limitations of your machine: speed, gradient, steering, and braking.
- Be aware of the dimensions of the machine’s height, width, and weight when you move the machine.
- Before you start the engine, make sure that all operating controls are in the stop or neutral position and that the emergency stop button is pulled out.
- Determine if the engine will be operated in an environment in which combustible gases could be drawn through the air inlet system. These gases could cause the engine to overspeed, which in turn could seriously damage the engine and result in bodily injury or property damage.
- Look for leaks in the fuel, hydraulic, and compressor systems.

4.6.2 Setup and Start Precautions

- Use only water in the water injection system tank.
- Do an inspection of the engine or motor before and after you start the machine.
- Do not start an engine or motor with the governor linkage disconnected.
- Always sound the horn before you start the machine if the machine is so equipped.
- Do a check of touch screens, gauges, and controls for correct operation. Stop the machine immediately and replace any that are defective.
- Start the engine or motor from the operator console only.
- Make sure that the machine is stabilized and level before you raise the tower.
- When raising the tower, make sure that there are no electric power lines within the operating area of the machine.
- Listen for unusual noises.
- Only use the emergency stop button in an emergency. Start the engine or motor only when the problem causing the emergency stop has been located and corrected.
- Examine all safety devices. Report any defects immediately.
- Engage hydraulic controls slowly in cold weather to avoid shock loading.
- On initial startup or overhaul, be prepared to STOP the machine should an overspeed condition occur. This may be accomplished by stopping the fuel and air supply to the engine.

4.6.3 Stopping and Shutdown Precautions

- Be prepared to stop the engine or motor should an emergency condition occur.
- Use the emergency stop button in an emergency. Start the engine or motor only when the problem is resolved.
- Move the machine away from high walls or faces before you stop work for the day.
- Do not park the machine under an overhang or where a bank can collapse.

- Always park the machine on solid, level ground. If this is not possible, always park the machine at a right angle to the slope. Do not let the tracks move uncontrollably.
- Always turn the drill/propel mode selector switch to the Drill position, and place all controls in neutral, off, or stop position before you leave the machine.
- Do not leave the controls when the engine or motor is on. Do not leave the operator platform when the machine is operating.
- Use proper flags, barriers, and warning devices, especially when you park in areas of heavy traffic.
- If the machine is left over the drill hole, remove the drill pipe from the drill hole and lower the jacks so that the tracks touch the ground.
- Make sure to release all of the pressure in the systems before you leave the machine.
- Before you turn the key switch to Off, let the machine operate for approximately five minutes at low idle so that the components can cool.
- Lock the ignition and remove the keys before you leave the operator cab.
- Lock all lockable compartments.

4.6.4 Drilling Safety Precautions

- Use the proper tools for the job. Do not try to lift drill pipe, DHD hammers, subs, stabilizers, or drill bits without the proper lifting devices.
- Use the proper technique in loading and unloading drill pipe. If a lifting bail is used, make sure that a helper on the ground can disconnect it.
- Use a drill pipe handling tool if the carousel needs to be filled. Make sure that the safety clip is in place.
- Do not let anyone climb the tower. If repairs must be made, lower the tower or use a man lift to reach the repair area.
- Do not use the hoist wire rope as a man lift.
- Do not ride the rotary head for any reason.
- Before you raise the tower, make sure that it is clear of tools or objects that could fall. Make sure that all personnel are away from the machine while you raise and lower the tower.
- If the machine is equipped with a remote control for drill-pipe loading or hoist functions, use the remote control unit from a safe location.
- Do not lift or brake too sharply. This can cause premature failure of equipment and can be dangerous.
- Do not retract the hoist so far that it slams into the crown block. Continuous pull on the wire rope can break it and drop the load.
- The drilling process can produce flying dust, which can cause serious respiratory difficulties for personnel who work in or visit the drilling site. Always use dust control measures to keep dust under control, and keep the dust curtains in place to prevent flying dust.

4.6.5 Night Operation Precautions

- Night operations require more attention by the operator because of limited visibility.
- Make sure that all the lights work properly.
- Use the lights to the best of your advantage.

4.6.6 Electrical Power Cable Safety

DANGER

Risk of Electric Shock

Operating near or contacting a power cable with any part of the machine can cause electrocution, causing death.

- ▶ Do not raise the tower or operate your machine near electric power cable.
- ▶ Keep at least 3 meters (10 feet) away from power cable.
- ▶ If there appears any danger of wind or other obstruction decreasing the distance, do not drill in that area.

- Put the machine as far as possible from electrical power cables and do not work inside of the minimum specified distance set by local, state, or federal regulations.
- Treat all electrical cables as energized power cables.
- Clear the area. Slowly raise and lower the tower. If the distance to the cable has been misjudged, your reaction time might be too slow.
- A signal person must be used to guide the machine in the vicinity of power cables. The signal person and machine operator must be in direct visual contact always.
- If the machine comes into contact with an energized wire:
  - Do not leave the machine.
  - Do not touch metal.
  - Warn others against approaching and touching the machine.
  - Have the energized wire de-energized.
  - Propel the machine out of the hazard zone.
  - Do not leave the machine until the damaged cable has been safely repaired or de-energized.

4.7 Safety Precautions During Service and Maintenance

NOTICE

Maintenance and Repairs

- ▶ Do not make repairs to machine components without a full understanding of the component and system.
- ▶ Use the maintenance manual or the Standard Operating Procedures when you work on the machine.

> ***NOTE:*** *In any work concerning the operation, conversion, or adjustment of the machine and its safety-oriented devices, or any work that is related to maintenance, inspection, or repair, observe the startup and shutdown procedures described in the operation and maintenance manuals.*

> ***NOTE:*** *All personnel that are involved in the setup of machines and doing maintenance and repairs must know and practice proper procedures, including safety locks and tags practices.*

- After you do repair or maintenance on the engine, be prepared to shut off the air or fuel supply to stop the engine if there is an over-speed condition during startup.
- Do not change the engine governor settings from those indicated in the engine manual and the engine option plate.
- If the machine is shut off for maintenance and repair work, it must be secured against inadvertent starting by:
  - Locking the principal control elements and removing the ignition key.
  - Attaching a safety lock and tag warning sign to the main starter key switch.
- Make sure that the maintenance area is secured.
- Do maintenance in accordance with the maintenance schedule.
- Make sure that the engine or motor is off, and the fluids are cool.
- Do maintenance and repair work only of the machine is positioned on stable and level ground and has been secured against inadvertent movement.
- Do maintenance in a safe area away from machine traffic, with a stable roof and adequate ventilation.
- When you do maintenance in the machine's hazard zone, secure all components that can be moved or continue to move before you start maintenance work.
- Avoid servicing, cleaning, or examining the machine while it is operating.
- Before you work on the compressor, receiver tank, or hose installations or connections, stop the engine or motor, and release the compressor air pressure completely from the receiver tank.
- To avoid the risk of accidents, be careful when you attach and secure lifting equipment to individual parts and to large assemblies being moved for replacement purposes. Always use a lifting device that is in perfect condition and has adequate lifting capacity. Do not work or stand below suspended loads.
- Always use the correct tools and workshop equipment when you do maintenance on the machine.
- Always use specially designed or otherwise safety-oriented ladders and working platforms when you do overhead assembly work. Do not use machine parts as a climbing aid. Do not climb the tower.
- Keep all handles, steps, handrails, platforms, landings, and ladders free from oil, lubrication, mud, dirt, snow, and ice.
- Make sure that all protective guards and covers are installed if you must start a machine to make adjustments or inspections. Work carefully around moving parts to help prevent an accident.
- Tighten all screwed connections that have been loosened during maintenance and repair.

