

Operation

PV-271D / PV-291D RCS 5.6



Original Instructions

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Revision History

Revision No.	Date	Revision
001	August 2019	Original release
002	April 2020	Editorial changes
003	May 2022	Updated Controls and Instruments chapter and Starting the Machine section. Updated Tier 4 engine content in Operation chapter. Added DHD content to Drilling with the Machine. Added TUM code content to the Starting the Machine section. Updated Drill Pipe Handling sections.
004	October 2022	Added PV-291D to title. Changed rotary head references: Standard is now PV-271D, optional is now PV-291D. Removed references to 3-hole gearbox. Minor editorial changes.
005	April 2023	Editorial changes throughout. Updated for RCS 5.5. Added Configuring Automatic TUM Code Transitions section. Updated the General Information section.
006	May 2023	Editorial changes throughout.
007	December 2023	Editorial changes throughout. Updated for RCS 5.6. Setup and Propel screen now Setup screen.

1 Introduction

1.1 Safety First

Always read and obey the information in the Safety manual before you operate the machine or before you start maintenance work. Also read and obey the safety messages in this manual.

1.2 The Purpose of this Publication

The Operation manual is intended to:

- Give an overall description of methods, required calculations, and settings.
- Give an overall description of machine features.
- Instruct the operator regarding applicable controls, handling, and operation of the machine.
- Instruct the operator about doing maintenance and troubleshooting.

1.3 Target Group

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

1.4 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 covered by 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.

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1.5 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](https://www.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

1.6 Abbreviations

Abbreviation	Definition
A/C	Air Conditioning
ACCB	Air Case Circuit Breaker
ACGT	Atlas Copco undercarriage
AM/FM	Amplitude Modulation / Frequency Modulation
Amp	Ampere
Btu	British thermal unit
CAC	Charged Air Cooler
CCI	Common Communication Interface
cfm	Cubic feet per minute
DDCB	Drill Deck Control Box
DEF	Diesel Exhaust Fluid
DHD	Down-Hole-Drill
EARS	Electronic Air Regulation System
EPA	Environmental Protection Agency

Abbreviation	Definition
FOPS	Falling Object Protective Structure
GPS	Global Positioning System
GUI	Graphical User Interface
GVW	Gross Vehicle Weight
HVAC	Heating, Ventilating, and Air Conditioning
IQAN	Electronic control systems for mobile machinery
ISO	International Organization for Standardization
LED	Light-emitting Diode
OEM	Original Equipment Manufacturer
PPE	Personal Protective Equipment
RCS	Rig Control System
RPM	Revolutions Per Minute
RRC	Radio Remote Control
SAE	Society of Automotive Engineers
SCR	Selective Catalytic Reduction
SE2	Service access level 2
TUM	Time Usage Model
WLAN	Wireless Local Area Network

2 Product Description

2.1 General Product Description

This machine is a track-driven blasthole drill that uses a rotary head to drive the drill pipe. It has a carousel that can hold two drill pipes.



Example of PV-271 Blasthole Drill

2.2 Intended Use of the Product

This machine is designed for drilling blastholes in open-pit mines using rotary or percussive action. The machine is designed solely for this purpose. All other uses are considered unsuitable.

2.3 Misuse of the Product

Any use not described in the section Intended Use of the Product is forbidden.

Examples of misuse and forbidden use are:

- Using the machine for pioneering or earth moving
- Traveling along inclines greater than those specified
- Traveling on soft, unstable ground without enough load-bearing capacity to support and maintain machine stability
- Towing other machines or equipment

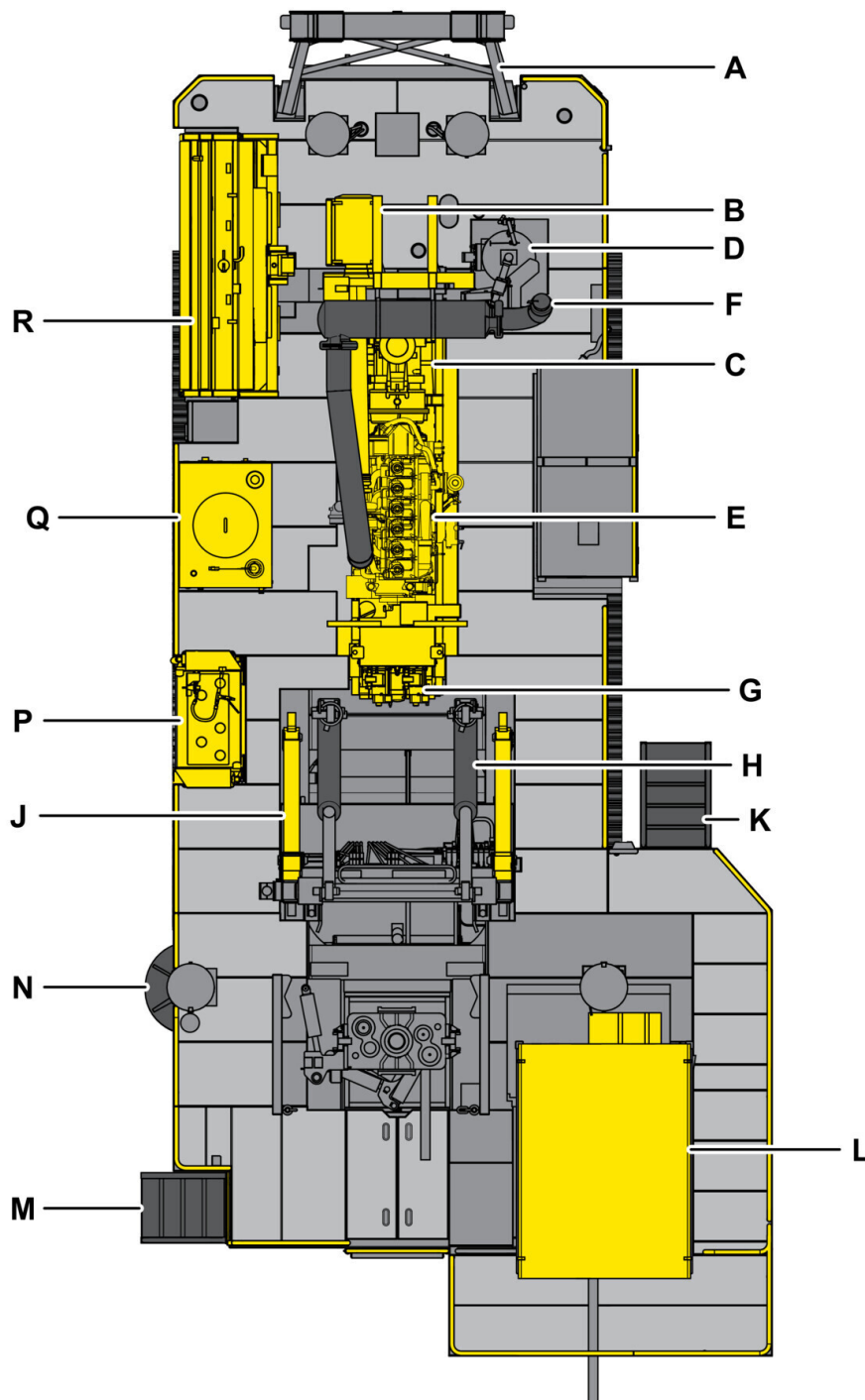
This list is not exhaustive.

2.4 Product Overview

This blasthole machine has the following features and characteristics:

- Track-driven machine
- Climate-controlled falling object protective structure (FOPS) cab
- Controlled from the cab using the Rig Control System (RCS)
- Powered by a diesel engine
- Hydrostatic rotary head drill and feed system
- Single-pass drill
- Carousel can hold two drill pipes
- "No bump" drill pipe changer protects the feed system
 - Limits the feed force when the carousel is unstowed
 - Prohibits carousel movement when the rotary head is not fully raised
- Delivers variable air volume while maintaining constant air pressure
- Side-by-side cooler package cools the hydraulic oil, compressor oil, and diesel engine coolant
- Optional hydraulic clutch disengages the compressor from the engine when the compressor is not needed
- Optional angle drilling package accommodates 0- to 20-degree angles at 5-degree increments
- Optional water injection stabilizes loose formations down the hole and aids in dust suppression
- Optional dust collector removes dust from the drilling area

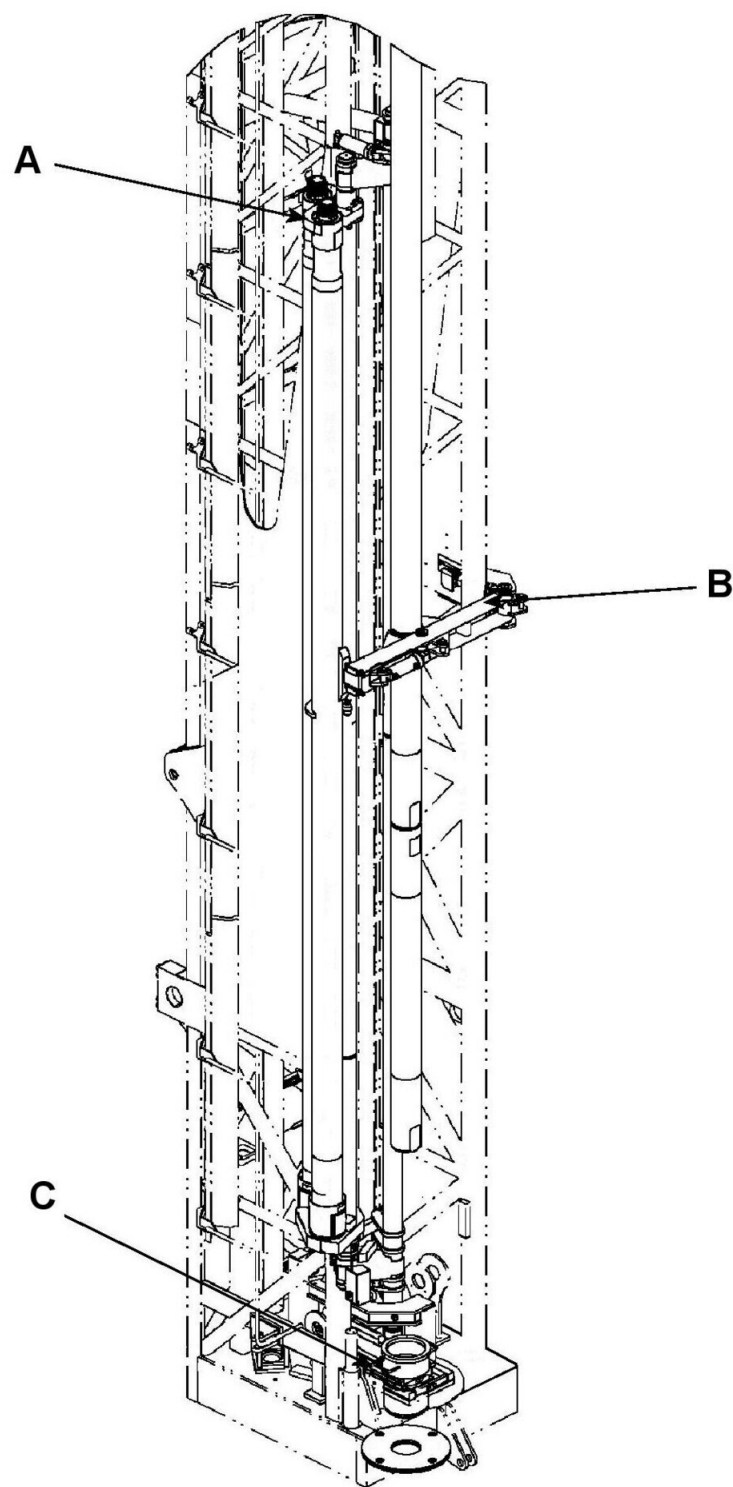
2.5 Main Components



PV-271D Deck Main Components

A	Tower rest	B	Air cleaners
C	Air compressor	D	Receiver tank
E	Engine	F	Exhaust

G	Pump drive and pumps	H	Tower-raising cylinders
J	Tower support	K	Stairs
L	Cab	M	Stairs
N	Hydraulic leveling jack	P	Hydraulic tank
Q	Down-hole-drilling tank	R	Cooler



PV-271D Tower Main Components

A	Drill pipe changer and carousel	B	Drill pipe support
C	Deck fork		

2.6 Data Plate

The data plate contains the serial number (product identification number) for each individual machine, and is required when:

- Contacting Epiroc for support
- Ordering components or kits
- Creating records
- Maintaining records

		Epiroc Drilling Solutions LLC Garland, Texas, USA	
Model:		 	
Serial No:			
Pressure:			psi
Flow:			cfm
Production Month:			Year:

3 Controls and Instruments

3.1 Location of Emergency Stops

Numerous emergency stops are available on the machine, depending on the configuration. Refer to the Safety Manual for this machine for the complete list.

3.2 Platform Overview

3.2.1 Electrical Isolation Station

The machine has one jump-start receptacle and three isolation switches; starter motor, negative battery, and positive battery. The isolation switches for the starter motor and battery must be switched on for the machine to start and function properly. The RCS Timer Reset switch must be cycled to reset the RCS Timed Out LED for the machine to start if the machine has not operated for more than 30 minutes or if the battery isolation switches are cycled.

The isolation station is at the cab side non-drill end drop-down panel.

Engine Starter Isolation Switch

The engine starter isolation switch controls the electrical power to the starter. The starter isolation switch has a switch lockout tab.

Battery Isolation Switch

The battery isolation switch controls the battery power to the machine. Turn the switch counter-clockwise and release to turn the battery system on. Turn the switch clockwise and release to shut off the battery system. The battery isolation switch has a switch lockout tab. Turn the switch to align the holes and attach a safety lock and tag.

3.2.2 Battery Jump Start

The optional battery jump start receptacle has two locations:

- On the power pack base non-cab side.
- On the fast service bracket non-drill end, cab side.

Pull off the receptacle cover to connect the external power. When the receptacle is not in use, install the cover to keep the dirt and unwanted material out of the socket.

3.2.3 Gauges and Indicators

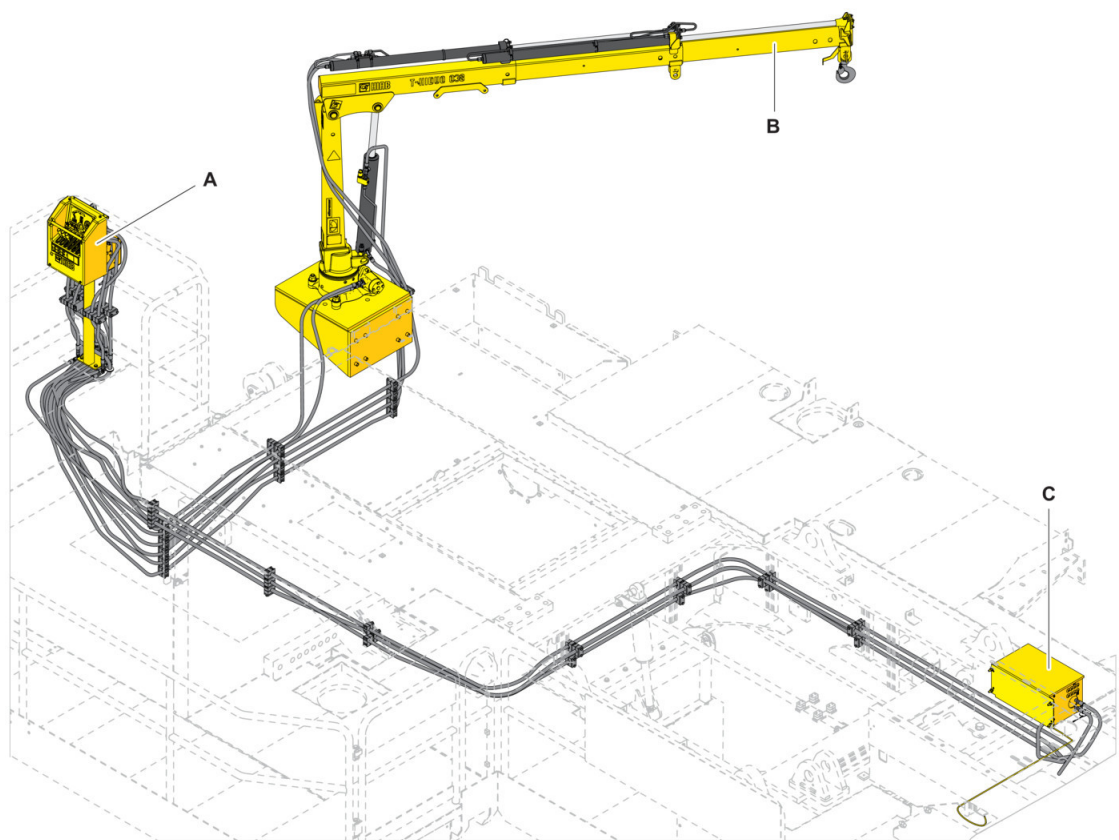
Gauges and indicators are primarily found within the Rig Control System. A dial pressure gauge is also located on the receiver tank. Sight level gauges and level indicators are also on various components.

3.2.4 Controls for the Washdown System

The control to switch on or off the water to the washdown system is on top of the water injection pump.

The trigger lever on the washdown system spray wand controls the spray volume from the wand.

3.2.5 Crane



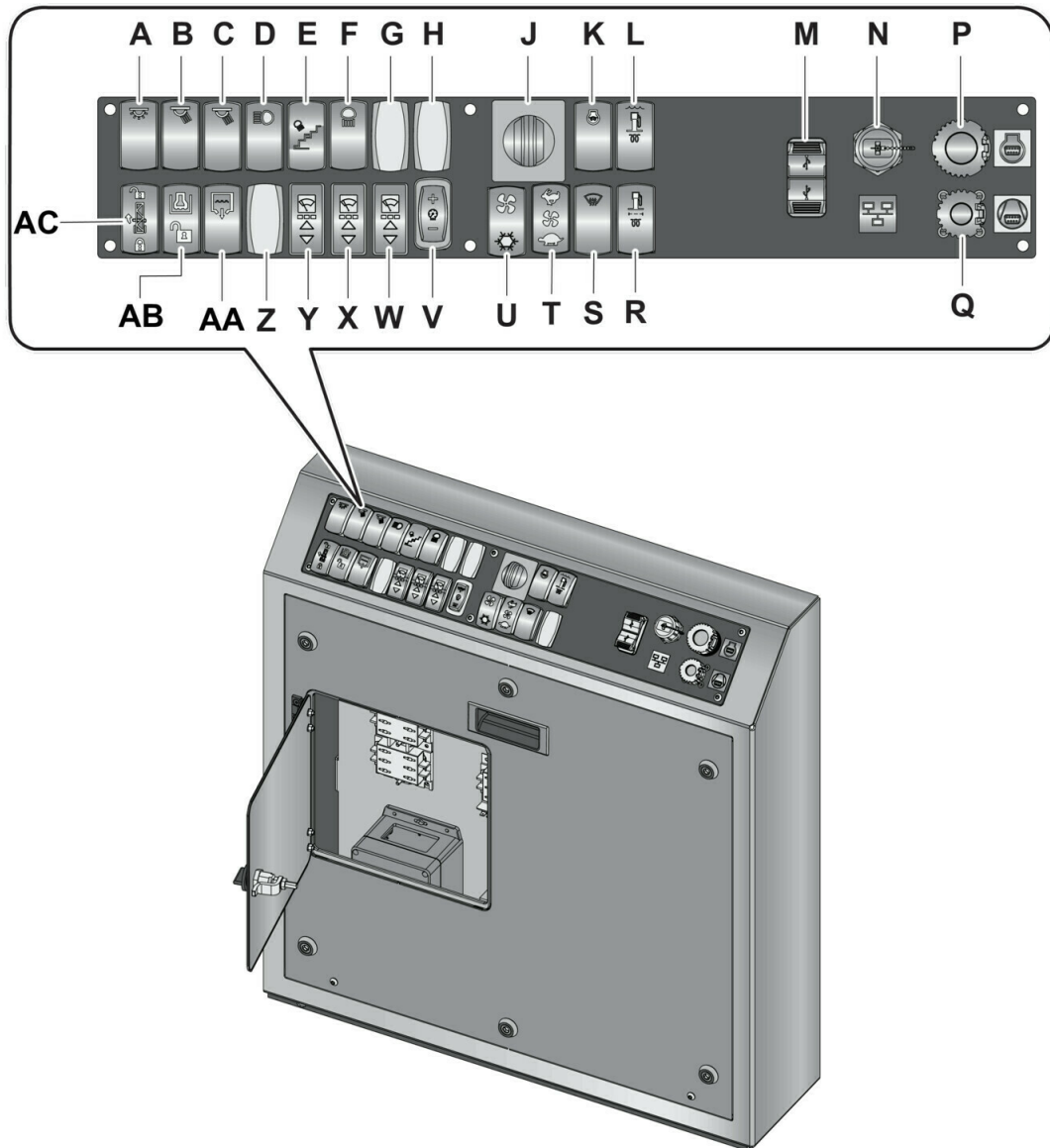
Crane

A	Crane controls	B	Articulating crane
C	Crane power pack		

The 24-VDC crane option allows for ease of moving drill bits to the drill string. The crane is on the non-cab side, drill end of the machine.