- Depressurize all system sections and pressure pipes (hydraulic, compressed air) that are to be removed in accordance with the specific instructions before you do any repair work.
- Any safety devices that were removed for setup, maintenance, or repair purposes must be installed and examined immediately upon completion of the maintenance and repair work.
- Make sure that all of the consumable and replaced parts are discarded safely and with minimum impact in accordance with local environmental regulations.
- When you drain fluids, make sure that adequate, sealable containers are available and every care is taken to prevent spills.
- Observe all product-related safety regulations, such as safety data sheets, when you use oil, lubrication, and other chemical substances.
- Be careful when you work with hot liquids, due to risk of burning or scalding.
- Only do welding, flame cutting, and grinding work on the machine if expressly authorized, as there may be a risk of explosion and fire.
- Do not weld or flame cut on pipes or tubes that contain flammable liquids.
- Before welding, flame cutting, or grinding operations, clean the machine and the surrounding area from dust and other flammable substances with a nonflammable cleaner. Make sure that the premises are adequately ventilated to reduce the risk of explosion.
- Put fire blankets on and around equipment where welding, flame cutting, or grinding to protect equipment from damage. Have a fully charged and inspected fire extinguisher immediately available.
- Examine all lines, hoses, and screwed connections regularly for any leaks and for obvious damage. Repair any damage found immediately. Splashed oil may cause injury and/or fire.
- When you work on the machine deck and the rotary head is above you, you are working below a suspended load. Lower the tower to the horizontal position, if possible, to do the maintenance task. When you work within a vertical tower, use the local locking procedure to prevent the rotary head from falling.
- Put on the proper head protection at all times when you work below and around the machine.
- Get the proper Confined Space Permit before you work in confined spaces.
- Do the following to prevent a muscle strain or back injury:
  - Use a two-man lift or an approved lifting device for weights over 21 kilograms (50 pounds).
  - Use lifting devices and proper lifting techniques when you remove or replace a heavy component.
- Do the following when you work from heights:
  - Assess the risks and plan the work carefully when you work from an elevated platform.
  - Secure yourself and tools properly.
  - Put equipment and tools in an appropriate area so that your footing is secure.
  - Use the proper body harnesses when you work from an elevated platform.
- Do the following when you use ladders:
  - Ladder rungs must be free of grease, oil, and other slipping hazards.
  - Do not put more load on the ladder than the manufacturer's recommended maximum load.
  - Do not use ladders on unstable or uneven surfaces unless the ladder is secure.

- When there is a need for service personnel to energize one or more of the machine functions for fault-finding or other work, such work must only be done under the following conditions:
  - There must always be two people present, both being fully instructed on the safety issues. One of them, from the main operator station, must supervise the safety of the technician doing the work.
  - The supervisor must have immediate access to an emergency stop.
  - Properly illuminate the area where the work is to be done.
  - Communication between the technician and the supervisor at the main operator station must be established in a reliable manner.
  - Only when the machine is shut off completely, and the means of starting are isolated, is someone allowed to do repair or maintenance work on the machine alone.

4.7.1 Maintenance Safety - Cleaning the Machine

- Clean the machine, especially connections and threaded unions, of any traces of oil, fuel, or preservatives before you do maintenance or repair. Use nonabrasive detergents and lint-free cleaning rags.
- After you clean the machine, examine all fuel, lubricant, and hydraulic fluid hoses for leaks, loose connections, chafe marks, and damage. Repair or replace defective parts immediately.
- Before you clean the machine with water, steam jet (high pressure cleaning), or detergents, cover or tape over all openings which, for safety and functional reasons, must be protected against water, steam, or detergent penetration. Special care must be taken with electronic components and switch gear cabinets.
- Wash all fittings, caps, plugs, and the like thoroughly with a non-flammable, non-toxic cleaning solution before you service the machine.
- When you clean the machine, make sure that temperature sensors do not come into contact with hot cleaning agents.
- Remove all of the covers and tapes applied for that purpose after you clean the machine.

4.7.2 Maintenance Safety - Guards

- If you remove guards from the machine to do service, install them before you start the machine.
- If a guard becomes damaged or lost, replace or repair it before you start the machine.
- Do not cut or modify a guard.

4.7.3 Maintenance Safety - Lubrication

!	***NOTE:*** *If a lubrication point does not take lubricant, report it immediately. A bearing can get hot and cause a fire if not lubricated properly.*

- Do not lubricate the machine while it is operating, unless the machine is equipped with an automatic lubrication injection system.

- To lubricate the fittings on the tower, lower the tower, and use a man lift to access hard to reach and inaccessible areas.

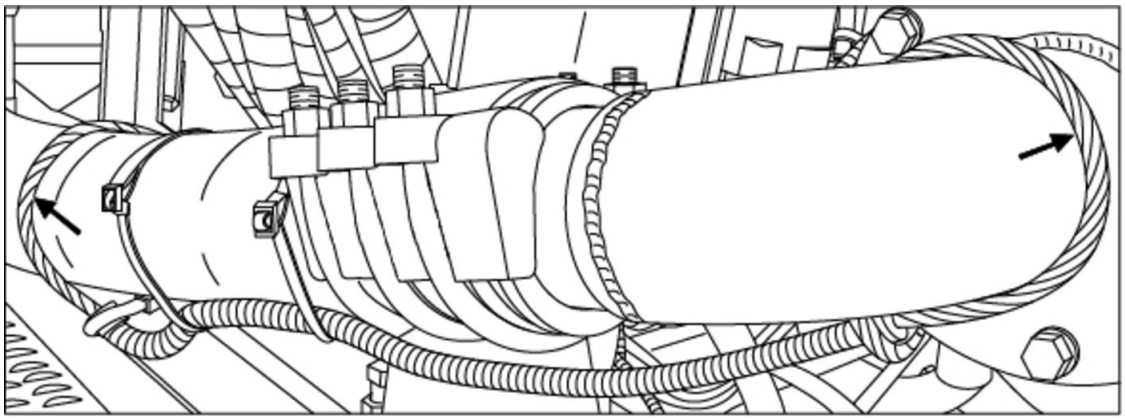
4.7.4 Maintenance Safety - Pipes and Hoses

- Repair any loose or damaged fuel and oil pipes and hoses. Leaks can cause fires.
- Examine all pipes and hoses carefully for wear or deterioration. They must be routed, supported, and clamped securely. Fire may result from lubricant being sprayed on hot surfaces, causing personal injury and property damage.
- When you examine pipes and hoses, do not use your bare hands to do a leak check.
- Tighten all connections to the recommended torque.
- Make sure that clamps, guards, and heat shields are installed correctly to prevent vibration, rubbing against other parts, and excessive heat during operation.
- Keep all shields in place and installed correctly to protect from oil spray in case of a line, tube, or seal failure.
- Do a check for the following:
  - End fittings damaged, leaking, or displaced
  - Outer covering chafed or cut and wire reinforcing exposed
  - Outer covering ballooning locally
  - Evidence of kinking or crushing of the flexible part of the hose
  - Armoring embedded in the outer cover
- Do not replace a hose with one of lesser strength or capacity. Breakage or leakage could result.
- Do not use a "will-fit" hose, as it may fail and cause an accident before it can be replaced by the correct type. Use the "First Aid Hose Kit."

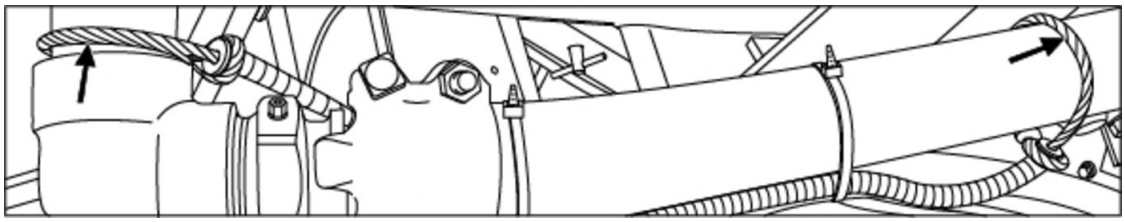
Secure Hoses Properly

!	***NOTE:*** *Do not reuse Dixon or Campbell clamps once torqued.*

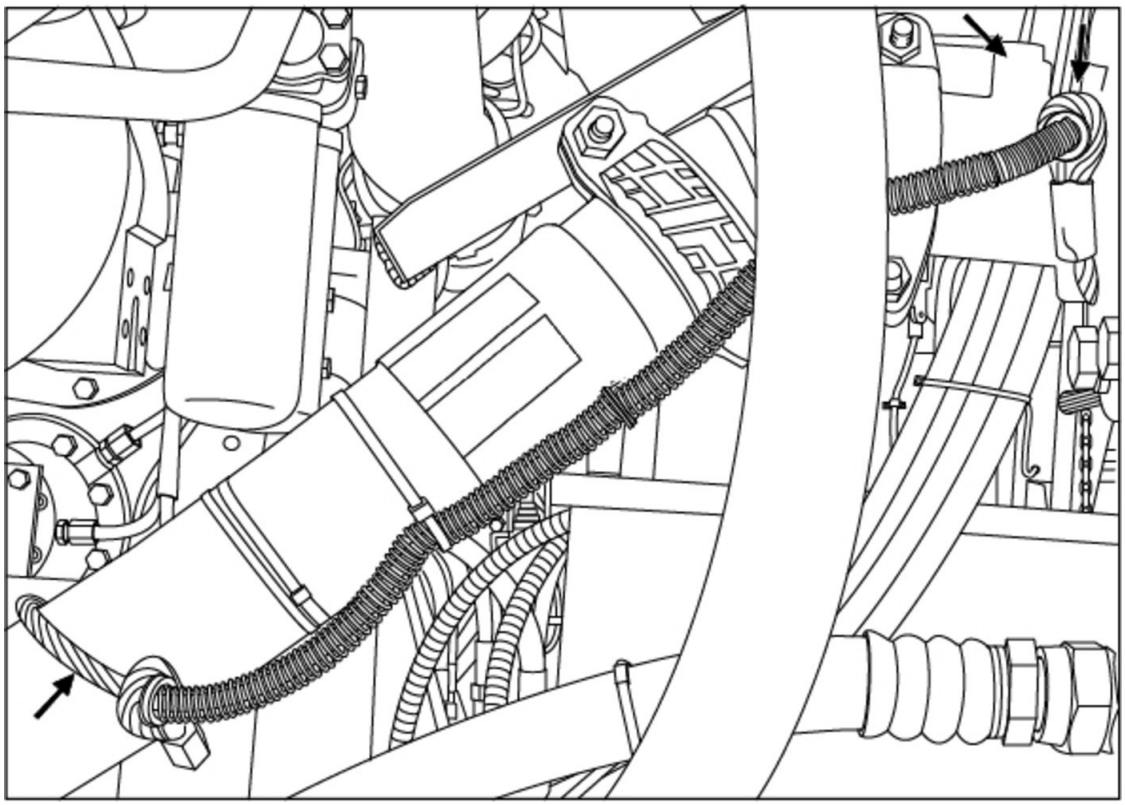
- Use a clamping device to secure the hose onto the coupling nipple per specific installation instructions.
- Make sure that a safety chain or suitable locking device (whip check) is installed for air hoses 19 mm (0.75 in) diameter or larger. The device will hold the hose if it becomes dislodged for any reason. The whip check must remain on the hose at all times.
- Make sure that the following conditions are met:
  - All slack is removed in the whip check.
  - One end of the device is secured to the rubber part of the hose.
  - Opposite end must be on the neck of the piping and placed beyond a positive stop point such as an elbow or fitting.
- Do not operate the machine, allowing flow through the hose or movement in the hose, without the hose being fully secured with clamping and a properly installed whip check.



Campbell® Hose Clamp with Whip Check



Dixon® Hose Clamp with Whip Check



Victaulic® Hose Clamp with Whip Check

4.7.5 Maintenance Safety - Wire Rope

> ***NOTE:*** *Wire rope routed over drums and through sheaves creates pinch points. Do not use hands or bars to guide wire rope onto drums. Instead, use rope guides. Keep clothing and all parts of the body away from wire rope and from machinery that moves the wire rope.*

- Replace the wire rope when it is worn or has any of the following:
  - Six randomly distributed broken wires are found in one lay.
  - Wear of one-third of the original diameter of the outside wires.
  - Evidence of any heat damage from any cause.
  - Any kinking or cracking occurs.
- Make sure that all hooks are connected properly.
  - Saddle and nuts must be around the lifting side of the wire rope.
  - Always use a thimble when you install a hook.
  - Always use the correct number of clamps for the size of the wire rope.
  - All hooks must have lock-type dogs to prevent the wire rope from jumping out of the hook throat.
- Only use Epiroc replacement wire ropes and hooks.
- Do not let the wire rope backlash on the hoist or the drum.
  - Make sure that the wire rope spools properly on the hoist or the drum.
  - Do not overload the hoist or the wire rope.

Examining the Wire Ropes

Hoists or winches and wire ropes must be examined frequently for unforeseen wear patterns and discarded in accordance with the latest revision of ISO 4309:

Visible broken wires	When the wire breaks occur randomly in sections of wire rope that route through one or more steel sheaves and spool on and off the drum in single-layer spooling.
	When the wire breaks occur at sections of wire rope that are coincident with cross-over zones in multi-layer spooling.
	When the localized grouping of wire breaks in sections of wire rope which do not spool on and off the drum.
	When there are two or more wire breaks at the inter-strand contact point or valley area between two outer strands in a wire rope lay length, equivalent to 6d of the wire rope.
	When there are two or more wire breaks at a termination.
Magnetic rope test	When the loss of metallic area is 6% over a length of 6d wire, and 10% over a length of 30d wire.
Decrease in rope diameter	When there is a uniform decrease of 10% and over in the diameter of wire rope for a single-layer wire rope with fiber core.

	When there is a uniform decrease of 7.5% and over in the diameter of wire rope for single-layer wire rope with steel core or parallel-closed wire rope.
	When there is a uniform decrease of 5% and over in the diameter of wire rope for rotation-resistant wire rope.
Fracture of strands	When a complete strand fracture occurs.
Corrosion	When the corrosion of unwanted material exudes from the valleys between the outer strands during internal corrosion.
	When the wire surface is heavily pitted and slack wires during external corrosion.
	When there is any doubt about its severity during fretting corrosion.
Deformation and damage	When there is waviness in wire rope.
	When there is a basket or lantern deformation.
	When there is a core or strand protrusion.
	When there are protruding wires in groups on the opposite side of the wire rope to that which is in contact with a sheave groove.
	When there is an increase in diameter by 5% or more for a wire rope with a steel core, or 10% or more for a wire rope with a fiber core.
	When there are flattened portions in a wire rope that routes through a sheave.
	When there is a kink or tightened loop in the wire rope.
	When there is a severe bend in the portion of wire rope that routes through a sheave.
	When there is damage to the wire rope due to heat or electric arcing.

4.7.6 Maintenance Safety - Electrical System

⚠ WARNING

Shock/Electrocution Hazard

Hazardous voltage can cause severe injury or death.