3.3 Cab Overview

3.3.1 Electrical Cabinet

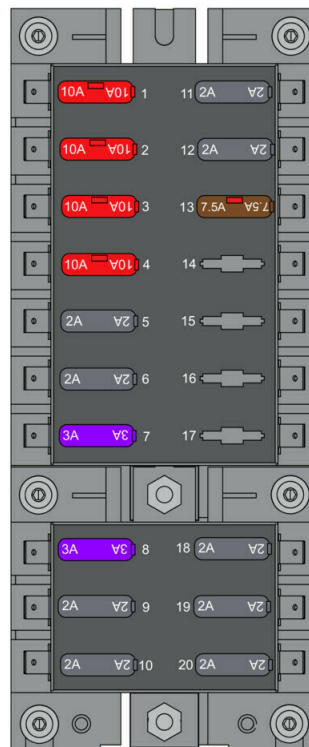


Electrical Cabinet

A	Dome lights	B	Reading lights 1
C	Reading lights 2 (over the operator seat)	D	Propel lights
E	Boarding lights	F	Drill lights
G	Spare	H	Spare
J	HVAC temperature control	K	Engine coolant heater (option)

L	Water and fuel tank heater (option)	M	USB charge port
N	Network switch access	P	Engine diagnostics
Q	EARS IQAN® diagnostics	R	Fuel filter heater (option)
S	Defroster for ground window	T	HVAC blower speed
U	HVAC On/Off	V	Switch LED dimmer
W	Ground window windshield wiper	X	Drill window windshield wiper
Y	Machine window windshield wiper	Z	Spare
AA	Water dump (option)	AB	Hydraulic drill bit basket (option)
AC	Hydraulic drill pipe catcher (option)		

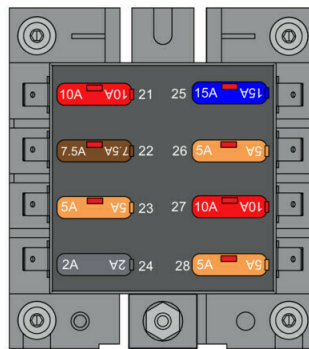
3.3.2 Fuses and Circuit Breakers



Key-Switched Power

1	C300 (10 Amp)	Windshield wiper machine side
2	C310 (10 Amp)	Windshield wiper drill window
3	C320 (10 Amp)	Windshield wiper ground window
4	C700 (10 Amp)	Air ride seat
5	R700 (2 Amp)	Hydraulic drill bit basket and hydraulic drill pipe catcher switches

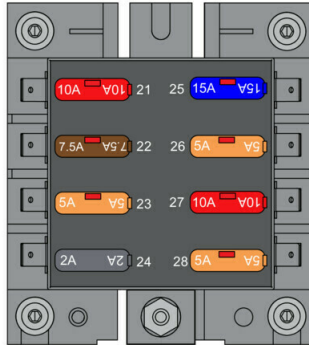
6	R200 (2 Amp)	Water dump switch (option)
7	T020 (3 Amp)	Mobile Communication Gateway (future option)
8	T400 (3 Amp)	GPS (option)
9	D520-1 (2 Amp)	Radio Remote Control Machine Unit (option)
10	D520-2 (2 Amp)	Radio Remote Control Operator Unit (option)
11	D700 (2 Amp)	CCI (option)
12	C001 (2 Amp)	HVAC switch
13	C400 (7.5 Amp)	Defrost switch
14	-	Spare
15	-	Spare
16	-	Spare
17	-	Spare
18	D501 (2 Amp)	Display
19	D500-1 (2 Amp)	Left decoder
20	D500-2 (2 Amp)	Right decoder



Un-switched Power

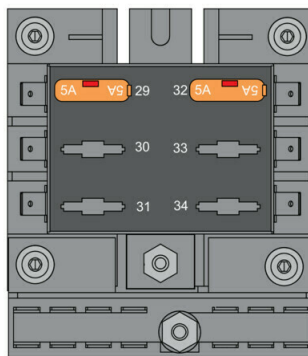
21	P006 (10 Amp)	Key switch, fuel filter heater switch
22	C800 (7.5 Amp)	Horn
23	C200 (5 Amp)	USB charge port
24	T010 (2 Amp)	Mobile Communication Gateway (future option)
25	P072 (15 Amp)	Cab propel lights
26	P073 (5 Amp)	Cab boarding light

27	P074 (10 Amp)	Cab drill lights
28	P070 (5 Amp)	Dimmer light switch power



Un-switched Power

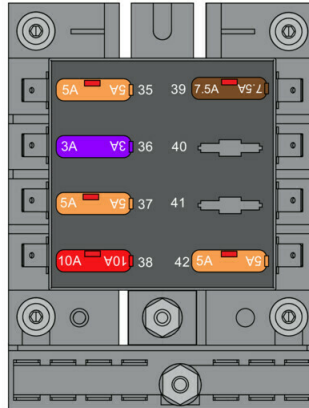
21	P006 (10 Amp)	Key switch, fuel filter heater switch
22	C800 (7.5 Amp)	Horn
23	C200 (5 Amp)	USB charge port
24	T010 (2 Amp)	Mobile Communication Gateway (future option)
25	P072 (15 Amp)	Cab propel lights
26	P073 (5 Amp)	Cab boarding light
27	P074 (10 Amp)	Cab drill lights
28	P070 (5 Amp)	Dimmer light switch power



12-Volt Un-isolated Power

29	V010 (5 Amp)	AM/FM and satellite radio (option)
30	-	Spare
31	-	Spare
32	V040 (5 Amp)	Mine radio (customer installed)

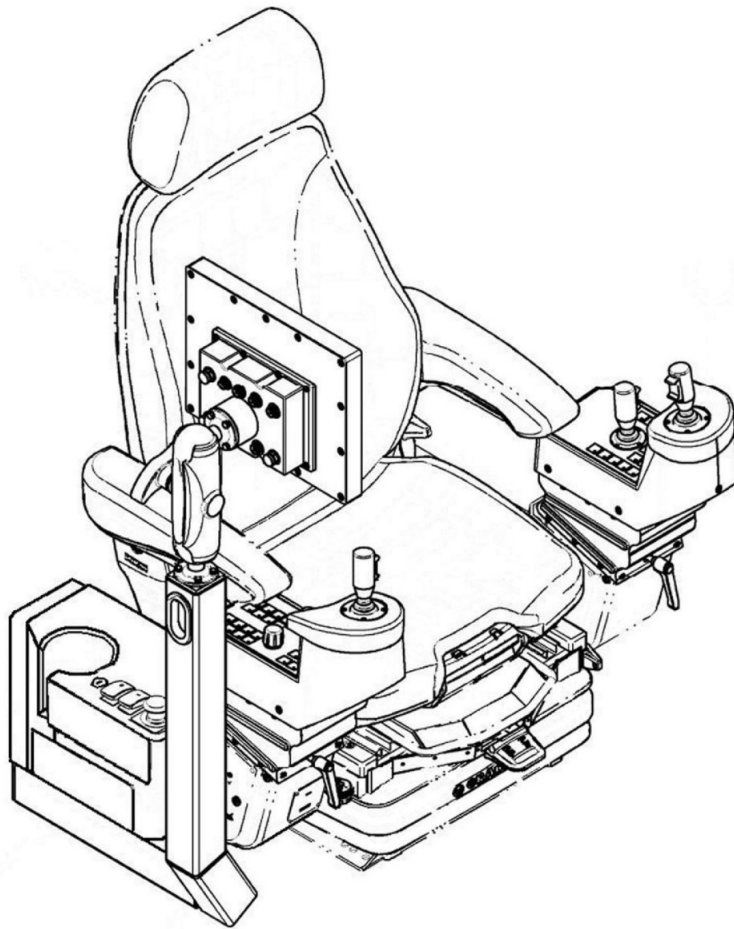
33	-	Spare
34	-	Spare



Technology Items Key-Switched Power (Rear Seat Compartment)

35	T100 (5 Amp)	Teleremote safety box (option)
36	T600 (3 Amp)	Network switch and router
37	T500 (5 Amp)	Video encoder (option)
38	T300 (10 Amp)	Proximity Detection (option)
39	T200 (7.5 Amp)	Access point (option)
40	-	Spare
41	-	Spare
42	T700 (5 Amp)	Refrigerator (option)

3.3.3 Rig Control System Operator Controls



Operator Seat and Controls

Refer to the PV-271D / PV-291D Control System manual for information about the RCS.

4 Operation

DANGER

Electrocution Hazard

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

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

WARNING

Failure to Observe Safety Instructions

Can cause severe injury or death

- ▶ Read the Safety Manual before operating, doing maintenance, service, or repairs on the machine.
- ▶ Know where the safety signs are on the equipment and understand their meanings.
- ▶ Obey all safety signs and warning statements.

4.1 General Information

WARNING

Safety Precaution

Failure to follow the instructions can cause serious injury.

- ▶ Always wear the correct safety gear while working on or around the machine. The safety gear includes an approved hard hat, safety glasses, steel toe shoes, gloves, respirator, and ear protection.
- ▶ Do not wear loose fitting clothing that can become caught in rotating components.

⚠ WARNING**Crushing Risk**

Unexpected machine motion or moving parts can cut or crush.

- ▶ Stop the engine before working on the machine.

⚠ WARNING**Tipping Risk**

Tipping over a machine can cause serious injury or death.

- ▶ Set up the machine on a firm level surface.
- ▶ If the level surface is not available, prepare the site adequately before the machine setup.

⚠ WARNING**Risk Due to Insufficient Training**

Can cause property damage or severe personal injury.

- ▶ Operating and maintaining RCS machines requires special training through Epiroc. Do not drill, operate, repair, or do maintenance on the machine if not trained or experienced with the RCS operating system controls and programs.

⚠ CAUTION**Machine Defects**

A defect in the machine can cause personal injury and damage the machine.

- ▶ Report any defects to the correct personnel.
- ▶ Do not operate the machine if defects are present.
- ▶ Correct the defects before you start and operate the machine.



NOTE: *If any controls, instruments, or devices do not function correctly, look for fault warnings and report any machine defects to the proper personnel. Defects must be corrected before you start and operate the machine.*

Observe the following operational guidelines:

- Always do safety checks before starting and using the machine.
- Do a check for safety locks and tags on the controls. Start the engine only when the safety lock and tag has been removed by the person who installed it.
- Make sure that the propel alarm is working correctly.

- Make sure that all propel and drill lights are working and provide good illumination to the work area.
- Always sound the horn before moving the machine to alert personnel in either direction, and let sufficient time pass before moving the machine.
- Make sure that all the leveling jacks are fully retracted before moving the machine.
- Always operate the machine at high speed during normal drilling and propelling conditions.
- Use the machine from a safe location if it is equipped with the remote control system option:
 - For propelling on unstable surfaces where there can be a risk of overturning.
 - For loading onto a transporter where there is a risk of overturning.
- Never propel or stop the machine on a slope or surface that could collapse.
- Never stop the machine against a high wall that could collapse or cause a crushing risk.
- Be aware of the risk of overturning when propelling on ramps which are unstable or have steep slopes. Maintain a safe distance between the edge of the ramp and the outer edges of the tracks.
- Always chock the tracks if there is a possibility of uncontrolled movement.
- Do not get on or off the machine when it is moving.
- Lower the tower if moving for a long distance.
- Be careful cornering to allow for tower overhang.
- Know the machine height, width, weight, and length before moving.
- Before you start the engine or move the machine, examine inside, outside, and below the machine for people or obstructions. Do a check of the work area for obstacles and personnel.
- Start the engine from the operator position only.
- After starting the engine, wait until the engine, hydraulics, and compressor reach normal operating temperatures before operating the machine.
- When propelling in tight spots or loading onto a trailer, use low engine speed to slow the response of the machine.
- When you leave the operator seat, make sure that all controls are in the neutral position and that the RCS control panels are de-energized by pressing the control panel Operator Control Panel On/Off  button.

4.1.1 Operator Areas

- Keep operator areas clean. Clean cab windows, mirrors, and all lights. Make sure that the steps, walkways, and grab rails are clean. Oil, grease, snow, ice, or mud in these areas can be slippery. Clean boots of excess mud before getting on the machine.
- Make sure all of the lights function.
- Remove all personal items or other objects from the operator cab, platform area, and tower. Secure these items in the tool box, tool cabinet, or remove them from the machine.

4.2 Pre-start Inspection

WARNING

Burn Hazard

Hot oil and components can cause personal injury.

- ▶ Do not touch hot oil or hot components.
- ▶ Use personal protective equipment.

WARNING

High Pressure

Can cause severe injury or death

- ▶ Completely release the pressure before you remove the filler plug, fittings, or receiver cover.

WARNING

Risk of Explosion

Use of anti-freeze additives to water creates an explosion risk in heated systems.

- ▶ Use only water for water injection systems. Heaters will keep the water from freezing. Do not use additives in the water.

WARNING

Burn Hazard

When removing the radiator cap, steam or fluid escaping from the radiator can burn. Inhibitor contains alkali.

- ▶ Stop the engine and let it cool before you remove the radiator cap.
- ▶ Remove the radiator cap slowly to release the pressure.
- ▶ Avoid contact of steam or escaping fluid with skin and eyes.

WARNING

Flammable and Toxic Liquid

Fuel is toxic and can cause injury. Fuel is flammable and causes burns, serious personal injury, or death.

- ▶ Shut off the engine.
- ▶ Use Personal Protective Equipment (PPE).
- ▶ Do not handle flammable fluids near hot surfaces, sparks, or flames.
- ▶ Clean up fuel spills.

Do the following inspections before each shift and at every startup.

- Do a check for warnings or safety locks and tags on the controls. Start the machine only when the safety lock and tag has been removed by the person who installed it.
- Examine the tower for loose, damaged, or bent items.
- Examine the hoses on the tower for hydraulic leaks.
- Examine the undercarriage for missing, loose, broken, or bent parts.
- Examine the drive motors, hosing, and final drive for leaks and loose, damaged, or missing parts.
- Examine the coolers for damage and leaks.
- Examine the machine area for leaks and damaged or missing parts.
- Examine the wire rope tensioning system for damage or leaks.
- Examine the wire rope for tension, wear, or damage.
- Examine the pump drive, pumps, valves, and hosing for leaks, damage, or missing components.
- Examine the lubricant level in the pump drive gearbox.
- Examine the drive train for any signs of failure, damage, or leaks.
- Examine the hydraulic oil tank for damage, leaks, or missing components.
- Examine the fluid level in the hydraulic oil tank sight glass.
- Examine the compressor assembly for loose, missing, or damaged parts.
- Examine the compressor assembly for oil leaks.
- Examine the oil level in the compressor receiver tank sight glass.
- Examine the compressor receiver tank safety valves for leaks, loose parts, or damage.
- Examine the fire suppression system for readiness, leaks, and damaged or missing components.
- Examine the cab for broken windows, damaged door hinges, latches, knobs, and torn seals.
- Examine the operator seat for visible controller damage, seat damage, and touchscreen damage or looseness.
- Examine fuel and water tanks for damage and leaks.
- Examine the engine for leaks and damaged or missing parts.
- Do an engine oil level check.

- Examine the compressor and engine air intake system for damage, air leaks, and missing or loose mountings.
- Do a coolant level check at the radiator sight glass.
- Make sure that the main batteries are switched on to supply the 24-volt electrical system.
- Do a diesel exhaust fluid (DEF) level check for machines with a Cummins® High-Horsepower Tier 4 engine.
- Top off any low fluid levels.
- Examine the area around the machine for any unauthorized vehicles, people, power line obstructions, or other obstructions in the immediate machine area.
- Report any damage, leaks, broken or missing components, and obvious malfunctions or safety hazards to your immediate supervisor.

4.3 Starting the Machine

4.3.1 Starting the Machine with the Key

WARNING

Risk Due to Insufficient Training

Can cause property damage or severe personal injury.

- ▶ Operating and maintaining RCS machines requires special training through Epiroc. Do not drill, operate, repair, or do maintenance on the machine if not trained or experienced with the RCS operating system controls and programs.

WARNING

Energized Machine

Can cause serious injury.

- ▶ The machine must be fully energized and the engine/motor must be switched on to complete this procedure.
- ▶ Be careful around moving parts and pinch points.

After all pre-operational inspection items are complete and any needed services or corrections have been done, proceed to the following start sequence:

1. Inform the supervisor, lead hand, and all other persons concerned of the intent to start the machine.



NOTE: Make sure that all personnel and bystanders are clear of the machine before start-up.

2. Remove the safety locks and tags from the machine in accordance with the site-specific procedures.



NOTE: Refer to *Safety Locks and Tags Minimum Requirements in the Maintenance manual*.

3. Pull out all of the emergency stop buttons.
4. Turn on the isolation switches if the machine is equipped with switches (at ground level or at battery location).
5. Toggle the RCS Timer Reset switch to reset the RCS Timed Out LED if the machine has not operated in more than 30 minutes or if the battery isolation switches are cycled. The RCS Timer Reset switch is in the ground-level isolation station.
6. Turn the Start key to the ON position.
7. Let the RCS power on.

Step result

→ The **User > Information** screen shows on the display.



Example of the User Screen

8. Press the control panel Operator Control Panel On/Off  button to energize the operator control panels.

Step result

→ The LED on the button lights up when the button is pressed to indicate that the control panels are active.

9. Select the **Menu** button and then select the **Performance** button.
10. Press the Attention horn button to alert personnel that the engine is about to start.

11.

NOTICE**Component Damage**

Engaging the starter motors for more than 30 seconds can cause damage to the starter motors.

- ▶ Do not engage the starter motors for more than 30 seconds.
- ▶ Wait for two minutes between each attempt to start the machine.

Turn the key to the start position to engage the engine starter motors.

12. Hold the key in the start position until the engine has started.

13. Release the key to the run (ON) position.

14. If the engine does not start within 30 seconds, release the start switch.



NOTE: To avoid overtaxing the starter motors or the batteries, do not use the starter for more than 30 seconds. Let the starter motors cool and the batteries recover for two minutes before trying again. If the engine will not start after a couple of tries, do a check of the fuel lines for possible fuel starvation or air leaks. A starting failure could mean that the fuel is not reaching the injectors. The absence of blue or white exhaust smoke during cranking indicates that no fuel is being delivered.

15. Let the engine operate at idle speed. Listen for unusual noises from the engine, compressor, and power pack area.

16. Make sure that the cooler fans are turning.

17.

NOTICE**Risk of Property Damage**

Can result in damage to the machine

- ▶ In the event of unusual noise, leaks, cooling fan non-operation, or any other non-listed problem, immediately shut off the machine and notify the immediate supervisor.
- ▶ Restart the machine only when the problem is corrected.

Observe the hydraulic system for obvious leaks.

18. Continue operating the engine at idle speed to let the engine and hydraulic systems warm to the minimum prescribed operating temperature of 65.5 °C (150 °F) for the engine and 24 °C (75 °F) for hydraulics.

19. Begin drilling operations when minimum operating temperatures are reached.

20. Monitor the hydraulic and compressor temperatures.



NOTE: Hydraulic temperatures must not exceed 76.6 °C (170 °F), and the compressor temperature must not exceed 115.5 °C (240 °F).

4.3.2 Starting the Machine with the RCS Start/Stop Button



WARNING

Risk Due to Insufficient Training

Can cause property damage or severe personal injury.

- ▶ Operating and maintaining RCS machines requires special training through Epiroc. Do not drill, operate, repair, or do maintenance on the machine if not trained or experienced with the RCS operating system controls and programs.



WARNING

Energized Machine

Can cause serious injury.

- ▶ The machine must be fully energized and the engine/motor must be switched on to complete this procedure.
- ▶ Be careful around moving parts and pinch points.

After all pre-operational inspection items are complete and any needed services or corrections have been completed, do the following start sequence:

1. Inform the supervisor, lead hand, and all other persons concerned of the intent to start the machine.



NOTE: Make sure that all personnel and bystanders are clear of the machine before start-up.

2. Remove the safety locks and tags from the machine in accordance with the site-specific procedures.



NOTE: Refer to Safety Locks and Tags Minimum Requirements in the Maintenance manual.

3. Pull out all of the emergency stop buttons.

4. Switch on the isolation switches if the machine is equipped with switches (ground level or at battery location).
5. Toggle the RCS Timer Reset switch to reset the RCS Timed Out LED if the machine has not operated in more than 30 minutes or if the battery isolation switches are cycled. The RCS Timer Reset switch is in the ground-level isolation station.
6. Turn the Start key to the ON position.
7. Let the RCS power on.