- ▶ Disconnect all sources of power before you service the machine.
- ▶ Apply safety locks and tags to the machine.
- ▶ Make sure there is no electricity or voltage present in the circuit receiving maintenance.
- ▶ Obey all instructions and warning.

WARNING

Risk of Electric Shock and Fire

Exposure to high voltages in cables, connectors, and electrical cabinets or exposure to loose connections can cause fatal injuries.

- ▶ Turn off the main power before you work on the electrical system.
- ▶ Work that involves fault finding of the electrical system or connection of loose wires should be done by authorized personnel only.

- Work on the electrical system or on electrical equipment may only be done by a skilled electrician or by specially-instructed personnel, under the direct supervision of an electrician and in accordance with the applicable engineering guidelines.
- Disconnect the electric power, and cover exposed terminals before you work on the electrical system.
- Disconnect the battery cables when you work on the electrical system or when you weld on the equipment. Disconnect the ground wire first when you disconnect batteries.
- Use only original circuit breakers with the specified current rating. Stop the machine immediately if trouble occurs in the electrical system.
- Before you start any work, examine the de-energized parts for the presence of power and ground or short circuit in addition to insulating adjacent live parts and elements.
- Do these simple steps before you do any maintenance or electrical work:
    1. Determine all of the locations of the disconnecting means for the circuit receiving maintenance.
    2. Carefully de-energize the circuit.
    3. Do an inspection of the circuit receiving maintenance for voltage to make sure that no electricity is present.
    4. Ground all of the phase conductors to the equipment grounding conductor with a jumper.
- Do the following steps to protect against shock:
    1. Disconnect capacitors or equipment from power before you do any work.
    2. Examine for an open circuit to be certain that the capacitors are disconnected from the power source.
    3. Wait for five minutes after de-energization, and then short-circuit and ground the capacitors before you work on them.
- Do the following steps when you work on capacitors:
    1. Discharge capacitors before you work on them.
    2. Use terminals with an appropriate high-voltage shorting device to short-circuit the terminals.
    3. Make sure that any residual charge is absent from the capacitor.

Some failed capacitors may be found considerably bulged due to internal pressure from gassing before circuit clearing. Such capacitors should be handled carefully. Short circuit a failed capacitor and let it cool before you work on it to lower the internal pressure and reduce the possibility of case rupture. Consult the Safety Data Sheet for information on further precautions when you work on failed capacitors.

4.7.7 Maintenance Safety - Batteries

> ***NOTE:*** *Refer to the Operation Manual for your specific machine.*

- Attach safety locks and tags to the battery disconnect switch when you work on the electrical system or when you weld on the machine.
- Make sure that the battery area is well-ventilated if it is necessary to connect a jump battery or battery charger. Fumes from the battery can ignite a spark and explode.
- If battery charging is required, make sure that the battery charger is "OFF" when making connections.
- When starting from an external source, connect the positive (+) jumper cable to the POSITIVE (+) terminal of the battery of the engine to be started first. Attach the negative (-) boost ground cable to the starter NEGATIVE (-) terminal (if equipped) or to the engine block last. This prevents potential sparks from igniting the combustible gases produced by some batteries.
- Do not disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operating. A spark can cause the flammable vapor mixture of hydrogen and oxygen to explode.
- Disconnect the ground wire first when you disconnect a battery.
- Use extreme caution when handling, cleaning, wiring, or recharging batteries. They can explode and spray acid. Keep battery covers in place at all times.
- Battery electrolyte contains acid and can cause injury. Avoid contact with skin and eyes. Wash your hands after you touch batteries and connectors.
- Put on the required Personal Protective Equipment when you service the batteries.
- Connect the ground cable last when you install a battery.
- Battery acid burns skin, eats holes in clothing, and causes blindness if splashed into the eyes.
- Batteries generate highly explosive fumes. A spark could ignite these gases.
- Do not short across batteries. A spark could ignite these gases.
- Keep battery covers in place. Make sure that there is no connection between the battery terminals and the cover.
- Thaw a frozen battery before you jump start it. Frozen batteries can explode.
- Do not smoke when you observe battery electrolyte levels.

4.7.8 Maintenance Safety - Hydraulic System

- When you do a high-pressure leak check, use cardboard or paper to find the leak.
- Keep hands and body away from the leak.
- Obey approved procedures for releasing hydraulic pressure before you loosen the hoses and open any component in the system.
- Depressurize the system before you do maintenance work on the hydraulic system accumulators.
- Hydraulic hoses must be laid and fitted correctly. Make sure that there are no connections that are interchanged. The fittings, lengths, and quality of the hoses must comply with technical requirements.

4.7.9 Maintenance Safety - Valves

- When you work on valves, keep the area clean to prevent contamination from getting inside of the valves.
- Make sure the valve being installed is the same type as the one removed. Motor and cylinder spools are interchangeable, and an accident or failure of a component may occur if they are used incorrectly.

4.7.10 Maintenance Safety - Pumps and Motors

- Make sure that hoses are plugged when you replace pumps and motors.
- Replace pumps and motors with the same size and type.
- Use the correct adapters when you install pumps or motors.

4.7.11 Maintenance Safety - Cylinder Repair or Replacement

- When you repair cylinders, make sure to block them up to prevent them from dropping or rolling off of the machine.
- Loosen the feed system wire ropes before you remove the feed cylinders.
- To prevent oil spills and slippery conditions, plug all hoses when they are removed from the cylinders.
- Use a hoist to lift the larger cylinders.
- After you repair or replace cylinders, especially the feed or tower-raising cylinders, release all air out of each end of the cylinder before you connect it to the machine. Air in one end can cause the tower or rotary head to fall and can cause an accident.

4.7.12 Maintenance Safety - Engine Cooling System

On water-cooled engines, hot coolant in the radiator can rush out if the radiator cap is removed too quickly. To decrease risk of injury:

- Let the radiator cool before you remove the cap.
- Turn the radiator cap to the first notch to vent any pressure in the system.
- After all pressure has been released, remove the cap.

4.7.13 Maintenance Safety - Fueling

> ! ***NOTE:*** *Refer to the Operation Manual for your specific machine.*

- Do not fill the fuel tank while the machine is in operation, while near an open flame, or while smoking. Wipe the spilled fuel immediately.
- Do not spill fuel on hot surfaces.
- Refuel in a well-ventilated area.
- Keep open lights, lighted smoking materials, flames, or spark-producing devices at a safe distance when refueling.

- Keep the fuel nozzle in contact with the tank being filled, or provide a ground to prevent static sparks from igniting fuel.
- Turn off cab and fuel heaters.
- Do not mix any other fuel with diesel fuel. An explosion can occur.

4.7.14 Maintenance Safety - Compressors

WARNING

Burning Hazard

Hot oil or components can cause serious injury.

- ▶ Avoid contact with hot oil or components.
- ▶ Use working gloves, a face shield, and cover arms with long sleeves when working on any hot fluid lines or components.

WARNING

Compressed Air

Can cause serious injury

- ▶ Do not remove any plugs or open the drain valve before making sure that all air pressure has been released from the system.
- ▶ Do not disconnect the machine hoses or couplings when the system is pressurized.

- Release all of the pressure in the receiver tank and hoses before you work on the compressor system.
- Do not remove any regulation or control hoses while the machine is operating or pressure is still in the system. High-pressure air can cause serious injuries.
- Turn off drill air, and exhaust the drill string before you loosen the drill pipe at the table.
- Make sure that there is no pressure before you remove the oil filler plug.

4.7.15 Maintenance Safety - Coolers and Fans

- Remove the fan guard only if the machine is stopped and safety locks and tags are attached.
- Examine the fan speed with the guard in place.
- Do not remove unwanted material from inside of the fan guard. Stop the machine. Attach safety locks and tags to the electrical disconnect switch before you remove unwanted material from the fan guard.
- Be careful while washing out coolers with high-pressure washers. Spray can injure eyes.
- Obtain a suitable hoist that is capable of lifting and moving coolers and radiators before you replace them.

4.7.16 Maintenance Safety - Tracks

- Always raise the machine on the jacks and block them before you replace idlers or track pads.
- Do not release all of the pressure from the track tensioning spring. It can cause an accident.

4.8 Safety Guidelines - Working with Pressurized Components

- Pressurized components must not be exposed to welding or heat treatment.
- Safety equipment such as pressure gauges, over-pressure control devices, and safety valves must be used while you work with pressurized components.
- Installation, design, and connections related to the pressure valve must not be modified.

4.9 Safety Guidelines - Working with Compressors

- Stop the machine if there is an indication that the compressor is overheated.
- Do not clog the compressor with paint, carbonized oil, or dirt, which could disrupt compressor operation.
- Regulate the air compressor pressure to conform to the rated pressures of tools and circuits being used. Do not operate tools or circuits at pressures above the rating established by the manufacturer.
- Shut the compressor outlet valve before you connect or disconnect a hose. Make sure that the hose is fully vented before you disconnect it.
- Do not turn on the high-pressure air too quickly when the air hoses are near people. Hoses can jump and cause injuries, especially if there is water or oil inside of the hose.
- Make sure that the open end of the hose or air line is steady before blowing compressed air from the other end. Impact from a loose end could cause injury or damage.
- Do not put external force on the air outlet valves (for example, pulling the hoses).
- Do not connect tools or air powered equipment to the machine hoses. They must be attached to the service regulator and the pressure adjusted to the working capacity of the tool being used.
- Use distribution lines, hose couplings, clamps, and air hoses that are of the correct dimension and suitable for the working pressure. Do not use damaged or worn hoses.
- Be careful when you use service air to clean off the working area. High-pressure air can be dangerous.
- If there is any doubt about the pressure rating of a tool or accessory, stop. Review the information supplied with the machine or contact your nearest Epiroc Customer Center representative for assistance.

4.10 Safety Guidelines - Electrical System

WARNING

Shock/Electrocution Hazard

Hazardous voltage can cause severe injury or death.

- ▶ Do not operate equipment or work on equipment unless you have read and understand the instructions and warnings in the Operation Manual.
- ▶ Obey all instructions and warnings.

- Do an inspection of the electrical equipment of the machine at regular intervals. Repair defects, such as loose connections or scorched cables, immediately.
- Examine the electrical system for loose wires, connections, and frayed insulation.
- Repair or replace damaged parts. Insulate all electrical connections and disconnected wires.
- Work on the electrical system or on electrical equipment must only be done by a skilled electrician or by specially-instructed personnel, under the direct supervision of an electrician and in accordance with the applicable engineering guidelines.

4.11 Safety Guidelines When Towing

WARNING

Towing

Personal injury or death can result from the incorrect towing of a disabled machine.

- ▶ Follow the recommendations below when towing a machine.

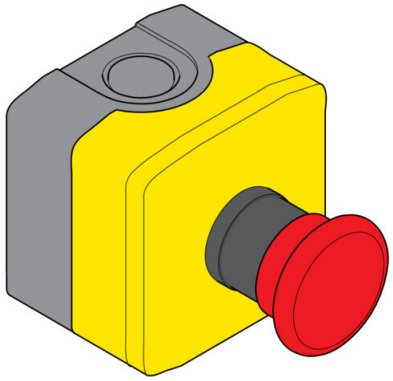
- Refer to the Operation Manual for your specific machine.
- Use the appropriately sized towing vehicle to tow the machine, with the correct tow bar for the machine, as applicable.
- Before you disconnect the drive or brakes, secure the machine to the tow vehicle.
- Tow the machine from the non-drilling end only.
- Make sure that all jacks and dust curtains are fully retracted.
- Make sure that the drill pipes are secured, and the tower is fully horizontal.
- While towing, observe the prescribed propelling position, admissible speed, and itinerary.
- Do not exceed the propelling speed for your specific machine. If the propelling speed is exceeded, there is a risk of raising the temperature in the drives and rollers.
- Monitor the temperature and brake release pressure when you tow the machine. The roller temperature should not exceed 79 °C (175 °F) anywhere on the roller. Constantly do a check of the bottom rollers for overheating. If the rollers become overheated, stop and let the rollers cool.

4.12 Safety Guidelines During Transporting

- If possible, haul the machine on a transporter if long distance moving is required.
- Shielding must be provided on the towing machine to protect the operator if the tow line or bar should break.
- Block (chock) the tracks to make sure that no movement takes place when the drive motors are disengaged.
- Position the machine on the transport vehicle centered from side to side. Use proper chock blocks in the front and rear of the tracks once the machine is loaded on the trailer.
- Machines must be transported in accordance with the operating instructions. Use only the appropriate means of transport and lifting equipment of adequate capacity.
- Entrust the fastening of loads and the instructing of crane operators to experienced persons only. The person giving the instructions must be within sight or sound of the operator.
- Do not load the machine onto the transport vehicle without knowledge of and experience with the operation of the machine.
- Always use a ramp when loading the machine onto the transport vehicle. Make sure that the ramps are of adequate strength, low angle, and proper height.
- Use proper chock blocks in the front and rear of the wheels of the transport vehicle after loading the machine onto the trailer.
- Make sure that the propelling and drill control levers and joysticks are in the Stop position.
- Lock all lockable compartments.
- Make sure that the trailer is on level ground.
- Approach the transport vehicle loading ramps squarely to make sure the machine does not drop off the side of the ramp.
- Keep the trailer deck clean of clay, oil, mud, ice, frost, and other material that can become slippery.
- Always know the overall height, weight, width, and length of the machine and hauling vehicle. Make sure that there is sufficient clearance when crossing underpasses, bridges, and tunnels, or when passing under overhead power lines.
- When you move the machine on public access roads, obey all traffic regulations. Make sure that proper clearance flags, lights, and warning signs, including the "Slow Moving Vehicle" emblem, are properly displayed. Know your approximate stopping distance at any given speed. Do not turn corners at excessive speeds. Look in all directions before reversing your direction of travel.
- Secure the machine to the deck of the transport vehicle with adequate chains or wire ropes and blocks to meet local regulations.
- Position the engine speed control to Low Idle and turn the key switch to Off.

5 Safety Functions

5.1 Emergency Stop



Example of an Emergency Stop

NOTICE

Risk of Machine Damage

Incorrect use of the emergency stops can cause technical problems and damage to the machine and related equipment.

▶ Only use the emergency stops in hazardous situations or when a hazardous situation is likely to occur.

The red emergency stop (E-Stop) button shuts off power to the fuel valve and stops the engine or motor when pressed.

An optional tower emergency stop line is available. Function of the tower emergency stop line is the same as the emergency stop button. When pulled, the line will stop the engine or motor.

5.1.1 Location of Emergency Stops

Numerous emergency stops are available on the machine, depending on the configuration:

- RCS control panel in the cab
- Tower
- Along the deck
- Power Pack
- Three accessible at ground level
- Remote control for the hoist
- Rig Remote Control console

5.1.2 Resetting the Emergency Stop

Once the emergency has been corrected, pull out the emergency stop button to reset it.

5.1.3 Resetting the Emergency Stop Line

Once the emergency has been corrected, press the reset button on the rope pull emergency stop switch to reset the emergency stop line.