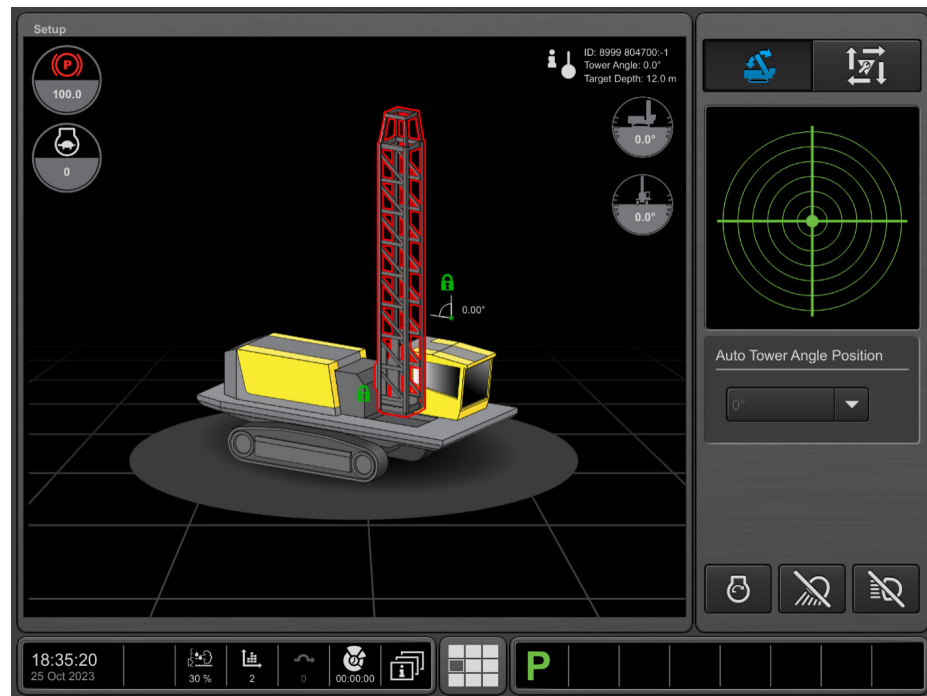
Step result

→ The **User > Information** screen shows on the display.



Example of the User Screen

8. Select the **Menu** button and then select the **Setup** screen.



Example of the **Setup** Screen

9. Select the engine **Start/Stop**  button.



NOTE: When using the engine **Start/Stop** button, the attention horn automatically alerts personnel that the engine is about to start. The length of time that the horn is actuated is configured from the **Setting > Setup > Parameters > Other** screen.



NOTE: If the engine does not start, a **Waiting for Power Pack Restart Time-out** message shows on the screen, and a white clock icon shows in the system status bar. When the white clock icon is pressed, a timeout message shows. The operator can attempt to start the engine again when the timeout expires.

10. Let the engine operate at idle speed.

11.

NOTICE**Risk of Property Damage**

Can result in damage to the machine

- ▶ In the event of unusual noise, leaks, cooling fan non-operation, or any other non-listed problem, immediately shut off the machine and notify the immediate supervisor.
- ▶ Restart the machine only when the problem is corrected.

Listen for unusual noises from the engine, compressor, and the power pack area.

12. Make sure that the cooler fans are turning.

13. Examine the hydraulic system for any leaks.



NOTE: In the event of unusual noises, leaks, cooling fan non-operations, or any other non-listed problem, immediately shut off the machine to prevent machine damage. Notify your immediate supervisor of the problem, and start the machine only after the problem is corrected.

14. Let the engine operate at idle speed until the engine and hydraulic systems reach the minimum operating temperatures of 65.5 °C (150 °F) for the engine and 24 °C (75 °F) for hydraulics.

15. Begin drilling operations when the minimum operating temperatures are reached.

4.3.3 Starting the Machine in Arctic Conditions

WARNING

Risk Due to Insufficient Training

Can cause property damage or severe personal injury.

- ▶ Operating and maintaining RCS machines requires special training through Epiroc. Do not drill, operate, repair, or do maintenance on the machine if not trained or experienced with the RCS operating system controls and programs.

WARNING

Energized Machine

Can cause serious injury.

- ▶ The machine must be fully energized and the engine/motor must be switched on to complete this procedure.
- ▶ Be careful around moving parts and pinch points.

After all pre-operational inspection items are complete and any needed services or corrections are done, do the following start sequence for arctic conditions:

1. Inform the supervisor, lead hand, and all other persons concerned of the intent to start the machine.



NOTE: Make sure that all personnel and bystanders are clear of the machine before start-up.

2. Remove the safety locks and tags from the machine in accordance with the site-specific procedures.



NOTE: Refer to Safety Locks and Tags Minimum Requirements in the Maintenance manual.

3. Pull out all of the emergency stop buttons.
4. Turn on the isolation switches if the machine is equipped with switches (at ground level and at battery location).
5. Toggle the RCS Timer Reset switch to reset the RCS Timed Out LED if the machine has not operated in more than 30 minutes or if the battery isolation switches are cycled. The RCS Timer Reset switch is in the ground-level isolation station.
6. Preheat the engine with the preheater until the coolant temperature reaches 35 °C (95 °F).

7.

WARNING

Energized Machine

Can cause serious injury.

- ▶ The machine must be fully energized and the engine must be switched on to complete this procedure.
- ▶ Be careful around moving parts and pinch points.

Turn the Start key to the ON position.

8. Let the RCS power on.

Step result

→ The **User > Information** screen shows on the display.



Example of the **User** Screen

9. Press the Operator Control Panel On/Off  button to energize the operator control panels.

Step result

→ The LED on the button illuminates when the button is pressed to indicate that the control panels are active.

10. Press the Attention horn button to alert personnel that the engine is about to start.

11.  **WARNING**

Energized Machine

Can cause serious injury

- ▶ The machine must be fully energized to complete this procedure.
- ▶ Be careful around moving parts and pinch points.

NOTICE**Component Damage**

Engaging the starter motors for more than 30 seconds can cause damage to the starter motors.

- ▶ Do not engage the starter motors for more than 30 seconds.
- ▶ Wait for two minutes between each attempt to start the machine.

NOTICE**Risk of Property Damage**

Can result in damage to the machine

- ▶ In the event of unusual noise, leaks, cooling fan non-operation, or any other non-listed problem, immediately shut off the machine and notify the immediate supervisor.
- ▶ Restart the machine only when the problem is corrected.

Start the engine, and allow it to operate at low idle until the coolant temperature reaches 50 °C (122 °F).

12. Bring the engine to high idle.
13. Switch on the air compressor and drilling air.



NOTE: This heats the receiver tank oil and warms the rotary head.

14. Warm the hydraulic oil temperature to 10 °C (50 °F) before slowly operating the drilling functions. Use a slow rotation speed of 20 rpm.
15. Listen for unusual noises from the engine, compressor, and power pack area.
16. After 5 to 10 minutes have passed, slowly raise the rotation speed to maximum. Leave the rotation speed set to maximum to let the rotation motors warm from the hydraulic flow.



NOTE: Rotation pressure must not exceed 48.3 bar (700 psi).

17. Make sure that the cooler fans are turning.
18. Observe the hydraulic system for obvious leaks.

19. Continue operating the engine at idle speed to let the engine and hydraulic systems warm to the minimum prescribed operating temperature of 65.5 °C (150 °F) for the engine and 24 °C (75 °F) for the hydraulics.
20. Begin drilling operations when the minimum operating temperatures are reached.
21. Monitor the hydraulic and compressor temperatures.



NOTE: Hydraulic temperatures must not exceed 76.6 °C (170 °F), and the compressor temperature must not exceed 115.5 °C (240 °F).

4.3.4 Activating the RCS Control Panels



NOTE: The control panels must be intentionally activated for any of the output commands or machine actuations to occur.

1. Press the Operator Control Panel On/Off  button to energize the operator control panel.
2. When you leave the operator seat, put all of the controls in the neutral position.
3. Press the Operator Control Panel On/Off  button to de-energize the RCS operator control panels.

4.3.5 Using TUM Codes

A Time Usage Model (TUM) is a complete and consistent way to describe and classify all machine time. TUM codes are used to classify both operational time and machine down time. Once a TUM code is active, it remains active until the next TUM code is selected. When a new TUM code is selected, the previous TUM code ends.



NOTE: Delay codes are no longer used on the RCS. TUM codes replace delay codes.

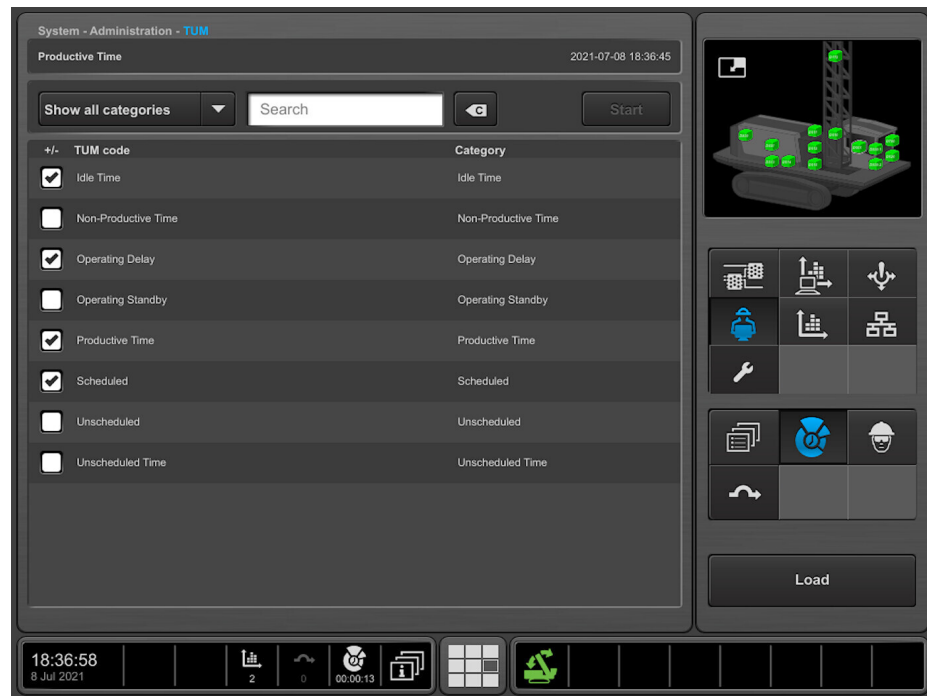
Loading TUM Codes

TUM codes must be loaded onto the RCS; they cannot be created on the RCS. A TUM codes file is either created using Mobius for Drills or Surface Manager and then sent to the RCS through the CCI, or it is placed on a USB flash drive and loaded directly from the USB port in the cab.

If the TUM codes are sent to the RCS through the CCI and the CCI is set as the source for TUM codes files, the **New TUM Codes File Available**  icon shows in the system tray and a pop-up message shows on the screen when the RCS starts. The new TUM codes file loads the next time the RCS starts.

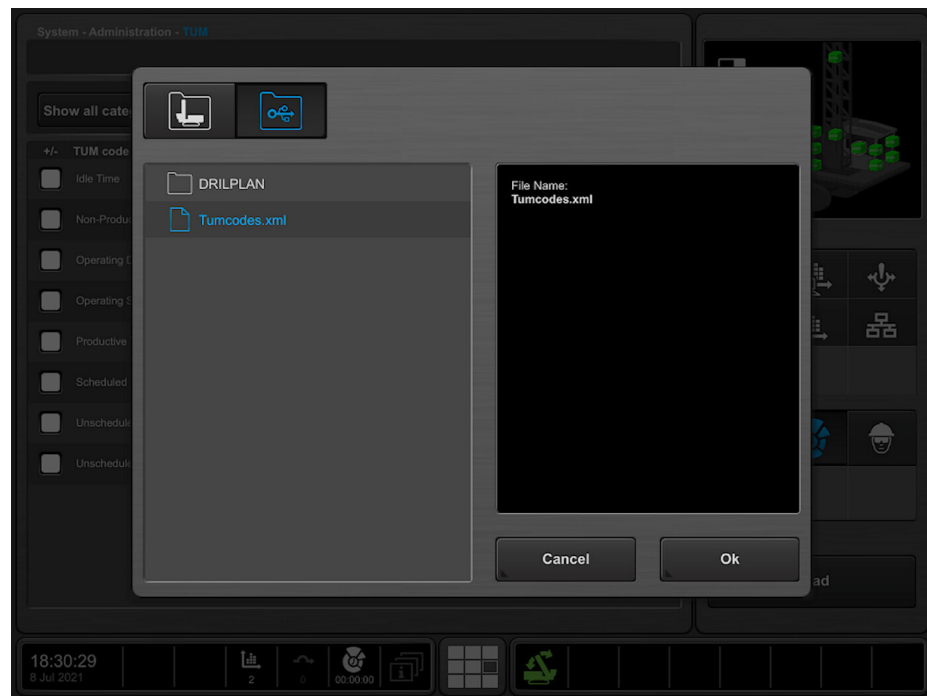
The following procedure describes how to select the TUM codes file source location and manually load the TUM codes file onto the RCS.

1. On the RCS display, select the **System > Administration > TUM** screen.



Example of the TUM Screen

2. Select **Load**.



Example of the TUM Code Load Window

- Set the source to Import from USB  if a USB flash drive containing a TUM codes file is inserted into the USB port, or set the source to Import from Machine  if the file is sent remotely.



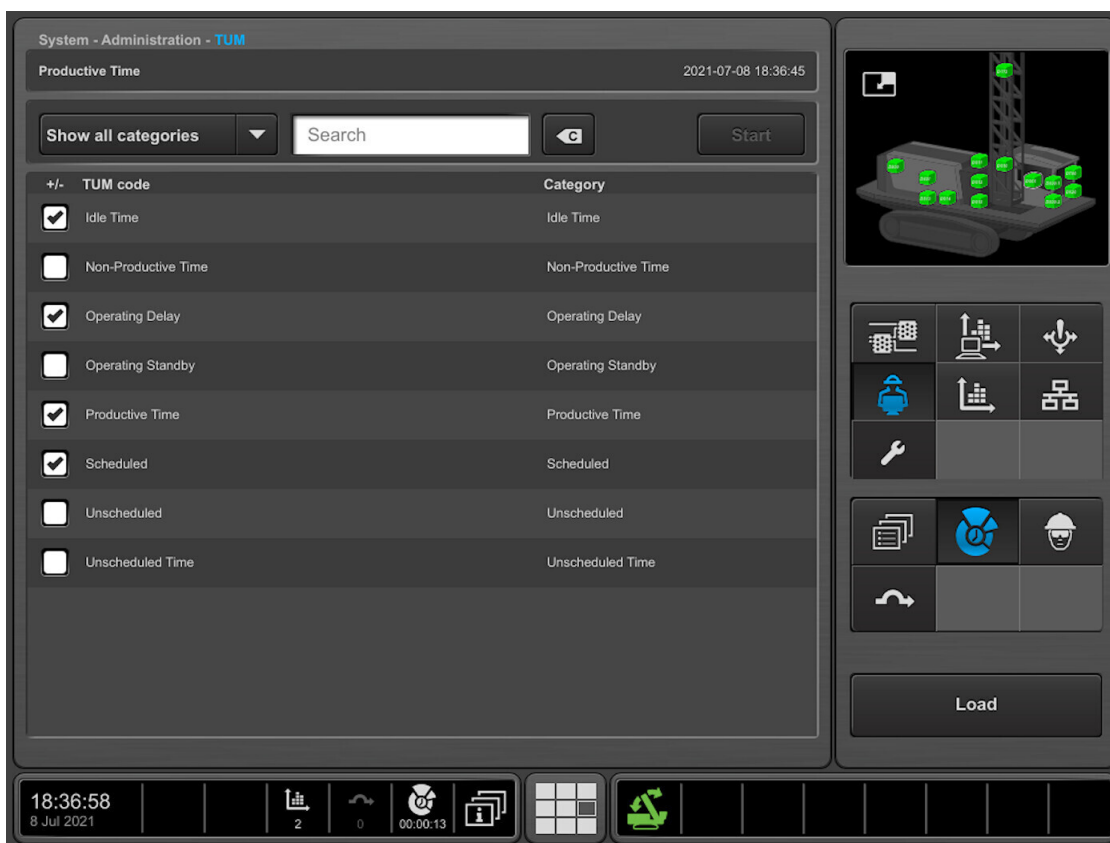
NOTE: SE+ level access is required to change the TUM codes file source.

- Select the TUM codes file and select **Ok** to load the file.

Step result

→ The RCS alerts that the TUM codes are loaded.

Changing the TUM Code Quick-Select List



Example of the TUM Screen

TUM codes with a selected check box show in the TUM code quick-select list in the system tray.

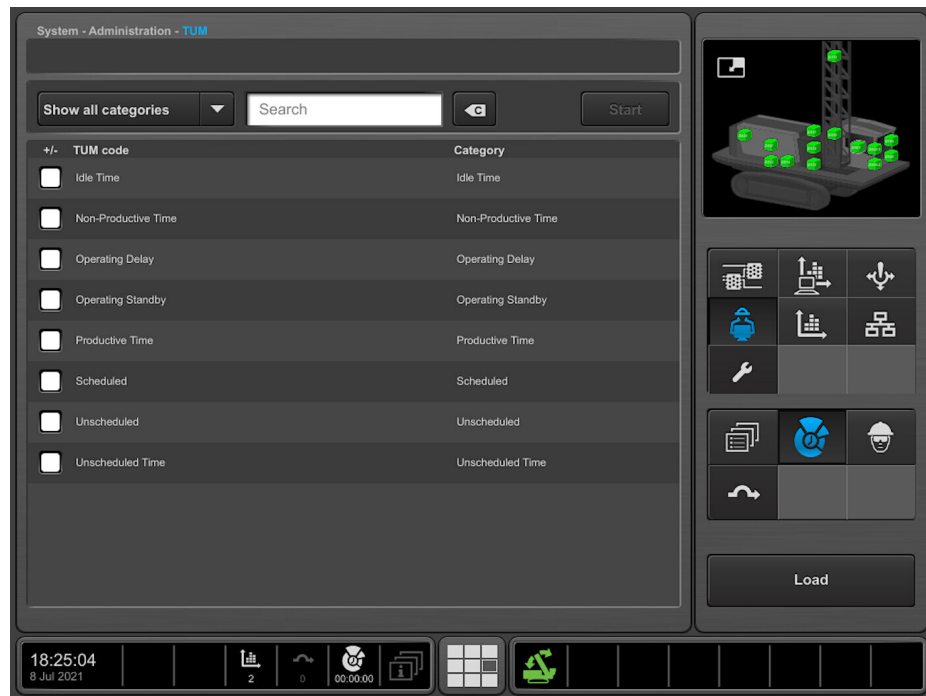
- Select the empty check box to add the TUM code to the quick-select list.
- Remove the check from the check box to remove the TUM code from the quick-select list.

Changing TUM Codes Manually

TUM codes can be started and changed manually on the **System > Administration > TUM** screen or with the quick-select menu.

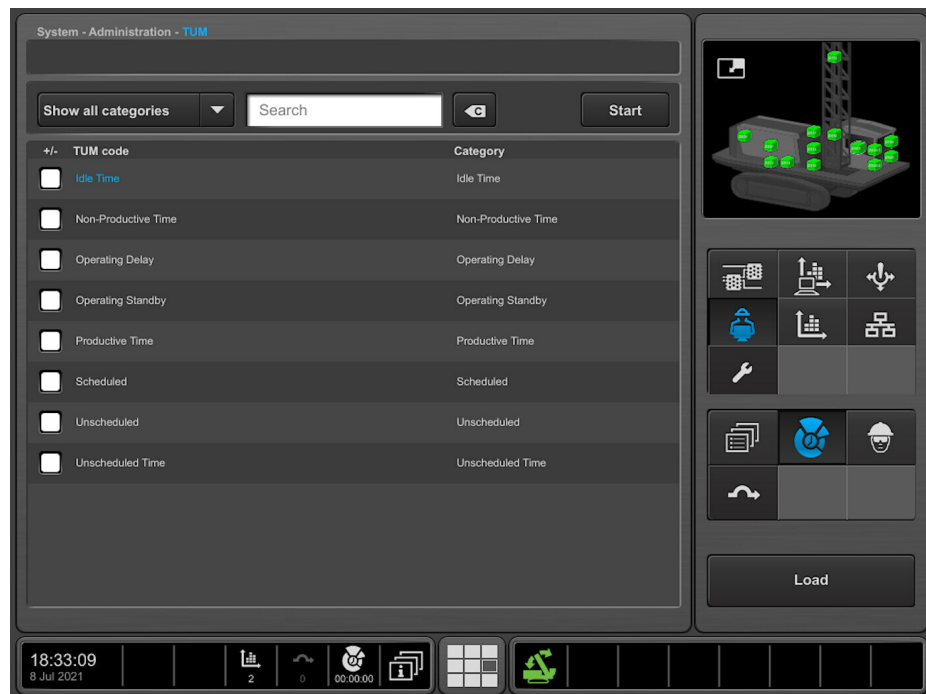
Changing TUM Codes with the TUM Screen

1. Open the **System > Administration > TUM** screen.



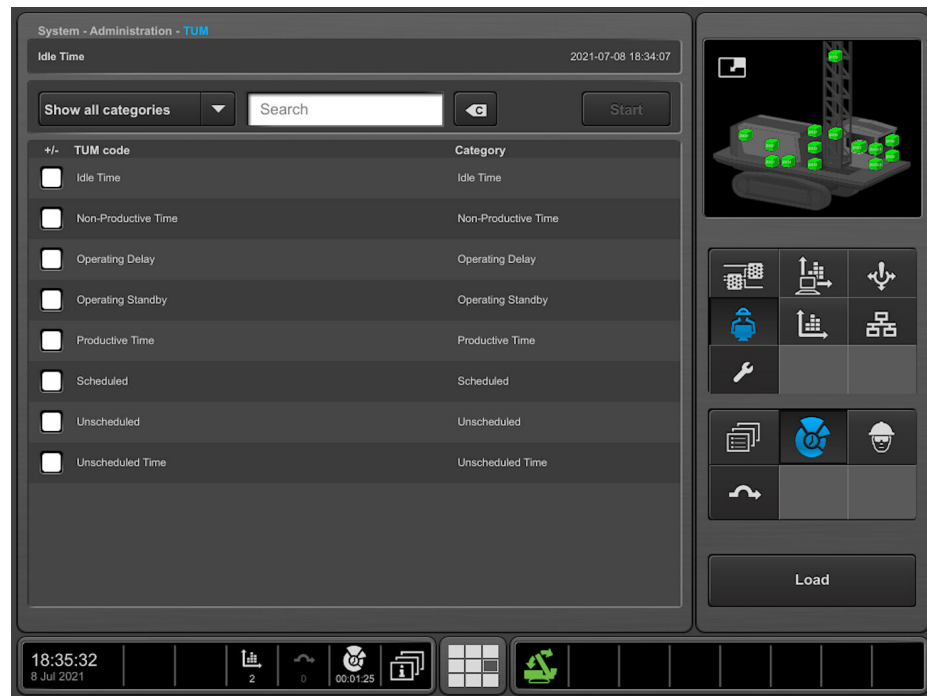
Example of the TUM Screen

2. Select the text of the applicable TUM code. Make sure that the text of the selected TUM code is blue.



Example of a Selected TUM Code

3. Select **Start**.



Example of a TUM Code in Use

End result

- The selected TUM code is shown in the upper left corner of the window. The start time and date of the selected TUM code is shown in the upper right corner of the window. The timer in the status bar also resets.