Some machines are equipped with an additional emergency stop button on the rope pull emergency stop switch. If so equipped, press the blue reset button on the rope pull emergency stop switch to reset the emergency stop line.

5.2 FOPS

The one-piece Falling Object Protective Structure (FOPS) cab is thermally insulated, heated, and pressurized. It is designed for convenience, ease of control, comfort, and safety, while providing maximum visibility to the work area.

5.3 Fire Suppression Equipment

5.3.1 Fire Prevention Readiness

Fire prevention readiness means that personnel know how to use the fire extinguisher and the automatic fire suppression system before they operate or work on the machine.

It is important to do the following before you operate or work on the machine:

- Read the instructions and know the location, function, and use of fire extinguishers and activating devices.
- Identify if the machine has a main power switch or a battery isolation switch or both. Be trained on how to turn the switches off in the case of fire.
- Identify if the machine has a fuel supply. Be trained on how to close the fuel supply in case of fire.

5.3.2 Automatic Fire-Extinguishing System

The machine can have an automatic fire-extinguishing system installed. The system is activated from switches that may be located in several locations, including inside of the cab near the door.

The following areas are typically covered by the fire-extinguishing system:

- Pump drive and pumps
- Turbochargers
- Fan motor
- Auxiliary valves at the valve stand

5.3.3 Description of the Fire Extinguishers

Make sure that the machine is equipped with approved portable fire extinguishers in accordance with the local regulations and laws that apply. The machine is equipped with designated locations for the fire extinguishers.

Classification of Fires

Class	Type of Fire
A	Fires of common materials that burn with both flames and glow like most of the interior materials
B	Fluid fires such as gasoline and oil
C	Gas fires

Obey the instructions on the fire extinguisher.

5.3.4 Location of Fire Extinguishers

An optional fire extinguisher can be installed in the cab. Two or four additional fire extinguishers can be installed on the platform of the machine.

5.3.5 In Case of Fire - Using a Handheld Fire Extinguisher

This equipment is **optional**.

> ! ***NOTE:*** *Obey local regulations if there is fire.*

Precondition ✓ The parking brake is applied.

1. Use a handheld fire extinguisher to extinguish the fire. Follow the manufacturer instructions.
2. Do the following steps only if this does not jeopardize personal safety:
   a. Turn off the main power switch and the battery isolation switch, or whichever is present on the machine.
   b. Close the fuel supply valve, if present.

   > ! ***NOTE:*** *Restart the machine only when the cause of the fire has been established and the faults have been corrected.*

3. Replace used fire extinguishers with approved new extinguishers.
4. Clean any extinguisher residue in the machine before operation.

5.3.6 Actions to Take After a Fire

> ***NOTE:*** *Start the machine only when the cause of the fire has been established and all faults have been corrected.*

Precondition ✓ The handheld fire extinguishers are used.

1. Replace the used fire extinguishers with new and approved extinguishers.
2. Do an inspection of the firefighting equipment.
3. Replace the damaged parts on the machine.
4. Clean off any extinguisher residue from the machine.

> ***NOTE:*** *Fire extinguisher medium is corrosive and must be cleaned off well.*

5.4 Protective Guard

- The protective guard must be shut during drilling.
- The machine must be shut off before the protective guard is opened for maintenance or any other type of work.

5.5 Seat Belts

Seat belts are included for the safety of the machine operator. It is the responsibility of the mine or machine operator to identify risks. The operator shall be seated with the seat belt securely fastened about them when propelling the machine to avoid the risks of being ejected from the seat, thrown about the cab, or thrown from the cab. To increase visibility on the non-cab side and the non-drill end while wearing the seat belt, consider the following alternatives:

- Camera system with a monitor in the cab
- Remote propel system
- Another person to help with spotting the machine

6 Warning Signals

6.1 Warning Beacon

An amber propel strobe light can be installed on the top of the cab.

Cab Strobe Light

A blue or amber attention strobe light can be installed on the top of the tower. The color of the attention strobe light varies depending on site conditions.

Tower Strobe Light

6.2 Warning Beacons for Automatic Systems

WARNING

Automatic Operation

Automatic operation can cause serious injury or death.

▶ Keep out of the hazard zone while the beacon is flashing.

On machines that are equipped with automatic systems, an array of warning beacons is on each corner of the platform. The beacons can be red, amber, green, and blue. The beacons turn on and are either steady or flashing when automatic systems are active.

6.3 Signal Horn Switch Location

The signal horn can be used to alert personnel near the machine of an operational sequence, a machine movement, or an emergency.

The signal horn switch is located next to the emergency stop button on the right control panel next to the operator seat.

Signal Horn Button

The signal horn is connected to two emergency pulls mounted onto each of the drilling end jacks. They are tied together by a wire rope that routes below the decking and around the machine. In the case of an emergency on the ground, the wire rope can be pulled down to energize the signal horn.

Signal Horn Emergency Pull

7 Noise and Vibration

7.1 Noise Levels

Noise Emission Values/Vibration Values	Drilling, Open Field
A-weighted sound power, uncertainty of 0.3 dB	119.0 dB(A)
A-weighted emission sound pressure level, at the workstation	66.1 dB(A)

In accordance with the requirements EU regulation 2023/1230, Annex III, section 1.7.4.2 and EN ISO 16228, the A-weighted emission sound pressure of the machine at the operator station (in closed cab, seated/standing positions). The machine was tested on a concrete surface.

7.2 Vibration Values

Vibration Values		Drilling, Open Field
Weighted average vibration value, in operator's seat during drilling	Arms	2.5 m/s²
	Body	0.5 m/s²

The weighted average vibration value has been tested in accordance with EU regulation 2023/1230, Annex III, section 3.6.3.1 and EN 16228. Tests were done with the machine at operating speed. The machine was in an open field with no structural objects reflecting sound.

7.3 Declared Values

- Declared values for noise and vibration are obtained by testing with the stated standards and they are comparable with the declared values of other machines tested using the same standards.
- The declared values are not adequate for use in risk assessments, as values measured in individual work places can be higher.
- The actual noise levels and vibration values to which an individual is exposed to are unique and dependent on: work practices, reflected sound from walls, road conditions, exposure duration, and the physical health of the individual.
- Incorrect use of the machine can cause health problems due to whole-body vibration and noise. A guide on the management of vibration is available in ISO/TR 25398 and a guide on hearing protection is available in EN 458.
- Epiroc recommends a program of health surveillance to detect early symptoms caused by exposure to noise and vibrations so that management procedures can be modified to prevent future impairment.

7.4 Causes of High Noise Levels

Noise levels higher than the stated values are likely to occur when:

- Working with open cab doors and windows
- Working underground
- Using the machine incorrectly
- Working with an increased load when compared to the specified values
- Using compressed air

7.5 Effects of Noise

Exposure to noise can cause adverse health effects, such as:

- Permanent hearing loss
- Tinnitus
- Fatigue and stress
- Balance issues
- Poor attention
- Impaired ability to communicate
- Impaired ability to perceive acoustic signals and warning signals

7.6 Noise Reduction Factors

To reduce risk from exposure to noise:

- Do regular maintenance on the noise suppression sealing strips.
- Use approved hearing protection. Refer to guide EN 458.
- Inspect and maintain all hearing protection regularly. Replace the hearing protection seals every six months.
- Use protective eyewear (safety goggles) and hearing protection (earmuffs). Wearing both protective eyewear and hearing protection interferes with the seal of the earmuff to the ear, compromising its sound reduction capability.
- Make sure that earplugs are placed in the ear canals correctly to create a tight seal. Incorrect sizing of ear plugs reduces the damping effect.
- Consider the higher noise level due to reflections from walls in the mine. The noise levels can be 1 to 12 dB higher, depending on:
  - The height and width of the mine drift
  - The characteristics of the noise source
  - The acoustic absorption factor of the rock in the mine
- Stay clear of the machine work area during non-working hours.
- Take frequent breaks in quiet areas to avoid continued exposure to noise levels.
- Do regular maintenance of the door and cab seals, insulation, and mufflers.
- Work with a closed cab door and closed windows.

7.7 Noise Combined with Other Risk Factors

Noise, with other risk factors, can cause serious health issues.

- Vibration and noise in combination can cause higher health hazards.

- People with sensitive conditions like pregnancy and people already with impaired hearing need protection against noise even at lower levels.
- Exposure to ototoxic substances and noise can increase the risk of hearing damage (even under 80 dB). Styrene, toluene and xylene, and certain solvent mixtures are ototoxic. Certain fuels such as kerosene and certain metals such as mercury and lead have also been proven to be potentially ototoxic.

7.8 Factors Affecting Whole Body Vibration

The following factors affect whole body vibration:

- Propelling for long periods of time.
- Speed, duty cycle, and ground conditions while operating from a cab or canopy. These factors are primarily influenced by the operator who controls, for example, speed, working cycle, and route options.

7.9 Vibration Reduction

- Maintain the machine according to the manufacturer's recommendation.
- Do not expose the machine to higher loads, speeds, or performance factors than specified. Excessive loads and mechanical wear increase vibration.
- Use the machine correctly together with related equipment required for the task. Use of incorrect equipment can increase vibrations.
- Using the remote control can reduce vibrations.
- Avoid large holes and uneven ground when propelling. Adapt the speed to the propelling conditions to reduce vibrations.
- Make sure that the seat is adjusted correctly and maintained regularly.
  - Use only original parts when replacing the seat or its included components.
  - Adjust the seat and its suspension according to the operators height and weight.
  - Do not overload the seat.
  - Examine and maintain the suspension and adjustment mechanism.
  - Always wear a seat belt.

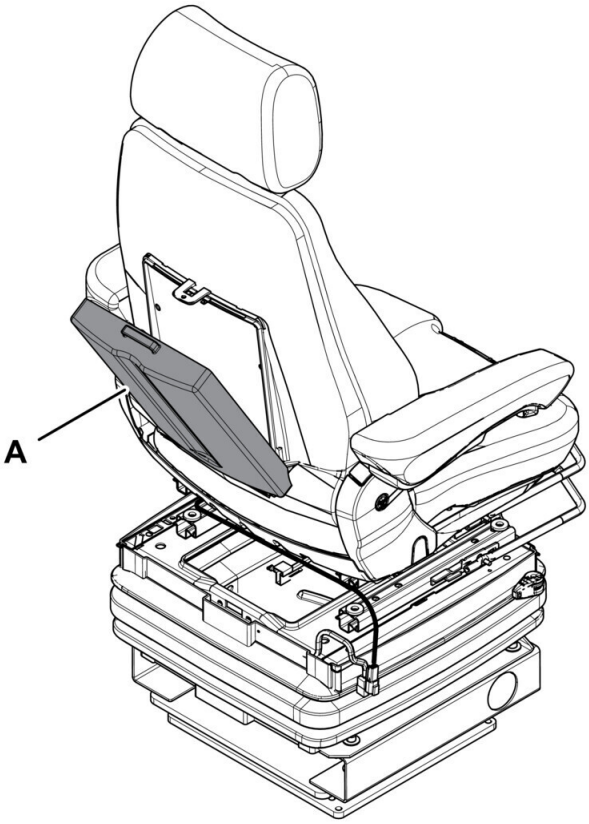
8 Signs

8.1 General Guidelines for Signs

- All machine signs must be in the correct locations, clean, and fully legible.
- To clean a sign, use only a soft cloth, water, and soap. Do not use gasoline or other harsh solvents.
- Replace any missing or damaged signs. Refer to your Spare Parts Catalog and contact your Epiroc representative for new safety signs.

8.2 Location of Safety Signs

The document Safety Manual for Rotary Drill identifies each safety decal and its location on the machine. The document is stored in a labeled compartment on the back of the operator chair.



Location of the Document Safety Manual for Rotary Drill

A	Labeled compartment		

9 Stability

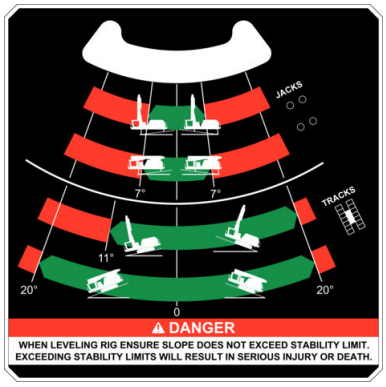
The machine is sufficiently stable for its intended operations. Do not exceed the machine stability and grade limits that are provided in this manual.

The machine operator is responsible for machine stability. If the operator is unsure about machine stability for any reason, stop the machine and consult a supervisor.

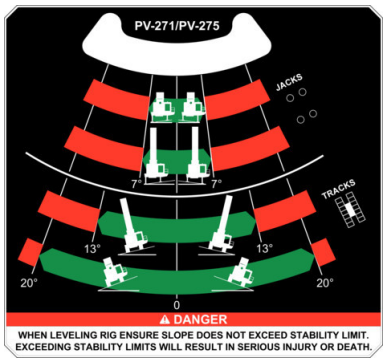
> ! ***NOTE:*** *This information is valid for a machine in its original factory configuration. Unauthorized modifications or extra equipment can cause instability.*

9.1 Inclinometers

The pitch and roll inclinometers display the angle of the machine. This information is critical when you operate the machine, most importantly while propelling and setting up the machine on the work site.



PV-270 Pitch Inclinometer

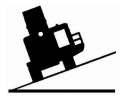


PV-270 Roll Inclinometer

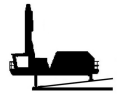
9.2 Stability and Grade Limitations

9.2.1 Stability

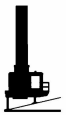
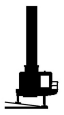
Stability and Grade Limits with the Machine on Tracks

Pitch		
	Tower Up (pitch to drill end)	11°
	Tower Up (pitch to non-drill end)	20°
	Tower Down (pitch to drill end)	20°
	Tower Down (pitch to non-drill end)	20°
Roll		
	Tower Up (roll to non-cab side)	13°
	Tower Up (roll to cab side)	13°
	Tower Down (roll to non-cab side)	20°
	Tower Down (roll to cab side)	20°

Stability and Leveling Limits with the Machine on Jacks

Pitch		
	Tower Up (pitch to drill end)	7°

Stability and Leveling Limits with the Machine on Jacks

	Tower Up (pitch to non-drill end)	7°
	Tower Down (pitch to drill end)	7°
	Tower Down (pitch to non-drill end)	7°
Roll		
	Tower Up (roll to non-cab side)	7°
	Tower Up (roll to cab side)	7°
	Tower Down (roll to non-cab side)	7°
	Tower Down (roll to cab side)	7°

9.3 Wind Speed Limitations

This machine is designed to operate in wind speeds of 72.42 km/h (45 mph) or less. Operating this machine in wind speeds greater than 72.42 km/h (45 mph) reduces the stability limits of the machine. If the wind speed exceeds the maximum allowable speed, park the machine on level ground on its tracks with the tower in the horizontal position.

> ! ***NOTE:*** *The column for wind load and dynamic load is calculated with a maximum wind speed of 20 m/s, Beaufort number 8.*

9.4 Maximum Ground Pressure

The maximum ground pressure of this machine is 0,9 bar (13 psi).