Changing TUM Codes with the Quick-Select Menu

1. Select the **TUM**  icon in the system tray.

2. Select the applicable TUM code and select **Start**.



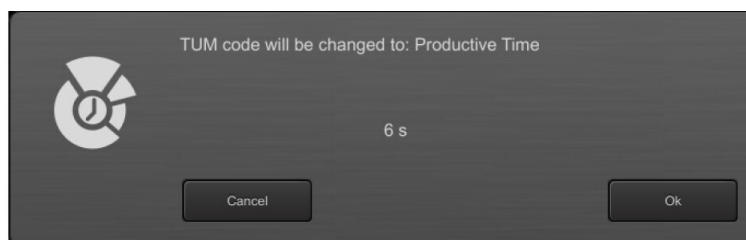
Example of the TUM Code Quick-Select Menu

- End result → The selected TUM code is shown in the upper left corner of the quick-select menu. The start time and date of the selected TUM code is shown in the upper right corner of the quick-select menu. The timer in the system tray resets.

Using Automatic TUM Code Changes

When the RCS detects an operational change that could indicate a TUM code change, one of the following messages shows on the screen:

- **TUM code will be changed to: Productive Time**
- **TUM code will be changed to: Unscheduled**
- **TUM code will be changed to: Operating Delay**



Example of an Automatic TUM Code Message

Respond to the message with one of the following:

- Select **Cancel** before the 10-second timer expires to close the system message without changing the TUM code.
- Select **Ok** before the 10-second timer expires to start the recommended TUM code.
- Let the 10-second timer expire to start the recommended TUM code.

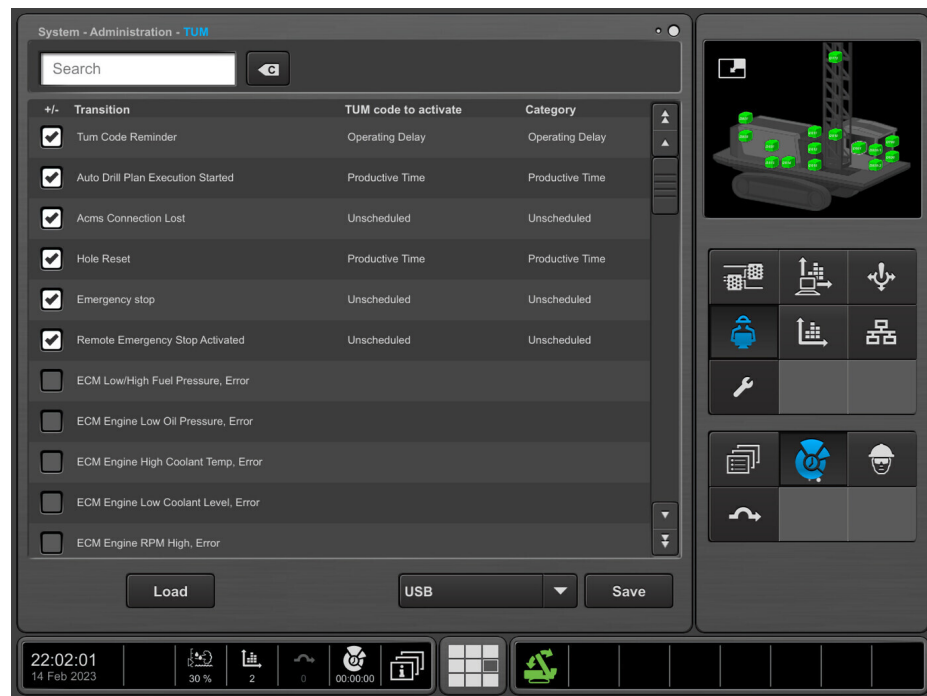


NOTE: The start time of the TUM code is the time that the message appeared, even if the 10-second timer expired.

Automatic TUM code changes can be stopped for 30 minutes by selecting **Disable Automatic TUM Code Changes** on the **Setting > Service > Parameters > Functions** screen.

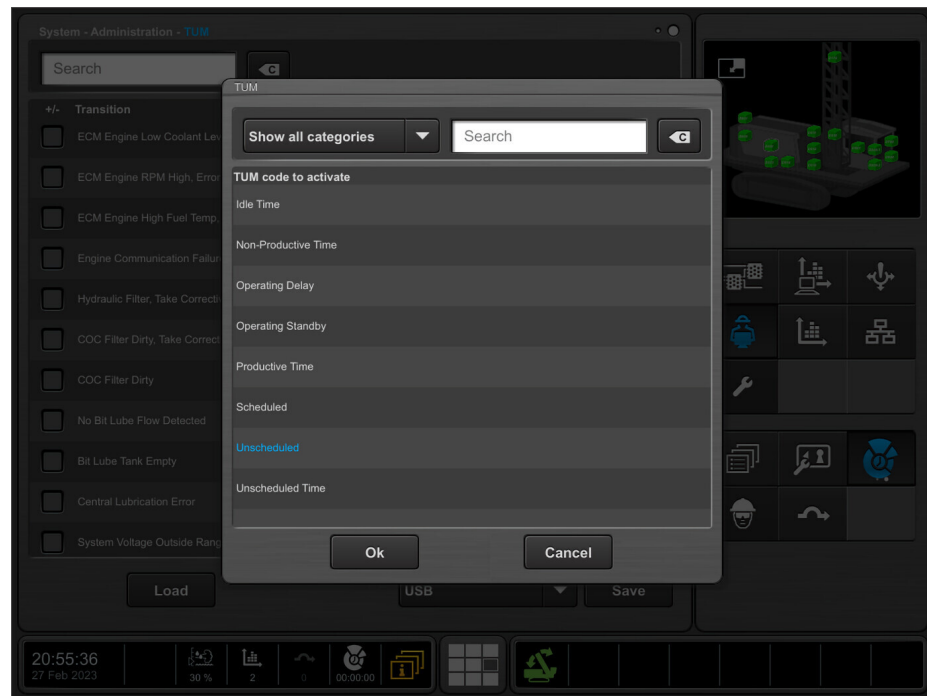
Configuring Automatic TUM Code Transitions

1. Open the **System > Administration > TUM** screen 2 of 2.



Example of the TUM Screen 2 of 2

2. Select the text of the TUM code transition to configure. The text of the selected TUM code switches to blue and a menu selection window opens.

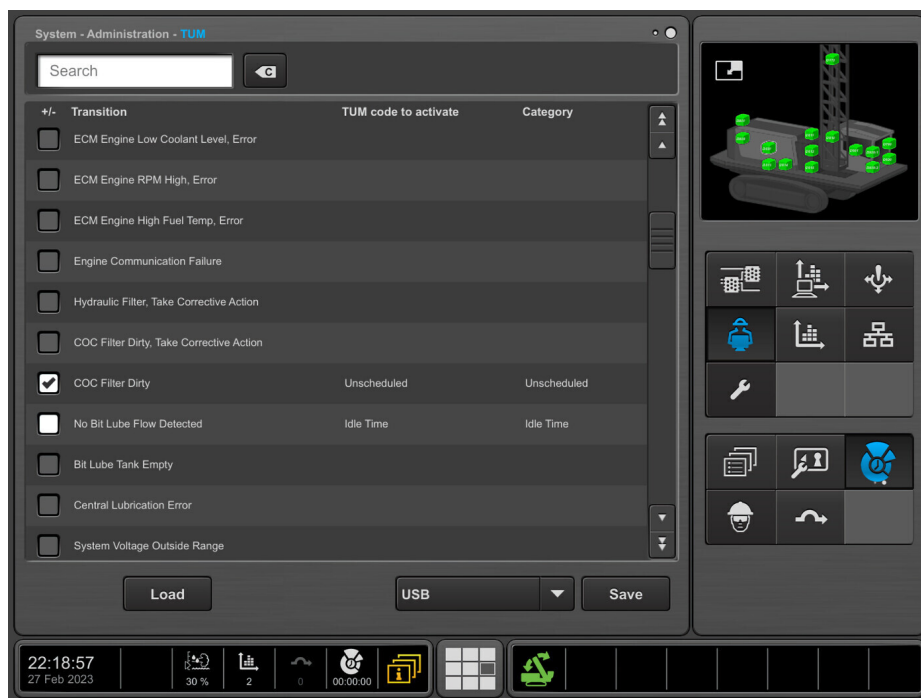


Example of the TUM Code Selection Window

3. Select the TUM code to activate.
4. Select **Ok**.

End result

- The configured TUM code transition is available for activation on the automated TUM screen.



Example of a Configured TUM Code Transition

Check Box Status

Icon	Description
White box with check mark	Currently used. Select the box to change its status.
White box without check mark	Configured but not currently used. Select the box to change its status.
Gray box	Not configured and not used.

4.4 Using a Tier 4 Engine

4.4.1 Using a Cat® Tier 4 Engine

Cat® Tier 4 engines use a PowerView® display as the engine interface. Refer to the manufacturer's documentation for more information.

4.4.2 Using a Cummins® Tier 4 Engine



NOTE: Diesel exhaust fluid (DEF) must be kept in the DEF tank above the minimum level always to prevent exhaust system faults. The **DEF Tank Level**  icon in the system tray displays the DEF tank level.

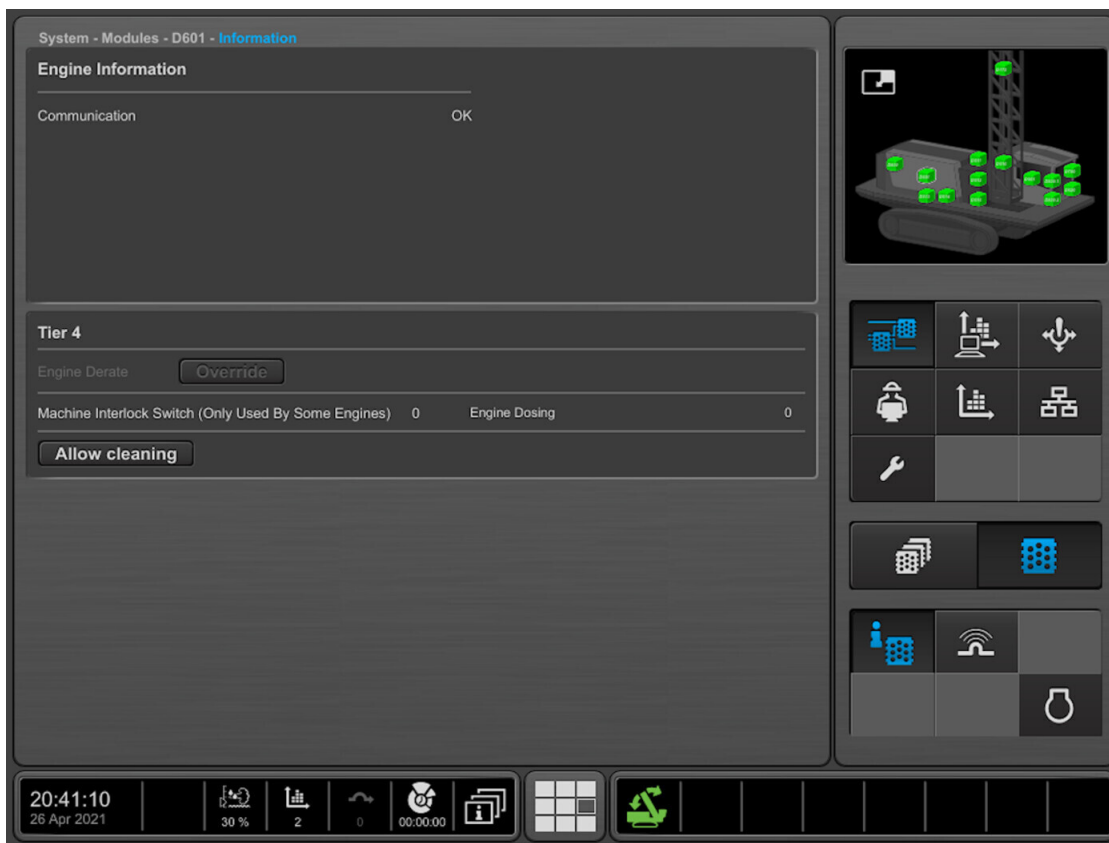
The **SCR System Cleaning**  icon shows in the system status bar when the Tier 4 engine indicates that a cleaning is needed. The RCS prevents the aftertreatment system from regenerating while the machine is in operation. If the engine determines that it needs a cleaning cycle, regeneration starts once the machine has not received any commands from the RCS for 5 minutes. If the machine has been idle for 5 minutes when the **SCR System Cleaning**  icon shows, regeneration starts immediately.



NOTE: Epiroc recommends that the **Low RPM When Machine Idle** option on the **Setting > Rig > Parameters > Engine** screen is set to active. Idling at a low RPM improves fuel efficiency and lets the machine automatically start a cleaning cycle when it is needed and the machine is idle for 5 minutes.

NOTE: If a high idle is needed when this option is active, the operator can move the left main joystick out of its neutral position without giving it a command.

The operator can override the 5-minute wait by selecting the **Allow cleaning** button on the **System > Modules > D601 > Information** screen.



Example of the **Information** Screen for the D601 Module



NOTE: The aftertreatment system adjusts the engine to a preset speed during cleaning:

- 1,800 rpm for a Cummins® QSK23 Tier 4 Final engine.
- 1,200 rpm for a Cummins® QSK50 Tier 4 Final engine.

If there is a fault with the aftertreatment system, the **Engine Derate**  icon and message appear. Select the **Engine Derate Override** button on the **System > Modules > D601 > Information** screen to override the fault for 30 minutes of operator time. The **Engine Derate Override** can be used a maximum of three times. Using the override gives time to stop drilling and move the machine to address the fault.

The **Engine Derate, Severe**  icon and message shows when two hours have passed since the initial **Engine Derate**  icon and message shows and the fault in the aftertreatment system is still active. A severe engine derate could cause the machine to shut off. Contact a service technician to correct the problem.



NOTE: To prevent a severe engine derate from occurring and shutting off the machine, correct issues with the aftertreatment system as soon as possible after the first message shows.

4.5 Preparing the Machine for Propelling

Do this procedure to propel the single-pass machine for long distances.

- Precondition**
- ✓ The rotary head is located in the middle of the tower with the first drill pipe installed.
 - ✓ The drill pipe arm support is closed to add extra support to the drill pipe.
 - ✓ The breakout wrench is in the unstowed position.

1. Stow one drill pipe in the carousel.
2. Connect the rotary head to the bottom drill pipe.
3. Raise the rotary head to the center of the tower and lift the deck bushing ± 25 millimeters (± 1 inch) without pulling the drill bit through the deck bushing. Use the **Bit In Hole, RH at Middle of Tower** function.

When this function is active, the vertical pins can be unlocked and the tower can be lowered to the rest position.



NOTE: The **Bit In Hole, RH at Middle of Tower** function must be selected again because overrides are deactivated when changing between operating modes.

Step result

→ The operator can now activate Propel mode.

4.6 Propelling the Machine

WARNING

Loss of Machine Control

Unexpected machine motion or sudden stop can cause loss of machine control, lurching, or serious personnel injury.

- ▶ Move the machine slowly.
- ▶ Do not stop the machine suddenly.

NOTICE

Damage to Components

Overheating of the track rollers can cause equipment damage.

- ▶ Make sure that the track rollers do not exceed 79.4 °C (175 °F).
- ▶ Use an infrared heat gun to do a check of the track rollers across their surface. Pay special attention to the area half way between the track rollers centers and outside edges.

The following preconditions must be met before propelling the machine:

- The machine must be within stability limits.
- If the tower is in the raised position, the following must be met:
 - The rotary head location must be calibrated.
 - All pins must be locked.
 - The drill bit must be above the ground.
- The leveling jacks must be retracted.
- The boarding ladder must be stowed (if equipped).
- The dust blower must be stowed (if equipped).
- The angle pins must be locked (if equipped).

The operator can choose to use the left multifunction joystick or the left main joystick and right main joystick when propelling the machine. Each mode is enabled from the **Settings > Rig > Parameters > Propel Params** screen.



NOTE: A reboot of the RCS is required when changing from one mode to another.

4.6.1 Propelling Long Distances or Over Uneven Ground

Propelling the machine farther than the distance to reach an adjacent hole in a drill pattern is considered a long distance. The preferred method to move the machine long distances is to haul it on a transporter. If a transporter is unavailable, extra precautions can be made to propel for longer distances or over uneven ground. Obey these precautions in addition to the propelling precautions that are found in the Operation manual and the Safety manual:

- Lower the tower onto the tower rest.
- Make sure that the carousel and breakout systems are in their stowed positions.
- Make sure that the tracks are cleared of unwanted material.
- Lubricate track pivot points before and after propelling.
- Propel the drill end first for increased visibility.
- Obey site-specific communication and escort procedures.
- 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 check of the bottom rollers for overheating. If the rollers become overheated, stop and let the rollers cool.

4.6.2 Single Joystick Propel

When propelling for long distances, stow additional drill pipes in the carousel, engage the upper drill pipe support, and use the **Bit In Hole, RH at Middle of Tower** function. To activate this function, the following conditions must be met:

- The rotary head is located in the middle of the tower with the first drill pipe installed.
- The drill pipe arm support is closed to add extra support to the drill pipe.
- The breakout wrench is in the unstowed position.

When this function is active, the vertical pins can be unlocked and the tower lowered to the rest position. The operator can now activate Propel mode.



NOTE: The **Bit In Hole, RH at Middle of Tower** needs to be selected again because over-rides are deactivated when changing between operating modes.

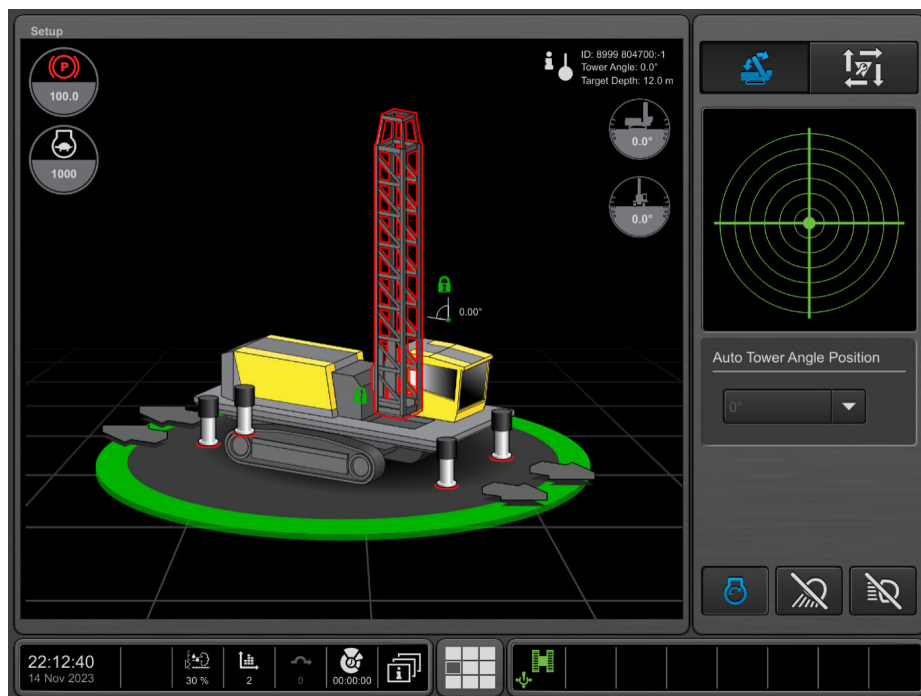
1. Visually locate the first drill hole.
2. Make sure there are no vehicles, obstacles, power lines, or unauthorized personnel near or on the machine.
3. Make sure that access ladders are fully raised.
4. Make sure that the drill string is not in the ground.
5. Press the Operator Control Panel On/Off  button to activate the left and right operator control panels.
6. Press the Propel mode  button to activate Propel mode.



NOTE: When Propel mode is selected, the hydraulics are shifted and the controls are mapped to propel functions.