10 Environmental Protection

10.1 Environmental Guidelines

A well maintained and correctly used machine has the least overall negative environmental impact. Read and obey the instructions that are provided when you use and work with the machine.

> ! ***NOTE:*** *Observe the local risk analysis for the local worksite.*

> ! ***NOTE:*** *Obey local regulations concerning the use and maintenance of machinery.*

- Only personnel who have the proper training can use and maintain the machine.
- Always use biodegradable hydraulic fluids and lubricants when you fill the systems for machine operation. Contact Epiroc for more information. See www.epiroc.com.
- Avoid prolonged idling and switch off the engine when not used.
- Use automatic speed control, if available.

10.2 Hazardous Substances

The following substances are used in the manufacturing of this machine and may be hazardous to personnel health if used incorrectly.

Substance	Precaution
Anti-Freeze	Avoid ingestion, skin contact, and breathing fumes
Hydraulic Oil	
Engine Lube Oil	
Compressor Oil	
Preservative Grease	
Rust Preventative	
Engine Fuel	
Battery Fluid	
Gear Oil	
Urea	

The following substances may be produced during operation of the machine and may be hazardous to personnel health.

Substance	Precaution
Engine Exhaust Fumes	Avoid breathing fumes. Avoid buildup of fumes in confined spaces.
Brake Lining Dust	Avoid breathing in dust during maintenance.

10.3 Oils and Greases

- Leaking hydraulic couplings and grease are hazardous to the environment. Do regular checks and make sure that there are no leaks on the machine.
- Contact Epiroc at https://www.epiroc.com for information about biologically-degradable hydraulic fluid and lubricants.

10.4 Fluid Penetration

- Always use a wooden board or cardboard when you do a check for leaks.
- Leaking fluid under pressure can cause serious injury or death.
- If fluid is injected into the skin, see a physician immediately.

10.5 Coolant

At engine operating temperature, the engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot water. When pressure is released rapidly, this hot water can turn into steam.

- Let the hot cooling system components cool before you drain them.
- Any contact with hot water or steam can cause severe burns.
- Do a check of the coolant level only after the engine has been stopped and the filler cap is cool enough to remove with your bare hand.
- Use caution when you remove the filler caps (grease fittings, pressure taps, breathers, or drain plugs).
- Hold a rag over the cap or plug to prevent being sprayed or splashed by liquids under pressure.
- Remove the cooling system filler cap slowly to release the pressure.
- Cooling system additive (conditioner) contains alkali. To prevent personal injury, avoid contact with the skin and eyes. Do not drink cooling system additives.

10.6 Fuel Spill

A fuel spill is a fire hazard and an environmental hazard. Avoid fuel spills when you fill the tank. Fumes from fuel spills are explosive.

10.7 Exhaust Gases

- Exhaust gases are toxic. Good ventilation is necessary when the engine is operating.
- Regular maintenance of the air filters can keep emission levels low.

10.8 Combustible Liquids

All fuels and most lubricants are flammable. Be careful when you work with fuels and lubricants. Before you weld or use a torch on the equipment, always clean the work area first.

- Provide a safe and appropriate method for waste oil disposal.
- Remove all trash or unwanted material from the machine. Examine the engine area, especially around the exhaust.
- Do not leave rags on the engine.
- If the equipment has had a fuel or an oil leak, repair the leak and clean the machine before you operate it.
- Do not store flammable liquids near the engine.
- Wipe the spilled oil.
- Store oily rags in a fireproof container.
- Use non-flammable cleaning solvent to clean the parts.

10.8.1 Starting Fluid

Epiroc does not recommend the use of ether starting fluid. However, if ether is used to start the engine in cold weather, only use in accordance with the OEM recommendations.

- Always use face protection when you use ether starting fluid.
- Ether and other starting aids are poisonous and flammable. Do not smoke while you change ether cylinders.
- Only use ether in well-ventilated areas.
- Do not store ether cylinders in living areas, the storage compartment on the machine, or the cab.
- Do not store ether cylinders in direct sunlight or at temperatures above 39 °C (102 °F).
- Safely discard used cylinders. Do not puncture or burn cylinders.

10.8.2 Air Conditioning Refrigeration System

Diagnosis and work on the air conditioning refrigeration system must only be done by authorized maintenance personnel.

10.9 Handling of Spills and Waste During Maintenance

- Discard expired or worn-out batteries in accordance with local environmental regulations.
- Do not burn oil residue or flush it into drains or water systems.
- Collect oil-content waste, such as filters and rags, in separate containers and discard them in accordance with local environmental regulations.
- Clean oil and fuel residue and spills in accordance with local environmental regulations.
- Do not mix coolant and brake fluids with oil spills. Collect coolant, brake fluids, and oil spills in separate containers and discard them in accordance with local environmental regulations.

- A used diesel particulate filter must be taken to an authorized dealer for discarding it.

10.9.1 Batteries and Work Lights

- Batteries contain acids and heavy metals and constitute a health and environmental hazard.
- Expended batteries must be sent for destruction in accordance with local environmental regulations.
- Certain types of work lights contain mercury and must be handled in accordance with local environmental regulations in force.

10.10 End-User Responsibility during Disposal of the Machine

Always follow local environmental regulations for recycling and the discarding waste.

A worn-out machine must be handled and discarded in such a way that maximizes the percentage of recyclable material. The negative impact on the environment must be as low as possible. If the end user has inadequate knowledge about disposal, a locally-authorized disposal company must be hired.

The following points must be considered during disposal of the machine:

- All steel structures, copper, and aluminum found in electrical cables can be recycled.
- Make sure that fluids are drained and filters are removed and handled in accordance with local regulations.
- Most plastic parts are recyclable. Do a check of the material type and date marked on each plastic part to determine if that part can be recycled.
- Rubber parts are not considered as hazardous waste and can be discarded according to local environmental regulations. Hydraulic hoses must be cleaned before they can be discarded.
- Air conditioning equipment must be taken to an approved recycling facility.
- The windshield and other cab windows must be discarded as waste, not as normal glass recycling.
- Electrical components, such as batteries and circuit boards, must be taken to an approved electrical recycling facility.
- A used diesel particulate filter must be given to an authorized dealer.

10.11 Handling and Disposal of Diesel Exhaust Fluid (DEF)

- DEF is not subject to any particular health and safety regulations. Contact with skin and eyes or swallowing the fluid must be avoided.
- DEF must be discarded properly in accordance with waste recycling and disposal regulations. The waste must be classified according to its origin in accordance with the European Waste List (EWL). Following this regulation, use waste code 06 10 99 (waste from MFSU of nitrogen chemicals, nitrogen chemical processes, and fertilizer manufacture, waste not otherwise specified).
- DEF must not enter the sewage system or groundwater (water hazard class 1). The solution is classified as slightly hazardous to water in accordance with the German Administrative Regulation on the Classification of Substances hazardous to water (VwVwS) Annex 2 (WGK 1).

- The fluid can pose a danger of slipping if spilled. It is essential to remove spilled fluid. Make sure that the fluid does not enter the sewage system or ground or surface water. All contamination must be physically removed and discarded in suitable containers. Minimal amounts of remaining fluid must be rinsed away with water.
- Packaging which has been contaminated with DEF and can no longer be used must initially be treated like the substance itself. After the packaging has been emptied and cleaned, it can be reused as long as the regulations are obeyed.
- DEF is non-combustible. Measures taken to extinguish any fire must be appropriate to the surroundings. High temperatures (>30 °C/ 86 °F) can lead to the release of ammonia, a hazardous substance.

See Reference Documentation
Diesel engine instruction manual

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epiroc.com