NOTE: The **Setup** screen on the display shows the engine rpm, the propel brake release pressure, the machine level, and the leveling jacks. When the leveling jacks are on the ground, the leveling jack indicators have a red highlight, and the Propel function is prohibited. When the leveling jacks are off the ground and fully retracted, the leveling jack indicators have a gray highlight under the pad, and the machine can proceed to the Propel function. Refer to the Controls manual for a detailed description of the **Setup** screen.



Example of the **Setup** Screen

7. Press and hold the joystick switch on the left multifunction joystick. With the joystick switch pressed, move the left multifunction joystick slowly toward you or away from you to command the tracks to move. Propel speed is proportional to the amount of joystick movement.



NOTE: The left multifunction joystick functions in Propel mode are as follows:

- Push the left multifunction joystick away from you to command the tracks to move the machine in the non-drilling end direction.
- Pull the left multifunction joystick toward you to command the tracks to move the machine in the drilling end direction.
- Move the left multifunction joystick to the left or right and forward or back to turn the machine.



NOTE: Buildup of ground materials against the tracks can occur during sharp turns and can cause one or both of the tracks to stall. If a stall occurs, propel the machine straight either forward or in reverse to clear the tracks and complete the turn.

8. Use the left multifunction joystick to propel the machine to the first drill hole location. If equipped with the GPS option, refer to the Auto Navigation manual.

4.6.3 Dual Joystick Propel

When dual-joystick propel is active, the right main and left main joysticks are used to propel the machine.

When propelling for long distances, stow additional drill pipes in the carousel, engage the upper drill pipe support, and use the **Bit In Hole, RH at Middle of Tower** function. To activate this function, the following conditions must be met:

- The rotary head is located in the middle of the tower with the first drill pipe installed.
- The drill pipe arm support is closed to add extra support to the drill pipe.
- The breakout wrench is in the unstowed position.

When this function is active, the vertical pins can be unlocked and the tower lowered to the rest position. The operator can now activate Propel mode.

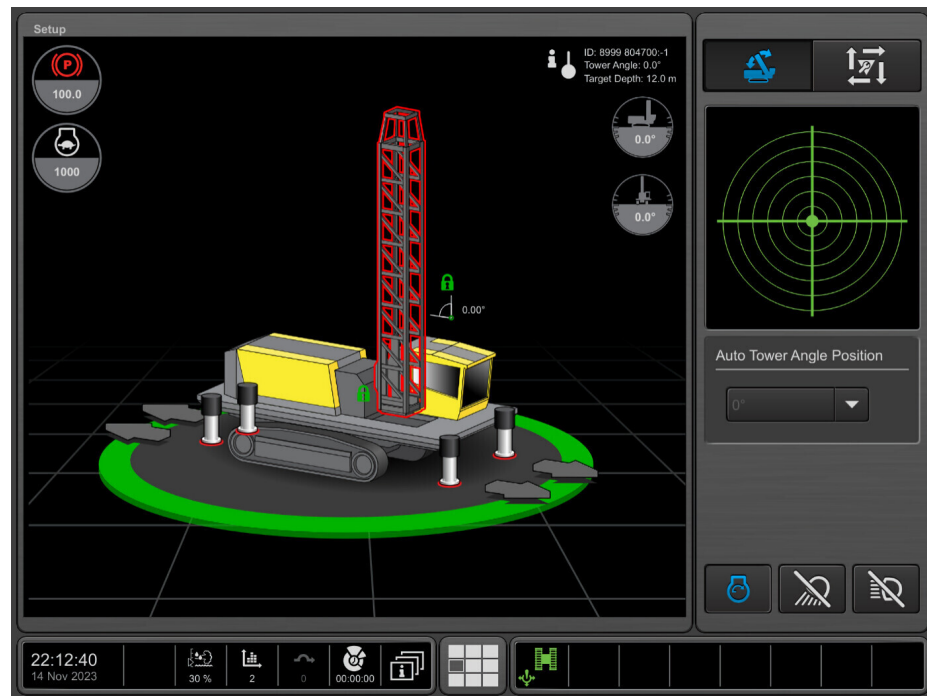


NOTE: The **Bit In Hole, RH at Middle of Tower** function needs to be selected again because overrides are deactivated when changing between operating modes.

1. Visually locate the first drill hole.
2. Make sure there are no vehicles, obstacles, power lines, or unauthorized personnel near or on the machine.
3. Make sure that access ladders are fully raised.
4. Make sure that the drill string is not in the ground.
5. Press the Operator Control Panel On/Off  button to activate the left and right operator control panels.
6. Press the Propel mode  button to select Propel mode. When Propel mode is selected, the hydraulics are shifted and the controls are mapped to propel functions.



NOTE: The **Setup** screen on the display shows the engine rpm, the propel brake release pressure, the machine level, and the leveling jacks. When the leveling jacks are on the ground, the leveling jack indicators have a red highlight, and the Propel function is prohibited. When the leveling jacks are off the ground and fully retracted, the leveling jack indicators have a gray highlight under the pad, and the machine can proceed to the Propel function. Refer to the Control System manual for a detailed description of the **Setup** screen.



Example of the **Setup** Screen

7. Press the High/Low Idle  button to switch on high idle.
8. Press and hold the joystick switches on the left main joystick and right main joystick to release the propel brake.
9. With both joystick switches pressed, move the left main joystick and right main joystick slowly to propel the machine.



NOTE: To initiate movement with the dual joystick propel function, both the left main joystick and right main joystick must be in the center position and both joystick switches must be pressed. Once movement has started, the operator can release one joystick switch at a time. This lets one hand rest when propelling for long distances.



NOTE: Propel speed is proportional to the amount of controller movement. Each propel track motor is operated independently. Both tracks must be operated when propelling the machine. Move the controllers slowly. Do not let a track to drag by only operating one controller at a time.



NOTE: Buildup of ground materials against the tracks can occur during sharp turns and can cause one or both of the tracks to stall. If a stall occurs, propel the machine straight either forwards or in reverse to clear the tracks and complete the turn.



NOTE: The machine can be counter-rotated when operating in a small area by engaging one controller in the forward position and one in the reverse position. Counter-rotating the tracks can disturb the ground beneath the machine and should only be done when necessary.

10. Use the left main joystick and right main joystick to propel the machine to the first drill hole location. If equipped with the GPS option, refer to the Auto Navigation manual.

4.7 Setting Up the Machine for Drilling

DANGER

Risk of Electrocution

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

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

WARNING

Energized Machine

Can cause serious injury.

- ▶ The machine must be fully energized and the engine/motor must be switched on to complete this procedure.
- ▶ Be careful around moving parts and pinch points.

CAUTION

Crushing Risk

Liable to collapse or cause a crushing risk.

- ▶ Make sure that the ground is level and solid before lowering the leveling jacks.

In Setup mode, the operator can do the following:

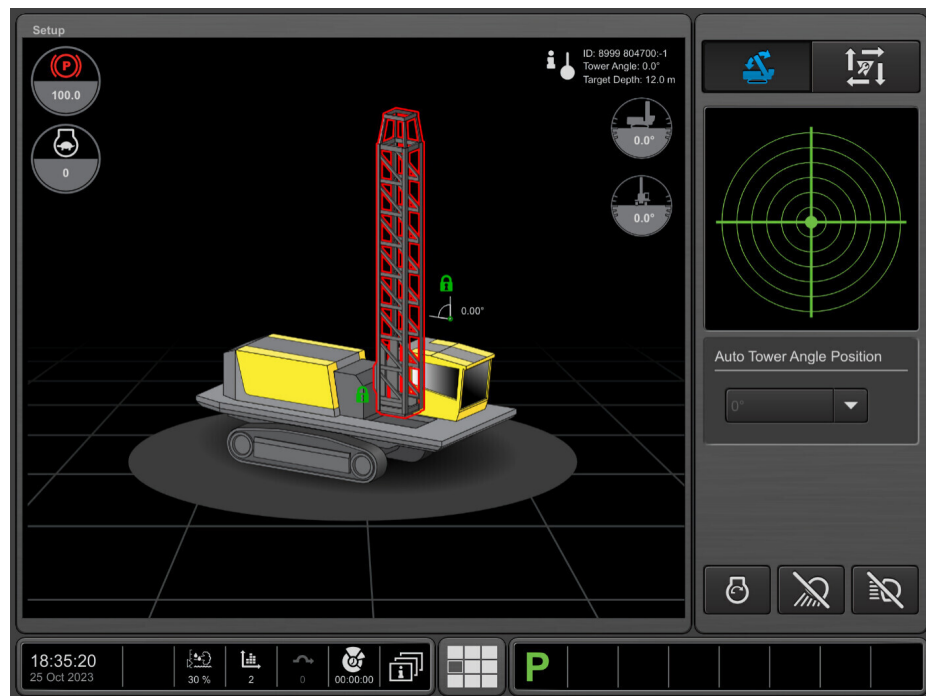
- lower the leveling jacks and level the machine
 - raise and pin the tower (for both vertical and angle pins)
 - lower and raise the dust curtains flap with buttons
 - raise and lower the hoist
1. Press the Operator Control Panel On/Off  button to enable the left and right operator control panels.
 2. Press the Setup mode  button.



NOTE: When the Setup mode  button is selected, the hydraulics are shifted and the controls are mapped to the setup functions.



NOTE: The display screen shows the engine speed, tower angle, tower pinning conditions, and the spirit level. The Setup  icon in the system status bar is green when Setup mode is active.



Example of the Setup Screen

3. Level the machine.
 - a. Refer to Leveling the Machine Manually.
 - b. If using AutoLevel, refer to Leveling the Machine with the AutoLevel Option.

4.

**WARNING****Falling Tower**

Tower locking pin disengagement can cause damage to the tower and serious personal injury

- ▶ Make sure that all locking pins for the tower are in the locked position.

Raise and pin the tower.

- a. For vertical drilling, refer to Raising and Pinning the Tower - Vertical Drilling.
- b. For angle drilling, refer to Lowering or Raising and Pinning the Tower with the Angle Drill Option.

4.8 Leveling the Machine

**CAUTION****Crushing Risk**

Liable to collapse or cause a crushing risk.

- ▶ Make sure that the ground is level and solid before lowering the leveling jacks.



NOTE: The leveling jacks carry the entire weight of the machine. It is imperative that adequate cribbing is used under each leveling jack. The liability for tipping a machine lies solely with the operator.

4.8.1 Leveling the Machine Manually



NOTE: While in Setup mode, the left multifunction joystick controls jack movement when the Activate Leveling Jacks  button is active on the Left Operator Control panel.

1. Make sure that the machine is in Setup mode.



NOTE: Refer to Setting Up the Machine for Drilling.

2. To manually activate the leveling jacks, press the Activate Leveling Jacks  button.



NOTE: The left multifunction joystick is mapped to level the machine when the Activate Leveling Jacks  button is active. The Activate Leveling Jacks  button must be deactivated to return to another function. Always deactivate the Activate Leveling Jacks  button when the leveling jacks are not in use.

3. Use the left multifunction joystick switch to lower all the leveling jacks to the ground.



NOTE: The joystick switch on the left multifunction joystick controls the up and down movement of the leveling jacks.

4. Move the left multifunction joystick to the proper quadrant and press the joystick switch to raise the lowest point to near zero.

Left Multifunction Joystick Movement When Leveling

Non-drill End	Non-cab Side	Cab Side
		



NOTE: Drilling operations require the tracks to be clear of the ground when the machine is leveled. The height must be sufficient to provide total clearance of the tracks, which prevents excess drive system wear during drilling operations.

5. Extend the leveling jacks evenly. Use the drill bubble level to keep the machine level.
 - a. Use the left multifunction joystick to extend the two drill end leveling jacks and level the machine side to side.
 - b. Use the left multifunction joystick to extend the non-drill end leveling jack or jacks and level the machine from the drill end to the non-drill end until the drill bubble level is centered.

4.8.2 Leveling the Machine with the AutoLevel Option



NOTE: While in Setup mode, the left multifunction joystick controls the leveling jacks when the Activate Jacks  button is active on the Left Operator Control panel.

1. Make sure that the machine is in Setup mode. Refer to Setting up the Machine for Drilling.
2. Press and hold the Auto  button.
3. Hold the left multifunction joystick in the center position. While pressing the Auto  button, press and hold the joystick switch on the left multifunction joystick in the up position to extend the leveling jacks and raise the machine.



NOTE: The AutoLevel  icon shows in the system status bar on the display screen when AutoLevel is active.

4. Once the AutoLevel  icon shows in the system status bar, release both the switch on the left multifunction joystick and the Auto  button.
5. To stop the AutoLevel operation, press the left multifunction joystick switch up or down.

Step result



Leveling jack movement stops, and the AutoLevel  icon in the system status bar disappears.

Using the Leveling Jack AutoLevel Bypass Button

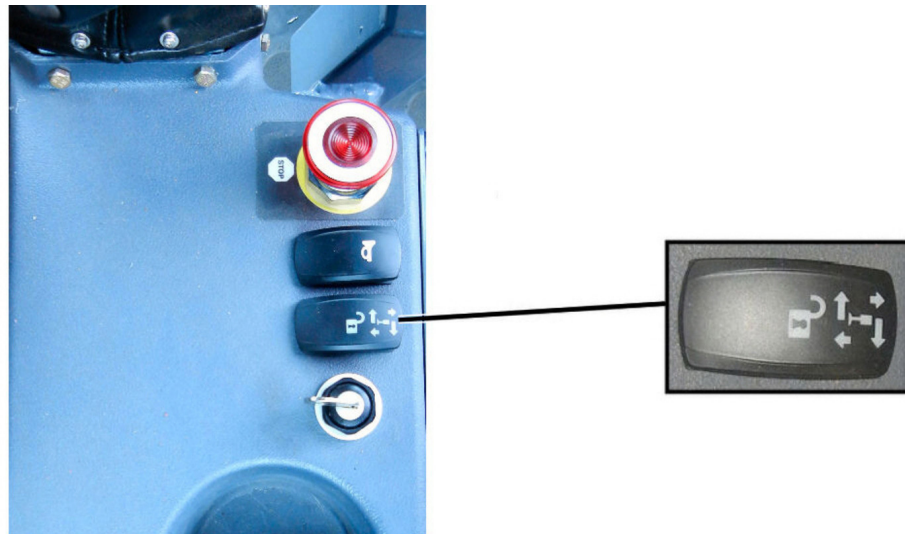


NOTE: The Leveling Jack AutoLevel Bypass button that is located on the key switch and emergency stop panel is used to level the machine if out-of-angle limits exceed 6 degrees. These conditions are when:

- The machine has exceeded 6 degrees of slope at the initial setup location of the drill hole.
- The machine has exceeded 6 degrees for more than one second during AutoLeveling or De-leveling.

1. Press the Setup mode  button to activate Setup mode.
2. Press the Activate Leveling Jacks  button.

3. Press and hold the Leveling Jack AutoLevel Bypass button.



Leveling Jack AutoLevel Bypass Button

4. Use the left multifunction joystick to manually bring the machine within limits.

4.9 Positioning the Tower

4.9.1 Lowering and Unpinning the Tower - Angle Drill

While in Setup mode, the right main joystick is the main control for tower raising and lowering functions. Tower unlocking functions are activated with the Tower Vertical Unlock  button or the Tower Angle Unlock  button.

Precondition ✓ To lower and unpin (unlock) the tower, the machine must be in Setup mode and the Operator Control Panel On/Off  button must be activated.

1. Level the machine.
2. Verify that the tower is in the vertical position.
3. Verify that the vertical locking pins and angle locking pins are in place and locked.



NOTE: For safety reasons, the vertical locking pins and angle locking pins are interlocked to prevent both sets from unlocking at the same time.



NOTE: The **Setup** screen displays the locking pins. The tower vertical pin (lower) icon is green when extended (locked) , yellow when disengaged or in transit , and red when retracted (unlocked) .

4.



WARNING

Unlocking Tower Pins

Can result in serious injury or property damage if the tower is moved.

- ▶ Do not unlock angle locking pins and vertical locking pins at the same time.
- ▶ Make sure that the vertical locking pins remain locked while the tower is in an angle-drilling position.

Press the Tower Vertical Unlock  button to unlock the tower vertical locking pins.

5.

NOTICE

Property Damage

Can cause damage to the machine

- ▶ Do not attempt to move the tower with only one vertical pin unlocked.

Physically verify that both vertical locking pins are unlocked.

6.



DANGER

Risk of Electrocution

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

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

Press and hold the switch on the right main joystick.

7. Pull the right main joystick towards you to enable tower movement and lower the tower.

4.9.2 Raising and Pinning the Tower - Vertical Drill

While in Setup mode, the right main joystick is the main control for tower raising and lowering functions. Tower locking functions are handled by the Tower Vertical Lock  button or Tower Angle Lock  button.

Precondition ✓ To raise and pin (lock) the tower for vertical drilling, the machine must be in Setup mode and the Operator Control Panel On/Off  button must be activated.

1. Make sure that the machine is level and supported by the leveling jacks before the tower is moved.



NOTE: Refer to *Leveling the Machine Manually* or *Leveling the Machine with the AutoLevel Option*.

2.



DANGER

Risk of Electrocution

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

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

NOTICE

Risk of Property Damage

Can cause structural damage to the machine

- ▶ Level the machine before you raise the tower.

Press and hold the joystick switch on the right main joystick.

3.

NOTICE**Damage to Tower**

Can cause damage to the tower structure

- ▶ Hard contact between the tower base and the tower support structure can damage the tower. Use the right main joystick to slow the tower when getting near the vertical stop blocks.

With the joystick switch held, push the right main joystick away from the center position to raise the tower to the vertical position. Use the right main joystick to slow the tower when getting near the vertical stop blocks.



NOTE: Engine speed affects the time to raise the tower.

4.

After the tower has been raised, press the Tower Vertical Lock  button to lock the vertical locking pins. To lock the angle locking pins, press the Tower Angle Lock  button. To lock the strut pinning engage pins, press the Strut Lock  button, if applicable.



NOTE: The display screen shows the active condition of vertical and angle pins. When the pins are extended (in the locked position), the lock indicators  are green.

5.

NOTICE**Property Damage**

Can cause severe damage to the machine

- ▶ Make sure that all locking pins are in the locked position before drilling.

Visually verify that the tower vertical locking pins and angle locking pins are locked in place.



NOTE: All locking pins must be in the locked position during drilling operations.

4.9.3 Manually Lowering or Raising and Pinning the Tower with the Angle Drill Option

While in Setup mode, the right main joystick is the main control for raising and lowering the tower. Tower locking functions are handled by the Tower Vertical Lock  button and the Tower Angle Lock  button.



NOTE: The machine must be leveled and supported by all leveling jacks before the tower is raised.

Precondition

- ✓ The Operator Control Panel On/Off  button must be on for Setup mode to activate.

1. Press the Setup mode  button to activate Setup mode.

- 2.



DANGER

Risk of Electrocution

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

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

NOTICE

Component Damage

Tower and platform damage can occur

- ▶ Adjust the drill table to the vertical position before you raise the tower to the vertical position.

Raise and pin the tower.



NOTE: Refer to Raising and Pinning the Tower.

3. Physically verify that the tower is in the vertical position.

4. Verify that the vertical locking pins and angle locking pins are in place and locked.



NOTE: For safety reasons, the tower angle locking pins and vertical locking pins are interlocked to prevent both sets of pins from unlocking at the same time.



NOTE: The **Setup** screen displays the locking pins. The icons for the tower angle pins and the vertical locking pins are green when engaged , yellow when in transit , and red when disengaged .

5. Press the Tower Angle Unlock  button to unlock the tower angle locking pins.

6. **WARNING**

Unlocking Tower Pins

Can result in serious injury or property damage if the tower is moved.

- ▶ Do not unlock angle locking pins and vertical locking pins at the same time.
- ▶ Make sure that the vertical locking pins remain locked while the tower is in an angle-drilling position.

Physically verify that both angle locking pins on the tower support are unlocked.

7. **DANGER**

Risk of Electrocution

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

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

NOTICE

Property Damage

Can cause property damage

- ▶ Do not move the tower to an angle-drilling position with only one angle lock pin disengaged.

Press and hold the switch on the right main joystick and pull the right main joystick towards you to enable tower movement.

8. Lower the tower until the proper angle is indicated on the **Setup** screen.
9. If a pin is stuck between the locked and unlocked position, use the tower wiggle feature.
 - a. Press and hold the Tower Angle Unlock  or the Tower Angle Lock  button for the pin directions to be moved.
 - b. With the other hand, press the switch on the right main joystick and move the right main joystick in one direction.
 - c. If the pin is not free, move the right main joystick in the other direction.
10. When the correct angle has been reached, lock the angle locking pins with the Tower Angle Lock  button.



NOTE: Due to the possibility of slight differences in manufacturing tolerances, wear, or slight damage, it may be necessary to gently move the right main joystick back and forth to fully lock both angle pins.

11. After the **Setup** screen angle pin indicator display shows the pins to be locked, put all cab controls are in the neutral position.
12. Physically verify that all angle locking pins and vertical locking pins are in the locked position. Always verify that the pins are locked.
13. Visually verify that the drill pipe support is supporting the drill pipe. The drill pipe support extend/retract is controlled by the operator.

4.9.4 Automatically Lowering or Raising and Pinning the Tower with the Angle Drill Option

While in Setup mode, the right main joystick is the main control for raising and lowering the tower. Tower locking functions are handled by the Tower Vertical Lock  button and the Tower Angle Lock  button.



NOTE: The machine must be leveled and supported by all leveling jacks before the tower is raised.

Precondition

- ✓ The Operator Control Panel On/Off  button must be on for Setup mode to activate.

1. Press the Setup mode  button to activate Setup mode.
2. Visually verify that the drill pipe support is supporting the drill pipe.



NOTE: The drill pipe support extend/retract must be controlled by the operator.

3.



DANGER

Risk of Electrocution

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

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

Raise and pin the tower.



NOTE: Refer to Raising and Pinning the Tower.

4. Physically verify that the tower is in the vertical position.
5. Verify that the vertical locking pins and angle locking pins are in place and locked.



NOTE: For safety reasons, the tower angle locking pins and vertical locking pins are interlocked to prevent both sets of pins from unlocking at the same time.



NOTE: The **Setup** screen displays the locking pins. The icons for the tower angle pins and the vertical locking pins are green when engaged , yellow when in transit , and red when disengaged .

6. Press the Tower Angle Unlock  button to unlock the tower angle locking pins.

7.



WARNING

Unlocking Tower Pins

Can result in serious injury or property damage if the tower is moved.

- ▶ Do not unlock angle locking pins and vertical locking pins at the same time.
- ▶ Make sure that the vertical locking pins remain locked while the tower is in an angle-drilling position.

Physically verify that both angle locking pins on the tower support are unlocked.

8.



DANGER

Risk of Electrocution

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

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

NOTICE

Property Damage

Can cause property damage

- ▶ Do not move the tower to an angle-drilling position with only one angle lock pin disengaged.

Select the desired tower angle shown under **Auto Tower Angle Position**.



Auto Tower Angle is Ready

Step result

→ A 10-second timer shows next to the selected angle and begins a countdown.

9. While the 10-second timer is counting down, press and hold the Auto  button for at least one second. Release the button after at least one second passes.



NOTE: The **Auto Tower Angle Position** action aborts when the operator activates one of the joysticks.

Step result

→ A yellow **Auto Tower Angle**  icon displays in the system status bar, indicating that the function is active. The RCS unlocks the angle pins and moves the tower. A yellow arrow displays at the top of the tower on the **Setup** screen to indicate the direction of travel.



Auto Tower Angle is Active

When the tower reaches the programmed angle, the tower stops moving and the angle pins lock. The **Auto Tower Angle Position** action is complete, and the **Auto Tower Angle**  icon disappears from the system status bar. If the angle pins do not lock, the tower wiggles to help align the angle pins so that they lock.

10. After the **Setup** screen angle pin indicator display shows the pins to be locked, make sure that all cab controls are in the neutral position. Physically verify that all angle locking pins and vertical locking pins are in the locked position. Always verify that the pins are locked.
11. Visually verify that the drill pipe support is supporting the drill pipe. The drill pipe support extend/retract must be controlled by the operator.

4.10 Using the Drill Pipe Support

Use the drill pipe support during the following operations:

- Aligning the drill pipe with the deck bushing.
- Stabilizing and aligning the drill pipe to guide the drill pipe while making or breaking a threaded joint connection (drill pipe, drill bit sub, stabilizer, hammer crossover sub, and the like).
- Stabilizing and aligning the drill pipe to guide the drill pipe while adding or removing from the carousel cups.

The drill pipe support is graphically shown on the drill profile on the **Drilling** screen as either being extended (closed position) or retracted (open position). Fully open the drill pipe support by pressing the Drill Pipe Support Open  button on the right operator control panel.

When the machine is operating, there is a selectable automatic drill pipe support feature that automatically actuates both opening and closing when the rotary head moves up and down the tower. Select the **Setting > Service > Parameters > Functions** screen. Automatic drill pipe support handling is active when **Use Auto Drill Pipe Support Handling** is selected.

4.11 Calibrating the Rotary Head Position

When the **Rotary Head Calibration Warning**  icon is active, the RCS does not know where the rotary head is within its length of travel. RCS software is configured so that when the **Rotary Head Calibration Warning**  icon becomes active for any reason, no rotary head movement will occur until the drill pipe support is moved to the open position.



NOTE: The Rotary Head Calibration Warning  icon becomes active when the rotary head position changes too rapidly.

1. Press the Drill Pipe Support Open  button to open the drill pipe support.



NOTE: After opening the drill pipe support, the feed only moves at the set reduced speed until the rotary head is properly calibrated.

2. Make sure that the carousel is in the stowed position.
3. Move the rotary head through its travel to activate the calibration switches.



NOTE: Moving the rotary head down over the tower midpoint or up over the upper calibration point recalibrates the rotary head position and sends the true location of the rotary head to the system. Once RCS recognizes the true rotary head position, this icon disappears and speed resumes to normal.

4.12 Using the Dust Flaps

The dust flaps are controlled automatically if **Auto Dust Flaps Active** is selected on **Setting > Service > Parameters > Functions**. The dust flaps raise when a delevel command is given. The dust flaps lower when the machine is level with all leveling jacks on the ground and Drill mode is selected.

This procedure describes how to operate the dust flaps manually when **Auto Dust Flaps Active** is not selected. While in Setup mode, dust flap functions are controlled by the Dust Flaps Up  button and Dust Flaps Down  button. The Operator Control Panel On/Off  button must be switched on to activate the dust flaps.

1. Press and hold the Dust Flaps Up  button to raise the dust curtains.
2. Release the Dust Flaps Up  button to stop the movement of the dust curtains.

3. Press and hold the Dust Flaps Down  button to lower the dust curtains.
4. Release the Dust Flaps Down  button to stop the movement of the dust curtains.

4.13 Using the Hoist

WARNING

Suspended Load

Can cause severe injury or death

- ▶ Do not stand in the working area of a crane or hoist when it is operating with an overhead load.
- ▶ Stay away from suspended loads.

In Setup mode, hoist functions are enabled with the left main joystick and activated with the Activate Cab Hoist  button.

Precondition ✓ To raise or lower the hoist, the machine must be in Setup mode, and the Operator Control Panel On/Off  button must be activated.

1. Press the Activate Cab Hoist  button to activate the hoist. The button has an LED that indicates that the hoist control is active.



NOTE: When activated, the left main joystick operates the appropriate spool valve for using the hoist to raise and lower loads.

2. Press and hold the joystick switch on the left main joystick.
3. With the joystick switch pressed on the left main joystick, move the left main joystick to enable hoist wire rope movement. Left main joystick movement will control the direction and speed of the hoist wire rope.
4. Press the Activate Cab Hoist  button to deactivate the hoist.



NOTE: Always deactivate the button when the hoist is not in use.

4.13.1 Using the Remote Hoist

WARNING

Suspended Load

Can cause severe injury or death

- ▶ Do not stand in the working area of a crane or hoist when it is operating with an overhead load.
- ▶ Stay away from suspended loads.

Precondition

- ✓ The Activate Cab Hoist  button must be deactivated to enable the remote hoist to function.

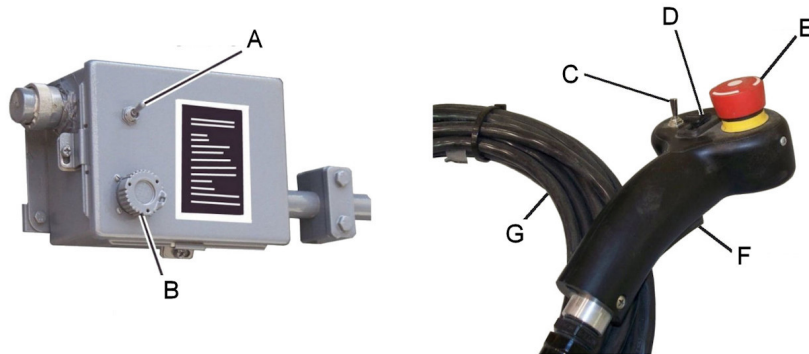
1. Remove the remote hoist cable connector cap and umbilical cable cap.
2. Plug the umbilical cable into the cable connector socket.
3. Move the remote hoist toggle switch on the electrical box to the REMOTE position.



NOTE: The remote hoist electrical box is located on the frame below the deck on the non-cab side, drill end of the machine.

4. Move the remote hoist cable control toggle switch to the upward position.

5. Squeeze the trigger and move the slider to raise or lower the hoist.



Remote Hoist

A	Remote hoist switch	B	Remote hoist cable connector
C	On/Off toggle	D	Slider
E	Emergency stop	F	Trigger
G	Umbilical cable		



NOTE: The remote hoist control emergency stop button should be in the extended position when Remote Hoist is enabled.

6. Do these steps to remove and store the hoist pendant:
 - a. Move the remote hoist toggle switch on the electrical box to the CAB position.
 - b. Unplug the umbilical cable from the cable connector socket.
 - c. Replace the remote hoist cable connector cap and umbilical cable cap.

Removing and Storing the Hoist Control Cable Unit

1. Move the remote hoist toggle switch to the RUN position.
2. Disconnect the umbilical cable from the cable connector socket on the electrical box.
3. Replace the cap.
4. Store the remote hoist control and the umbilical cable in the operator cab.

4.14 Using Drill Mode

1. Push the Drill mode  button to activate Drill mode.



NOTE: When in Drill mode, the left main joystick controls the drill string rotation, and the right main joystick controls the feed rate.

2. Press the Activate Leveling Jacks  button to level the machine in Drill mode.



NOTE: The left multifunction joystick controls the leveling jacks. Always deactivate the jacks when not in use.

4.14.1 Rotation



NOTE: In Drill mode, the left main joystick controls drill string rotation. Rotation is proportional to the left main joystick position.

1. Press and hold the joystick switch on the left main joystick.



NOTE: Pressing the top section of the joystick switch activates Precision Control. Pressing the bottom section of the joystick switch activates normal rotation.

2. Move the left main joystick to start drill string rotation.

Alternative step

- a. Push the left main joystick forward from the center position to start the drill string rotating in a counterclockwise direction.

Alternative step

- b. Pull the left main joystick toward you from the center position to start the drill string rotating in a clockwise direction.

3. If direction change is required, activate the joystick switch when the left main joystick moves through the center position.

4.14.2 Feed



NOTE: In Drill mode, the right main joystick controls the feed speed and direction. The Feed Force control is used to control the feed pressure.

1. Press and hold the joystick switch on the right main joystick.
2. Push the right main joystick forward or pull backward to start the feed flow.

3. Release the joystick switch when the rotary head is moving.

Feed Flow — In Drill mode, pushing the right main joystick away from the center position increases feed speed up direction. Pulling the right main joystick towards you from the center position increases feed speed down direction. Feed flow is proportional to the right main joystick position. To enable feed flow, the joystick switch must be pushed and held before moving the right main joystick. When the rotary head is moving, the joystick switch on the right main joystick can be released. Moving the right main joystick through the center position without activating the joystick switch on the right main joystick stops the feed.

Feed Pressure — Rotating the Feed Force control clockwise increases the feed pressure. Rotating the Feed Force control counterclockwise decreases the feed pressure. The working area of the Feed Force control is 270 degrees.

Holdback (option) — Rotating the Holdback control clockwise increases holdback force. Rotating the Holdback control counterclockwise decreases the holdback force.

4.14.3 Air Regulation



NOTE: The Air Regulation On/Off  button on the right operator control panel activates drill air control. The Operator Control Panel On/Off  button on the left operator control panel must be on for air regulation to activate.

Air Regulation With a Clutch

1. Press the Air Regulation On/Off  button to engage and disengage the clutch.
2. Press the Air Flow Decrease  button to decrease the commanded air flow.
3. Press the Air Flow Increase  button to increase the commanded air flow.



NOTE: When the air is switched off using the Air Regulation On/Off  button, the air tank pressure will blow down to < 0.34 bar (<5 psi). The clutch disengages when the air tank pressure is <4.83 bar (<70 psi).



NOTE: Commanding <6% air flow sets the compressor to stand by pressure and keeps the clutch engaged.

Air Regulation Without a Clutch

1. Press the Air Regulation On/Off  button to control power to the air function.



NOTE: When the Air Regulation On/Off  button is off, the air flow is set to stand by and the pressure limit is set to <0.34 bar (<5 psi).



NOTE: When the Air Regulation On/Off  button is on, the air flow is set to the commanded value and the maximum pressure limit is set to the compressor pressure rating.

2. Press the Air Flow Decrease  button to decrease the commanded air flow.
3. Press the Air Flow Increase  button to increase the commanded air flow.
4. When the air is switched off using the Air Regulation On/Off  button, the air tank pressure will blow down to < 0.34 bar (<5 psi).

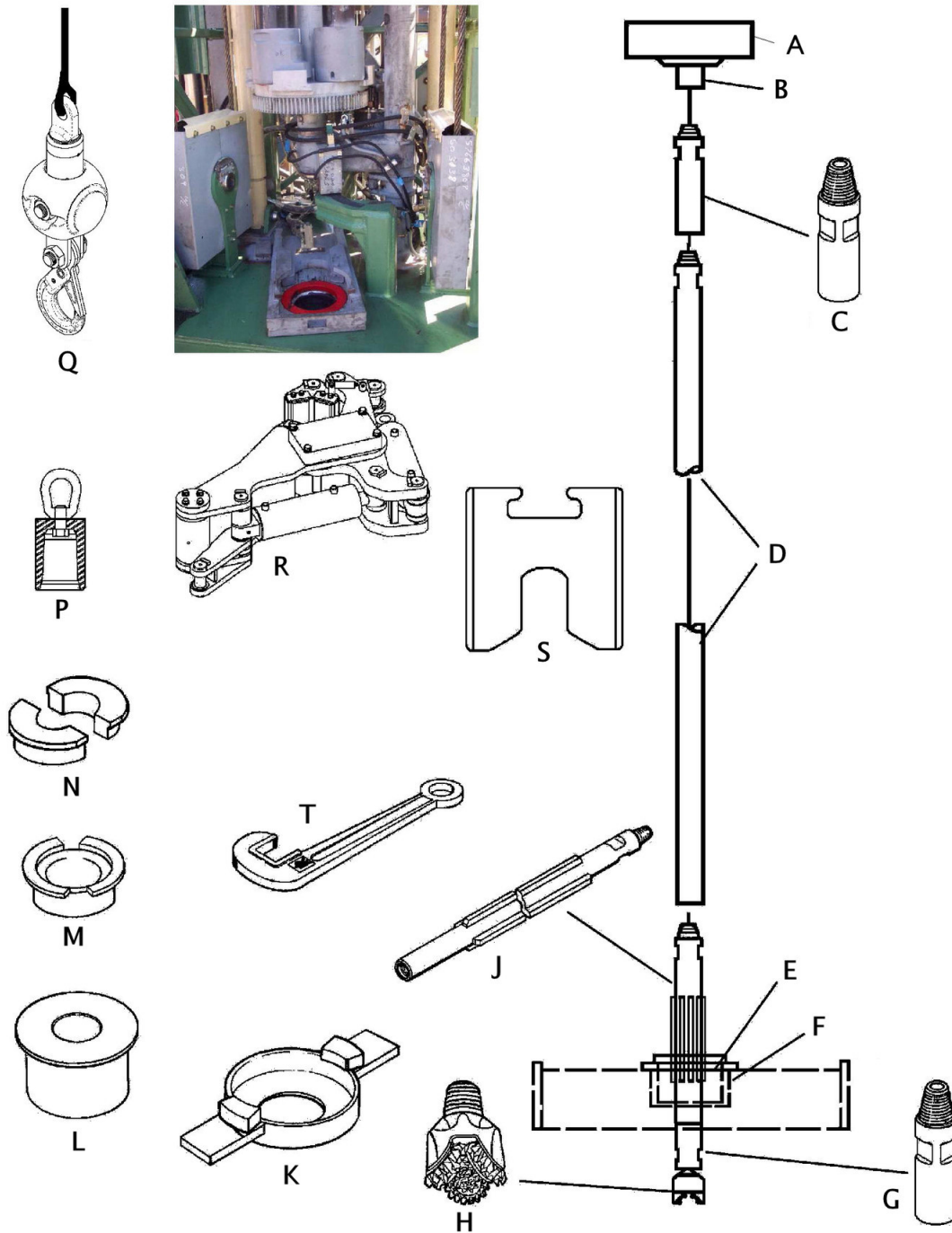
4.15 Drilling with the Machine



NOTE: Epiroc recommends using a shock sub for high-pressure applications.

4.15.1 Rotary Drill String Tools and Accessories

The following are drill string tools and accessories used in rotary drilling for installing or changing the tricone drill bit and breaking tight threaded-joints between drill pipes, the rotary head, the spindle, or drill bits.



Rotary Tools and Accessories

A	Rotary head	B	Shock sub
C	Spindle sub	D	Drill pipe
E	Drill pipe centralizer bushing	F	Table centralizer bushing
G	Drill bit sub	H	Tricone drill bit
J	Stabilizer	K	Drill Bit basket

L	Table centralizer bushing	M	Drill pipe centralizer bushing
N	Drill split bushing	P	Lifting bail
Q	Auxiliary hoist wire rope with safety hook	R	Breakout wrench
S	Deck fork (drill pipe retainer)	T	J-wrench

4.15.2 Installing the Stabilizer

WARNING

Energized Machine

Can cause serious injury.

- ▶ The machine must be fully energized and the engine/motor must be switched on to complete this procedure.
- ▶ Be careful around moving parts and pinch points.

WARNING

Crushing Hazard

Can cause personal injury

- ▶ All lifting equipment must be adequately sized, have the proper lifting capacity, and be in good condition.
- ▶ Be careful when you lift heavy components.

- Precondition**
- ✓ The machine is not over an existing hole.
 - ✓ The machine is in Drill mode.
 - ✓ The rotary head is at the top of the tower, and the drill pipe changer and the carousel are in the stowed position.

1. Install the correct lifting bail on the pin end of the stabilizer. Use the hoist to raise the stabilizer, and align it over the table. Refer to Using the Hoist.

2.

**WARNING****Falling Drill String Component**

Can cause serious injury or death.

- ▶ Make sure a good joint has been made by looking at the connection between the lifting bail and the stabilizer pin end threads before moving the stabilizer.

Make sure that a good joint has been made by looking at the connection between the lifting bail and the stabilizer pin-end threads.

3. Lower the stabilizer through the deck fork table until the flats of the tool joint align with the deck fork.
4. Press the Deck Fork Engage  button to engage the deck fork so that the rotary head or shock sub spindle can be threaded and secured to the stabilizer.
5. Release the hoist wire rope tension so that the stabilizer shoulders rest on the deck fork.
6. Remove the lifting bail, and move the hoist wire rope out of the way.



NOTE: Deactivate the hoist button when the hoist is not in use.

7. Lubricate the thread joints correctly.
8. Install the centralizer bushing around the stabilizer and rest on the deck fork.
9. With the right main joystick, press and hold the top side of the joystick switch to use Precision Control. Feed down the rotary head to engage the threads on the pin end of the stabilizer.
10. With the left main joystick, press and hold the top side of the joystick switch to use Precision Control. Use slow clockwise rotation to securely tighten the stabilizer.



NOTE: In Precision Control, use the top side of the joystick switch for rotation and drilling. This reduces the speed for rotation and drill feed operations.

11. Press the Deck Fork Disengage  button to remove the deck fork from the stabilizer.
12. Raise the stabilizer above the table.

4.15.3 Removing the Stabilizer

WARNING

Energized Machine

Can cause serious injury.

- ▶ The machine must be fully energized and the engine/motor must be switched on to complete this procedure.
- ▶ Be careful around moving parts and pinch points.

WARNING

Crushing Hazard

Can cause personal injury

- ▶ All lifting equipment must be adequately sized, have the proper lifting capacity, and be in good condition.
- ▶ Be careful when you lift heavy components.



NOTE: The centralizer roller bushing weighs approximately 90.7 kilograms (200 pounds). Lift the centralizer roller bushing above the drill pipe flats with the hoist. Attach eyelets to the holes in the top surface of the bushing to aid in lifting the bushing.

- Precondition
- ✓ The machine is not over an existing drill hole.
 - ✓ The drill bit is removed.

1. Close the drill pipe support around the drill pipe, but do not clamp the drill pipe completely. The drill pipe must be able to raise, lower, and turn freely.
2. Use the right Drill Feed Up/Down joystick (with Precision Control) to slowly raise the rotary head until the stabilizer flats in the tool joint align with the deck fork.



NOTE: In Precision Control, use the top side of the rocker switch for rotation and drilling. This reduces the speed for rotation and drill feed operations.

3. Attach lifting eyes to the holes provided in the centralizer bushing. Connect a lifting sling or wire rope to the lifting eyes with shackles.
4. Connect the hoist hook to the lifting sling, and lift the centralizer bushing high enough to engage the breakout wrench.

5. Swing in the breakout wrench, and clamp its jaws around the stabilizer. Continue applying pressure until the drill pipe joint breaks loose. Repeat this step until the joint breaks loose.
6. Lower the centralizer bushing and set it on the deck fork. Disconnect the lifting sling from the hook and store the lifting sling in a safe place.
7. Use the left Drill Rotation joystick (with Precision Control) to turn the drill pipe counter-clockwise. At the same time, use the right Drill Feed Up/Down joystick (with Precision Control) to slowly raise the rotary head and uncouple the drill pipe from the stabilizer.



NOTE: Make sure that the drill pipe and the rotary head joint stay coupled when uncoupling the stabilizer.

8. Raise the rotary head high enough to connect the lifting sling to the stabilizer bushing to lift it off the deck fork.
9. Store the centralizer bushing in a safe place.
10. Attach a lifting bail to the stabilizer, and connect the hook to the lifting bail.
11. Use the hoist to lift the stabilizer from the deck fork. Retract the deck fork.
12. Lift the stabilizer above the drill deck opening, and store it in a safe place.

4.15.4 Replacing the Drill Bit

WARNING

Energized Machine

Can cause serious injury.

- ▶ The machine must be fully energized and the engine/motor must be switched on to complete this procedure.
- ▶ Be careful around moving parts and pinch points.

WARNING

Crushing Hazard

Can cause personal injury

- ▶ All lifting equipment must be adequately sized, have the proper lifting capacity, and be in good condition.
- ▶ Be careful when you lift heavy components.

WARNING

Moving Parts

Sudden uncontrolled movement can cause serious injury.

- ▶ Do not stand directly below the drill pipe.
- ▶ Do not put hands or fingers in pinch points.

This procedure is for installing the tricone drill bit or DHD drill bit directly onto the drill pipe. The drill bit installation procedure is the same if you are installing the drill bit onto a starter drill pipe or stabilizer.



NOTE: When using a hydraulic drill bit basket, refer to the procedure for *Installing the Drill Bit with the hydraulic drill bit basket*.

Precondition

- ✓ The machine must not be over an existing drill hole when changing the drill bit.

1. Close the drill pipe support around the drill pipe.
2. Open the breakout wrench jaws, and stow the breakout wrench in its safe stowed position.
3. Use the right main joystick (with Precision Control) to raise the rotary head so that the centralizer bushing and drill bit clear the drill deck with enough clearance to install the drill bit basket.



NOTE: In Precision Control, use the top side of the rocker switch for rotation and drilling to reduce the speed for rotation and drill feed operations.

4. Install the drill bit basket, and lower the drill bit into the drill bit basket.
5. Swing in the breakout wrench.
6. Clamp the jaws around the drill pipe and apply rotation. Repeat this step until the drill pipe joint breaks loose.
7. Open the breakout wrench jaws, and stow the breakout wrench in its safe stowed position.
8. Use the left main joystick (with Precision Control) to slowly turn the drill pipe counter-clockwise. At the same time, slowly raise the rotary head with Precision Control on the right main joystick until the joint is uncoupled from the drill bit.
9. Use the right main joystick (with Precision Control) to raise the rotary head enough to be able to lift the drill bit out of the drill bit basket.

10.

**WARNING****Suspended Load**

Can cause severe injury or death

- ▶ Do not stand in the working area of a crane or hoist when it is operating with an overhead load.
- ▶ Stay away from suspended loads.

Connect the lifting bail to the drill bit. Hook the hoist wire rope to the lifting bail. Use the hoist to remove the drill bit from the drill bit basket.

11. Remove the lifting bail from the used drill bit, and connect it to the new drill bit.
12. Make sure that the new drill bit has the correctly sized nozzles installed. Place the new drill bit into the drill bit basket, and apply a liberal amount of thread lubricant.
13. Use the right main joystick (with Precision Control) to lower slowly the rotary head, while using the left main joystick (with Precision Control) to turn the drill pipe clockwise until the drill bit is fully threaded onto the drill pipe.
14. Make sure that the drill bit is secured in the drill bit basket, and apply a rotation torque to tighten the drill pipe to the drill bit.



NOTE: Make sure that a good joint has been made by looking at the connection between the drill bit and the drill pipe. There should not be a gap between the drill pipe and drill bit.

15. Use the right main joystick (with Precision Control) to raise the rotary head, and raise the drill bit high enough to be able to lift the drill bit basket from the drill deck.
16. Remove the drill bit basket from the drill deck.
17. Use the right main joystick (with Precision Control) to slowly lower the rotary head so that the drill bit passes through the opening in the drill deck.
18. Open the drill pipe support and stow it in its safe stowed position.
19. Stow the drill bit basket in a safe place.

4.15.5 Drilling Procedure

WARNING

Energized Machine

Can cause serious injury.

- ▶ The machine must be fully energized and the engine/motor must be switched on to complete this procedure.
- ▶ Be careful around moving parts and pinch points.



NOTE: Drilling procedures are the same if you are drilling with either a tricone drill bit or DHD drill bit. If you are using a DHD drill bit, select **DTH Drilling** on the **Setting > Service > Parameters > Functions** screen. The **DTH Drilling** setting adjusts the holdback force so that the hammer on the DHD drill bit can activate. Also be sure that drill bit lubrication is active to lubricate the hammer on the DHD drill bit.

Precondition

- ✓ Make sure that the rotary drill bit, starter drill pipe or drill bit sub, and drill pipe are installed correctly.
- ✓ Press the control panel On/Off  button on the left control panel to enable both control panels.

Step result

1. Press the Drill mode  button to activate and enable drilling functions.
→ The **Drilling** screen shows on the display screen.
2. Press the Engine Speed High/Low  button to activate the engine throttle. Raise the engine speed to high idle.
3. Select the **Settings > Service > Parameters > Functions** screen to verify drill parameters.
4. Return to the **Drilling** screen.
5. Press and hold the joystick switch on the right main joystick. Gently pull the right main joystick toward you to move the drill string in the downward position until the drill bit touches the ground.



NOTE: Feed flow is proportional to the right main joystick position.

6. Press the Air Regulation On/Off  button to switch on the air compressor air flow. Make sure that the correct air pressure for collaring the drill hole is being supplied by pressing the Air Flow Increase  button or the Air Flow Decrease  button.

7. If rock contact is activated, a pop-up message shows that asks if the drill hole needs to be zeroed. Select **Yes**. If rock contact is not activated, select the **hole zero** button.
8. Retract from the drill hole zero position at least the distance equal to the drill bit diameter.
- Optional step ➤ If using DTH hammer drilling, use drill hole punching to start the drill hole with less deviation. Do the following substeps to use drill hole punching.
 - a. Switch on the air and then feed down without using rotation.
 - b. Drill for about 2.54 centimeters (1 inch).
 - c. Pull up a distance equal to the drill bit diameter while rotating the drill bit a small amount.
 - d. Stop rotation and punch again.
 - e. Repeat steps a to d for 4 to 5 punches, then start drilling normally.
9. Press and hold the joystick switch on the left main joystick, and gently pull the left main joystick toward you to start clockwise drill string rotation at a rate of 20 to 30 rpm.
10. Press and hold the joystick switch on the right main joystick, and gently pull the right main joystick toward you.
11. Slowly rotate the Feed Force control knob clockwise to increase feed pressure until the drill string starts moving downward.
12. Observe the drill string, and make sure that a positive rate of feed at the desired feed pressure and rotation speed has been established.



NOTE: The soft soil, broken rock, gravel, or clay that is above consolidated rock is called overburden. It can be anywhere from 0.3 meter (1 foot) to several meters or yards thick. When drilling through this mixture to collar a new drill hole, care must be taken to prevent excessive cuttings from being blown out of the drill hole and causing a washout.

13. Monitor the drill bit air pressure on the **Drilling** screen to make sure that the drill hole and nozzles do not become plugged with rock or unwanted material.



NOTE: A sudden marked increase of air pressure indicates a plugged drill bit or plugged drill hole.

14. After approximately 3 meters (9.8 feet) of penetration, increase the feed pressure and rotation speed to the nominal values determined by site management.
15. Make sure that a positive rate of feed has been established.

16. Observe the drilling operation, and make feed, rotation, and air pressure changes as needed.



NOTE: Drill with the machine in a way that keeps the drill string from vibrating. Drilling with incorrectly adjusted pressures for the drilling conditions causes drill string vibration. If vibration occurs, reduce the rotation speed until the vibration stops. Feed force pressure can be reduced as well.

NOTE: After vibration stops, gradually increase rotation speed and feed force pressure until the drill bit is smoothly breaking the rock.

17. Use the dust collector or water injection or to control dust during drilling operations. Make sure that only minimal dust is being released into the atmosphere during drilling. Switch on and off the dust collector using the Dust Collector On/Off  button. Do steps **a** through **c** to use water injection.



NOTE: If switching from water injection to dust collection, shut off the water supply before switching on the compressor to clear the water out of the drill pipe to prevent clogging the dust collector. The RCS lets you switch on the dust collector after the water has been on when the compressor has been on long enough to clear the water from the air pipes.

- a. Press the Water Injection On/Off  button to activate the Water Injection On/Off function. When it is on, water flows in the amount preset in the RCS parameters. It must be switched on to activate the Water Flow Increase  button and the Water Flow Decrease  button.
- b. To increase the water flow, press the Water Flow Increase  button to override the preset amount.
- c. To decrease the water flow, press the Water Flow Decrease  button to override the preset amount.



NOTE: Too much water causes the cuttings to ball up and plug the drill hole.

18. Monitor torque and feed force on the **Drilling** screen, and make any necessary corrections to the feed and rotation circuit during drilling.

19. During drilling operations, monitor the drill bit air pressure and cuttings flow to make sure that the drill hole is being bailed correctly, air circulation is being maintained, and the drill hole has not become plugged.



NOTE: A void or rock fracture that causes loss of air circulation does not cause any displayed air pressure changes, but it allows the drill hole to plug quickly. The first indication of a plugged drill hole due to a void or fracture is normally a rapid increase in rotation or torque pressure without an air pressure change. Rotation pressure must be monitored continuously to avoid the drill string getting stuck in the hole.

20. Drill the drill hole to the desired drill hole depth or the maximum depth attainable for the drill pipe.
21. When the depth has been reached, stop the feed and let the drill string to rotate for approximately 15 seconds to clear the hole.
22. When the drill hole is complete, press the Water Injection On/Off  button to switch off the water injection, and slow the rotation to 20 to 30 rpm.
23. Raise the drill pipe until the drill string is no longer red on the **Drilling** screen.
24. Press the Air Regulation On/Off  button to switch off the air.
25. Raise the leveling jacks.
26. Propel the machine to the next drill hole, and repeat the drilling process.

4.15.6 Freeing a Jammed Drill String

NOTICE

Machine Damage

Using the leveling jacks to pull a jammed drill string will damage the machine.

- Do not use the leveling jacks to attempt to pull a jammed drill string from the drill hole. The leveling jacks are only designed to support the weight of the machine.

Many variables can cause a blockage or jam in the drill hole. An attentive operator can minimize the number of blockages or jams. Carefully monitor the rotation and air pressure gauges while drilling. Slight increases in air and rotation pressures can indicate that the drill hole is either collapsing or closing behind the drill bit.



NOTE: The drill bit requires airflow to keep the bearings clean and cool. Drilling without air damages the drill bit.

Proper use of drill bit air while drilling is important for drilling a good drill hole and for retrieving a jammed drill string. When feed force is switched on, switch on drill bit air for effective drill hole clearing. Use drill bit air when retracting the drill bit through areas of consolidated material. However, reducing the drill bit air when removing the drill string from a drill hole that is drilled in unconsolidated material helps maintain the stability of the drill hole.



NOTE: *Slow movement of the controls is essential when freeing a jammed drill string.*

If a problem with the drill hole is suspected, maintain airflow and rotation while raising the drill bit off the bottom of the drill hole. Continue to retract the drill string to clear the drill hole before proceeding.

If there is a drill hole collapse, jammed drill string, and a loss of cuttings that are removed from the drill hole, an alternative approach is to shut off the drill bit air for a short time. Shutting off the drill bit air releases pressure on the drill hole and lets cuttings fall past the drill bit. Switch on the drill bit air to try to clear the drill hole and protect the drill bit.

4.15.7 Drill Pipe Changing Sequence



WARNING

Energized Machine

Can cause serious injury.

- ▶ The machine must be fully energized and the engine/motor must be switched on to complete this procedure.
- ▶ Be careful around moving parts and pinch points.

NOTICE

Damage to Threads

Can cause thread damage

- ▶ While connecting the spindle onto the drill pipe, do not force down the rotary head. Let the drill pipe be picked up as it connects onto the spindle.

1. Drill the hole to the maximum depth attainable for the current drill string.
2. When that depth has been reached, stop the feed. Raise the drill bit from the bottom of the hole, and let the drill string turn for approximately 15 seconds to clear the hole.
3. Press the Water Injection On/Off  button to switch off water injection.

4. Use the left main joystick with Precision Control to slow the drill string rotation to 20 to 30 rpm.



NOTE: In Precision Control, use the top side of the joystick switch for rotation and drilling to reduce the speed for rotation and drill feed operation.

5. Raise the drill string with the right main joystick until the flats on the pin end of the drill pipe are aligned with the deck fork on the drill deck.
6. Switch off the air with the Air Regulation On/Off  button.
7. Align the drill pipe flats with the deck fork. Secure the drill pipe in the deck fork using the drill pipe flats and press the Deck Fork Engage  button. Use rotation if necessary to align the drill pipe flats with the deck fork. Engagement shows on the Drilling screen.
8. Use counterclockwise rotation to loosen the drill pipe bottom joint. Make sure that the joint between the rotary head spindle and the drill pipe joint does not loosen.
9. If the counterclockwise rotation torque is not sufficient to loosen the threads, use the breakout wrench.
10. To activate the breakout wrench, press the Activate Breakout Wrench  button.



NOTE: The left multifunction joystick has different functions. Make sure that the correct function is active before using the left multifunction joystick. When you are done using a function, switch off the function that is no longer needed.



NOTE: To enable the breakout wrench, the joystick switch on the left multifunction joystick must be pushed and held in before and while operating the breakout wrench.

NOTE: The left multifunction joystick controls for the breakout wrench are as follows:

- Push the left multifunction joystick away from you to swing the breakout wrench out of the way and move it to the disengaged position.
- Pull the left multifunction joystick toward you to swing the breakout wrench in and engage the drill pipe (move to the engaged position).
- Move the left multifunction joystick to the right to rotate the breakout wrench counterclockwise and loosen the thread joint.
- Move the left multifunction joystick to the left to rotate the breakout wrench clockwise and open the breakout wrench jaws.

11. While holding the drill pipe with the deck fork, pull the left multifunction joystick toward you to swing in the breakout wrench to engage the breakout wrench with the drill pipe.



NOTE: The breakout wrench jaws should not be engaged on the hard facing on the drill pipe or accessories. Engaging the jaws on the hard facing damage the teeth on the inserts.

12. Move the left multifunction joystick to the right to pin the breakout wrench and clamp the drill pipe. Continue to hold the left multifunction joystick to the right to turn the drill pipe counterclockwise to loosen the thread joint.
13. When the thread is loose, move the left multifunction joystick to the left, and rotate the breakout wrench clockwise to open the breakout wrench jaws.
14. Repeat steps 12 and 13 as necessary to fully break the joint. If the breakout wrench slips, examine the inserts in the jaws of the breakout wrench for damage.
15. Push the left multifunction joystick away from you to move the breakout wrench to the stowed position.
16. Use counterclockwise rotation to loosen the first drill pipe from the second drill pipe. Use the left main joystick with Precision Control for rotation and the right main joystick with Precision Control for feed up.
17. Apply lubricant to the drill pipe threads.
18. When the first drill pipe is loosened from the second drill pipe, raise the rotary head high enough to swing the carousel without interference from the rotary head and spindle. The RCS shows that the rotary head is free from the drill string after the rotary head moves up the tower and the RCS has seen counterclockwise rotation for 1 second.

Step result

- The rotary head must be above **above carousel top** to unstow the carousel. The **Carousel**  icon on the **Drilling** screen is green when the carousel can swing, index, and stow.

19.

NOTICE

Damage to the Carousel

Contact between the rotary head, spindle, and the carousel can damage the carousel.

- Make sure that the carousel clears the rotary head and spindle before unstowing the carousel.

Make sure that the carousel clears the rotary head by physically doing a check of the carousel position. Press and hold the Carousel Swing Unstow  button, and swing the carousel to its loading and unloading position below the rotary head.

20. Press the Drill Pipe Support Close  button, and engage the drill pipe support on the drill pipe to be added.
21. Use the left main joystick with Precision Control to start forward rotation at 20 to 30 rpm.
22. Observe the drill pipe in the carousel. Gently lower the rotary head with the right main joystick with Precision Control until contact is made with the drill pipe. The slight downward movement of the drill pipe in the carousel verifies contact.

23.

NOTICE**Damage to the Carousel**

Using excess force can damage the carousel.

- Do not force the rotary head down further once contact has been made.

NOTICE**Damage to Threads**

Can cause thread damage

- While connecting the spindle onto the drill pipe, do not force down the rotary head. Let the drill pipe be picked up as it connects onto the spindle.

When contact has been made, continue forward rotation at the suggested speed of 20 to 30 rpm. Let the rotary head connect onto the drill pipe. The drill pipe rises in the carousel cup as it connects into the rotary head spindle.



NOTE: The drill pipe and the carousel show a slight bending movement when the spindle is tight.

24. When the drill pipe has connected onto the rotary head spindle, stop rotation. Nudge the left main joystick momentarily in the reverse direction to relieve torque pressure on the carousel.



NOTE: Do not "slap" the cup in the counterclockwise direction.

25. Use the right main joystick to raise the drill pipe clear of the carousel cup.



NOTE: A clearance of less than 50.8 millimeters (2 inches) between the drill pipe and the carousel cup is sufficient for any drill pipe change operation. Do not exceed 50.8 millimeters (2 inches).

26. Press and hold the Carousel Swing Stow  button to move the carousel to the stowed position.
27. Use the right main joystick with Precision Control to slowly feed the drill pipe down to the point of contact with the pin section of the second drill pipe being held in the deck fork.
28. Use the left main joystick with Precision Control to turn the drill pipe in the clockwise direction at a speed of 20 to 30 rpm to tighten the threads only tight enough to shoulder the drill pipe thread joint. This tightening squeezes out the excess thread lubricant.
29. Press the Deck Fork Disengage  button to stow the deck fork.
30. Press the Air Regulation On/Off  button to switch on the drilling air system.
31. Return to the drill process and press the Water Injection On/Off  button to switch on the water injection if it is being used.



NOTE: Make sure that the drill pipe support disengages from the drill pipe automatically if Auto Drill Pipe Support is switched on. Otherwise, manually stow the drill pipe support before drilling.

32. Switch off the water injection with the Water Injection On/Off  button.
33. Use the left main joystick with Precision Control to slow the drill string rotation to 20 to 30 rpm. Raise the drill string with the right main joystick until joint between the first and second drill pipe is aligned with the deck fork on the drill deck.



NOTE: In Precision Control, use the top side of the joystick switch for rotation and drilling to reduce the speed for rotation and drill feed operation.

34. When the drill string is high enough to engage the Deck Fork Engage function, stop the rotation with the left main joystick.
35. Press the Air Regulation On/Off  button to switch off the compressor.

36.

 WARNING
Compressed Air

Can cause glass damage to the cab or injury to personnel

- ▶ Switch off the drilling air before disconnecting the drill pipe joint.

Align the drill pipe flats with the deck fork. Use the drill pipe flats to hold and secure the drill string with the deck fork by pressing the Deck Fork Engage  button. Engagement shows on the **Drilling** screen.

37. Press the Drill Pipe Support Close  button, and engage the clamp onto the drill pipe to be removed.

38. Use counterclockwise rotation with the left main joystick with Precision Control to loosen the drill pipe joint, and loosen it from the second drill pipe. Make sure that the joint between the rotary head spindle and the drill pipe joint does not loosen.



NOTE: If the rotation torque is not sufficient to break the joint connection, use the breakout wrench.



NOTE: If the top joint breaks instead of the bottom joint, tighten the joints and use the breakout wrench on the bottom joint to make the bottom joint looser than the top joint.

39. While loosening the drill pipe with the left main joystick with Precision Control, use the right main joystick with Precision Control to raise the rotary head slightly to compensate for the length of the pin height between the drill pipe joints.

Step result

- RCS shows that the rotary head is being removed and is free from the drill string after the rotary head turns counterclockwise for 1 second.

40. Raise the drill pipe to a height that lets the lower end of the drill pipe clear the carousel cup, approximately 50.8 millimeters (2 inches).



NOTE: If the drill pipe is raised too high, it interferes with the top locking ring and does not load into the carousel or lock correctly. The

Carousel  icon shows when the RCS lets the carousel engage.

41. Swing the carousel to the load/unload position under the rotary head using the Carousel Swing Unstow  button.
42. Align the drill pipe flats with the carousel cup receiving flats using the left main joystick.

43. Lower the drill pipe into the carousel cup using the right main joystick with Precision Control, leaving the drill pipe positioned about 50.8 millimeters (2 inches) off the bottom of the cup.



NOTE: The drill pipe drops into the cup as it loosens from the rotary head, allowing for positive engagement of the drill pipe in the carousel cup and upper lock plate. Positive engagement locks the drill pipe in place in the carousel.

44.



WARNING

Falling Objects

Drill pipe not secured into the carousel can fall out during operation and cause serious injury, death, or equipment damage.

- ▶ Make sure that drill pipe is securely locked into the carousel.

NOTICE

Damage to the Carousel

Can cause damage to carousel

- ▶ Do not hit on the carousel repeatedly to loosen the drill pipe.
- ▶ If the drill pipe does not come loose with a maximum of three tries, the drill pipe must be repositioned to use the breakout wrench system.

Turn the drill pipe clockwise slowly against the stops, then loosen the drill pipe from the rotary head using counterclockwise rotation with the left main joystick with Precision Control.

45. When the drill pipe has been stowed in the correct carousel cup, raise the rotary head to make sure that there is clearance on top of the carousel, and open the drill pipe support to its full open position with the Drill Pipe Support Open  button.
46. Swing the carousel to the stowed position using the Carousel Swing Stow  button, and make sure that it is fully stowed.
47. With the right main joystick, bring the rotary head down to the remaining drill pipe being held in the deck fork.
48. Use the left main joystick with Precision Control to start forward rotation of 20 to 30 rpm.

49.

NOTICE**Damage to Threads**

Can cause thread damage

- ▶ While connecting the spindle onto the drill pipe, do not force down the rotary head. Let the drill pipe be picked up as it connects onto the spindle.

With the right main joystick, connect the rotary head spindle onto the drill pipe.

50. Stow the deck fork using the Deck Fork Disengage  button.
51. Raise the rotary head and drill string to the top of the tower.
52. Repeat the process with the next drill pipe if necessary

4.16 Drill Pipe Handling

4.16.1 Carousel Control

WARNING

Energized Machine

Can cause serious injury.

- ▶ The machine must be fully energized and the engine/motor must be switched on to complete this procedure.
- ▶ Be careful around moving parts and pinch points.



NOTE: The carousel is indexed with the Carousel Index Clockwise  button and the Carousel Index Counterclockwise  button. Carousel movement is controlled using the Carousel Swing Stow  button and the Carousel Swing Unstow  button.

Precondition ✓ The tower is locked in the vertical position.

1. Engage the carousel so that it aligns with the rotary head.

- Turn (or index) the carousel to an empty drill pipe holding cup.



NOTE: When the drill pipe is correctly aligned, it is positioned with its axis aligned to the axis of the rotary head spindle.

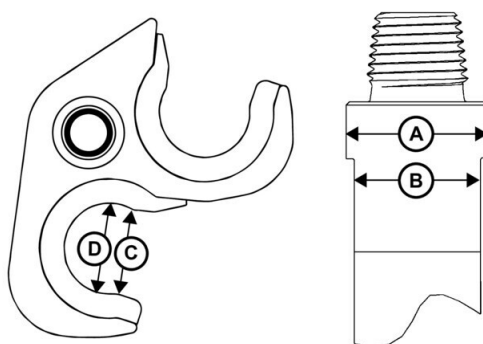
- Continue the loading or unloading process.

4.16.2 Measure the Carousel and Drill Pipe Clearance

Do this procedure when loading, rotating, or examining drill pipe.



NOTE: This figure is for illustration purposes only.



Carousel and Drill Pipe Clearance Measurement Locations

A	Upper shoulder diameter	B	Drill pipe diameter
C	Upper lock plate opening	D	Upper holding slot diameter

- Park the machine on a dry, level surface.
- DANGER**

Risk of Electrocution

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

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

Lower the tower to the horizontal position.

3. Put all of the controls in the OFF or neutral position.
4. Stop the machine.
5. Attach the safety locks and tags to the machine in accordance with the site-specific procedures.



NOTE: Refer to the *Safety Locks and Tags Minimum Requirements* in the *Maintenance manual*.

6. Make sure that the machine is in a zero-energy state.
7. Put blocks at the tracks, as applicable.
8. Measure the minimum diameter of the upper shoulder of the drill pipe.
9. Measure the maximum width of the upper holding slot diameter.
10. Compare the two dimensions. Make sure that the upper shoulder diameter is larger than the upper holding slot opening. If not, replace the upper lock plate, drill pipe, or both so that the upper holding slot diameter is smaller than the drill pipe upper shoulder diameter.
11. Measure the maximum drill pipe diameter near the upper shoulder of the drill pipe.
12. Measure the minimum width of the upper lock plate opening.
13. Compare the two dimensions. Make sure that the drill pipe diameter is smaller than the upper lock plate opening. If not, replace the upper lock plate, drill pipe, or both so that the drill pipe diameter is smaller than the upper lock plate opening.
14. Make sure that the upper shoulder diameter is larger than the drill pipe diameter. Replace the drill pipe if the upper shoulder is not wider than the drill pipe.
15. Remove the safety locks and tags from the machine in accordance with the site-specific procedures.



NOTE: Refer to the *Safety Locks and Tags Minimum Requirements* in the *Maintenance manual*.

4.16.3 Removing Drill Pipe



NOTE: Epiroc recommends loading and unloading drill pipe to and from the machine with the tower in either the horizontal or vertical position. Do not load or unload drill pipe with the tower set at an angle.

Horizontally Removing Worn or Damaged Drill Pipe

DANGER

Risk of Electrocution

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

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

WARNING

Energized Machine

Can cause serious injury

- ▶ The machine is energized during this procedure. Take all precautions necessary for a safe work environment.
- ▶ The operator and surrounding personnel must be in constant communication during this procedure.
- ▶ Warn surrounding personnel when the machine is about to operate.

WARNING

Handling Drill Pipes

Can cause serious injury or death

- ▶ Use lifting devices that are adequately sized and in good condition.
- ▶ Use extreme care and follow safe work practices when handling drill pipes.
- ▶ Make sure that the drill pipe catcher wire rope or chain is disconnected and secured.
- ▶ Make sure that all tower and drill pipe handling systems are purged and free of air before commencing drill pipe installation.

The minimum safe personnel requirement for this task is five persons.

The following equipment is needed to remove drill pipe:

- One lifting crane with approved capacity to lift the required drill pipe weight.

- Two lifting straps of equal length, with the approved capacity to lift the required drill pipe weight.
 - One tag line, used to control the movement of the load.
 - Two safety harnesses and other required PPE.
 - One man lift for access in and out of the tower.
1. Level the machine at the lowest possible condition with tracks not on the ground.
 2. If the machine has two drill pipes, drill down the full length of the first drill pipe and proceed to step 42. If the machine has more than two drill pipes, drill down the full length of two drill pipes and proceed to step 3.



NOTE: Do not drill down past the point where the deck fork engages into the pin end of the drill pipe that connects to the rotary head spindle sub.

3.



WARNING

Loosening Rotary Head Sub

Can cause serious injury

- ▶ Do not loosen the rotary head sub from the rotary head while loosening the joint between the drill pipes.

Press the Deck Fork Engage  button to engage the deck fork into the upper drill pipe pin end.

Step result

➔ Engagement shows on the **Drilling** screen.

4. Press the Activate Breakout Wrench  button to activate control of the breakout wrench.
5. Use the left multifunction joystick to swing the breakout wrench into the drill pipe.
6. Engage and rotate the breakout wrench jaw to break the joint.
7. Disengage the breakout wrench jaw and engage the breakout wrench jaw until the joint is broken loose. If more than three attempts are needed to break the joint, examine the breakout wrench jaws for damage.
8. Stow the breakout wrench jaw.
9. Stow the breakout wrench swing.
10. Press the Activate Breakout Wrench  button to deactivate the breakout wrench and move it out of the way.
11. Use counterclockwise rotation to loosen the rotary head spindle sub from the drill pipe.

Step result

12. Move the rotary head to the top of the tower. RCS shows that the rotary head is free from the drill string after the rotary head turns counterclockwise for 1 second.

→ The rotary head must be above the **above carousel top** position to unstow the carousel. The **Carousel**  icon on the **Drilling** screen is green when the carousel can swing, index, and stow.

13. Secure the deck bushing by retracting the deck fork out far enough to hold the deck bushing in place, but do not engage the drill pipe.
14. Raise the machine by extending the leveling jacks, keeping the machine level.
15. Raise the machine high enough to clear the drill pipe in the ground when the tower is laid over to the horizontal position.

16.



DANGER

Risk of Electrocution

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

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

NOTICE

Property Damage

Can cause damage to the machine

- ▶ Do not attempt to move the tower with only one vertical pin unlocked.

Press the Tower Vertical Unlock  button to unlock the tower pinning.

17. Lower the tower to the horizontal position.
18. Press the Carousel Swing Unstow  button to extend the carousel.
19. Uncouple one side of the lower drill pipe catcher, if equipped, and secure the wire rope or chain.

20.

**WARNING****Moving Parts**

Sudden uncontrolled movement can cause serious injury.

- ▶ Do not stand directly below the drill pipe.
- ▶ Do not put hands or fingers in pinch points.

Raise the crane lifting hook and over the carousel and lower to attach lifting straps.

21.

**WARNING****Equipment Interference Hazard**

Can cause severe injury or property damage.

- ▶ Make sure that no overhanging power lines or any other obstructions are present that can interfere with the use of a boom truck crane or mobile crane.

Install both lifting straps to the drill pipe. Make sure that the lifting straps are placed at equal distances from both ends of the drill pipe to keep the drill pipe level during lifting.

22. Install both lifting straps to the crane lifting hook with safety latches.

23. Install the tag line to the drill pipe approximately 914 millimeters (36 inches) above the box end.

24.

**WARNING****Suspended Load**

Can cause severe injury or death

- ▶ Do not stand in the working area of a crane or hoist when it is operating with an overhead load.
- ▶ Stay away from suspended loads.

Lift the drill pipe with the crane. Keep the drill pipe level with the crane until the crane is supporting the weight of the drill pipe.

25. Slide the drill pipe out of the drill pipe cup and the locking plate at the top of the carousel. Make sure the tool joint undercut does not hang up on the upper carousel lock plate.

26.

**WARNING****Crushing Hazard**

Can cause personal injury.

- ▶ Lifting equipment must be adequately sized, have the correct lifting capacity, and be in good condition.
- ▶ Be careful when you lift heavy components.

Lift the drill pipe with the crane. Keep the drill pipe level. If the drill pipe is not level, lower the drill pipe and adjust the lifting straps to level the load.

27. Lower the drill pipe to the ground or the trailer.

28. Put blocks below the drill pipe to secure the drill pipe in place.

29. Remove the lifting straps and tag line from the drill pipe.

30. Press the Carousel Index Clockwise  button or the Carousel Index Counterclockwise  button to index the carousel to remove the next drill pipe.

31. Repeat steps 20 through 30 until all drill pipes are removed from the carousel.

32. Reconnect the wire rope or chain onto the lower drill pipe catcher, if equipped.

33. Remove personnel from the tower.

34.

**DANGER****Risk of Electrocution**

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

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

WARNING

Falling Tower

Tower locking pin disengagement can cause damage to the tower and serious personal injury

- Make sure that all locking pins for the tower are in the locked position.

Raise the tower to the vertical position.

35. Press the Tower Vertical Lock  button to lock the tower pinning.
36. Press the Carousel Swing Stow  button to retract the carousel.
37. Keeping the machine level, retract the leveling jacks and lower the machine.
38. Lower the machine over the drill pipe in the ground.
39. When the drill pipe is through the deck bushing, press the Deck Fork Engage  button to engage the deck fork into the pin end of the drill pipe.

Step result

→ Engagement shows on the **Drilling** screen.

40. Lower the rotary head and reconnect to the drill pipe in the deck fork.
41. Tighten the rotary head with the spindle sub to the drill string.
42. Press the Deck Fork Disengage  button to disengage the deck fork from the upper drill string.
43. Raise the rotary head up the tower.
44. Press the Deck Fork Engage  button to engage the deck fork into the lower drill string pin end. Engagement shows on the **Drilling** screen.
45. Press the Drill Pipe Support Close  button to extend the drill pipe support and clamp the drill string.
46. Press the Activate Breakout Wrench  button to activate control of the breakout wrench.
47. Use the left multifunction joystick to swing the breakout wrench into the drill string.
48. Engage and rotate the breakout wrench jaw to break the joint.
49. Disengage the breakout wrench jaw and engage the breakout wrench jaw until the joint is broken loose. If more than three attempts are needed to break the joint, examine the breakout wrench jaws for damage.
50. Stow the breakout wrench jaw.
51. Stow the breakout wrench swing.

52. Press the Activate Breakout Wrench  button to deactivate the breakout wrench and move it out of the way.
53. Use counterclockwise rotation to loosen the drill string component from the drill string component in the breakout clamp.
54. Raise the rotary head above the carousel. RCS shows that the rotary head is free from the drill string after 1 second of counterclockwise rotation.

Step result

→ The rotary head must be between **below carousel top** and **above carousel top** to unstow the carousel. The **Carousel**  icon on the **Drilling** screen is green when the carousel can swing, index, and engage.

55. Make sure that the carousel is indexed correctly. Swing the carousel in line with the drill string.
56. Feed the rotary head down until the hex area on the box end of the drill pipe is above the carousel cup. Make sure that the box end aligns with the drill pipe cup and the upper pin end of the drill pipe is seated in the upper carousel holding slot.
57. Feed down so that the drill pipe is inside the cup and about 51 millimeters (2 inches) from the bottom of the cup.
58. Use counterclockwise rotation to break the joint between the spindle sub and the drill pipe. Rotate counterclockwise until the drill pipe falls the rest of the way into the cup. After the drill pipe is unthreaded, feed up to above **above carousel top**.



NOTE: In Precision Control, use the top side of the rocker switch for rotation and drilling to reduce the speed for rotation and drill feed operation.

59. Press the Drill Pipe Support Open  button to open the drill pipe support.
60. Use the Carousel Index Clockwise  button or the Carousel Index Counterclockwise  button to index the carousel to receive the next drill pipe.
61. Press the Carousel Swing Stow  button to retract the carousel.
62. Repeat steps 40 through 61.
63. Move the rotary head to the top of the tower.
64. Install a lifting bail on the threads of the drill bit sub or stabilizer in the breakout clamp.

65.

**WARNING****Moving Parts**

Sudden uncontrolled movement can cause serious injury.

- ▶ Do not stand directly below the drill pipe.
- ▶ Do not put hands or fingers in pinch points.

Attach the hoist, deck crane, or mobile crane to the lifting bail.

66. Lift the components slightly without pulling up on the deck fork.
67. Put the components on the ground and secure them from moving.
68. Open the deck fork.
69. Use the hoist, deck crane, or mobile crane to remove the deck bushing from the bottom of the tower and place it on the ground. Secure the components from moving.
70. Remove any loose items from the tower bottom.
71. Repeat steps 14 through 36 to remove the drill pipes from the carousel.

Vertically Removing Drill Pipe Using the Hoist

DANGER

Risk of Electrocution

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

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

WARNING

Energized Machine

Can cause serious injury

- ▶ The machine is energized during this procedure. Take all precautions necessary for a safe work environment.
- ▶ The operator and surrounding personnel must be in constant communication during this procedure.
- ▶ Warn surrounding personnel when the machine is about to operate.

WARNING

Handling Drill Pipes

Can cause serious injury or death

- ▶ Use lifting devices that are adequately sized and in good condition.
- ▶ Use extreme care and follow safe work practices when handling drill pipes.
- ▶ Make sure that the drill pipe catcher wire rope or chain is disconnected and secured.
- ▶ Make sure that all tower and drill pipe handling systems are purged and free of air before commencing drill pipe installation.

WARNING

Moving Parts

Sudden uncontrolled movement can cause serious injury.

- ▶ Do not stand directly below the drill pipe.
- ▶ Do not put hands or fingers in pinch points.

WARNING

Falling Drill Pipe

Can cause personal injury or death

- ▶ The lifting bail must be securely connected to the drill pipe before doing any movement of the drill pipe.

WARNING

Suspended Load

Can cause severe injury or death

- ▶ Do not stand in the working area of a crane or hoist when it is operating with an overhead load.
- ▶ Stay away from suspended loads.

- Precondition
- ✓ A crane is available to help remove and replace the drill pipe.
 - ✓ A lifting bail is required to load drill pipe vertically.

1. Level the machine.

2. Drill a hole slightly past the first drill pipe joint and clear the cuttings from the hole with air.
3. Use the right main joystick with Precision Control to raise the rotary head so the centralizer bushing and drill bit clear the drill deck with enough clearance to install the drill bit basket.



NOTE: In Precision Control, use the top side of the joystick switch for rotation and drilling to reduce the speed for rotation and drill feed operations.

4. Install the drill bit basket, and lower the drill bit into the drill bit basket.
5. Press the Activate Breakout Wrench  button to activate control of the breakout wrench.
6. Use the left multifunction joystick to swing the breakout wrench into the drill pipe.
7. Engage and rotate the breakout wrench jaw to break the joint.
8. Disengage the breakout wrench jaw and engage the breakout wrench jaw until the joint breaks loose. If more than three attempts are needed to break the joint, examine the breakout wrench jaws for damage.
9. Stow the breakout wrench jaw.
10. Stow the breakout wrench swing.
11. Press the Activate Breakout Wrench  button to deactivate the breakout wrench and move it out of the way.
12. Use the left main joystick with Precision Control to turn slowly the stabilizer counter-clockwise. At the same time, slowly raise the rotary head with Precision Control on the right main joystick until the joint is uncoupled from the drill bit.
13. Use the right main joystick with Precision Control to raise the rotary head enough to be able to lift the drill bit out of the drill bit basket.
14. Connect the lifting bail to the drill bit. Hook the hoist rope to the lifting bail. Use the hoist to remove the drill bit from the drill bit basket.
15. Store the drill bit assembly in an area that does not interfere with replacing the drill pipe.
16. Remove the drill bit basket.
17. Lower the drill string into the hole to the first drill pipe joint.
18. Press the Deck Fork Engage  button to engage the deck fork in the drill pipe wrench flats.
19. Press the Activate Breakout Wrench  button to activate control of the breakout wrench. Use the breakout wrench assembly to disconnect the drill pipe that is in the ground from the remaining drill string.

20. Press the Activate Breakout Wrench  button to deactivate the breakout wrench and move it out of the way.
21. Press the Carousel Index Clockwise  button or the Carousel Index Counterclockwise  button to index the carousel to an empty position.
22. Press the Carousel Swing Unstow  button to extend the carousel to the load position.
23. Raise the rotary head and the remaining drill pipe to the top of the tower.
24. Put the drill pipe that is attached to the rotary head into the carousel.
25. Install the drill pipe lifting bail onto the drill pipe that is in the deck fork.
26. Press the Activate Cab Hoist  button to activate the hoist. Use the left main joystick to operate the hoist.
27. Lower the hoist wire rope and attach the hoist hook to the lifting bail.

28. **WARNING**

Moving Parts

Sudden uncontrolled movement can cause serious injury.

- ▶ Do not stand directly below the drill pipe.
- ▶ Do not put hands or fingers in pinch points.

Use the hoist control to lift the drill pipe to remove its weight from the deck fork slowly.

29. Press the Deck Fork Disengage  button to disengage the deck fork and move it to its over-bushing position.

30. **WARNING**

Moving Parts

Sudden uncontrolled movement can cause serious injury.

- ▶ Do not stand directly below the drill pipe.
- ▶ Do not put hands or fingers in pinch points.

Use the hoist control to raise the drill pipe from the ground.

31. Press the Activate Cab Hoist  button to deactivate the hoist.

32. Retract the leveling jacks and propel the machine forward a distance that lets the drill pipe lay on the ground. Extend the drill-end leveling jacks so that they touch the ground. Extend the non-drill end leveling jacks to tilt the tower so that the drill pipe swings out past the deck and over the ground.

33. Press the Activate Cab Hoist  button to activate the hoist.

34. **WARNING**

Moving Parts

Sudden uncontrolled movement can cause serious injury.

- ▶ Do not stand directly below the drill pipe.
- ▶ Do not put hands or fingers in pinch points.

Use the hoist to lower the box section of the drill pipe to the ground.

35. Retract all of the leveling jacks so that the machine can be propelled.
36. Propel the machine away from the drill pipe and lay the drill pipe on the ground.
37. When the drill pipe is safely on the ground, disconnect the lifting bail from the drill pipe and remove the lifting bail from the hoist hook. Securely stow the lifting bail.
38. Place blocks under the drill pipe to secure it in place.
39. Stow the hoist hook.
40. Press the Activate Cab Hoist  button to deactivate the hoist.
41. Propel the machine back over the hole and level the machine.
42. Lower the drill pipe into the hole. Repeat steps 5 to 24 with the remaining drill pipes until all of the drill pipes are removed from the machine.
43. Position the machine over the drilled hole and level the machine.
44. Position the supply truck parallel to the machine and directly in front of the drill deck.
45. Thread the lifting bail onto the pin end of the drill pipe.
46. Make sure that the protective plug is removed from the box end of the drill pipe.
47. Press the Activate Cab Hoist  button to activate the hoist.

48. **WARNING**

Moving Parts

Sudden uncontrolled movement can cause serious injury.

- ▶ Do not stand directly below the drill pipe.
- ▶ Do not put hands or fingers in pinch points.

Use the hoist to raise the drill pipe to the drill table and lower the drill pipe into the drilled hole.

49. Press the Activate Cab Hoist  button to deactivate the hoist.
50. Press the Deck Fork Engage  button to engage the deck fork in the drill pipe wrench flats.
51. Remove the lifting bail and stow the hoist hook to the base of the machine.
52. Lower the rotary head to the pin section of the drill pipe being held by the deck fork.
53. Lubricate the threads on the drill pipe.
54. Connect the spindle joint onto the drill pipe being held by the deck fork.
55. Press the Deck Fork Disengage  button to disengage the deck fork and move it to its stowed position.
56. Raise the drill pipe.
57. Press the Carousel Swing Stow  button to retract the carousel to the stowed position.
58. Repeat steps 28 to 43 with the remaining drill pipes. The last drill pipe remains threaded onto the rotary head.
59. Raise the rotary head to the top of the tower.
60. Press the Drill Pipe Support Close  button to extend the drill pipe support and clamp the drill pipe.
61. Install the drill bit sub and drill bit to the drill pipe that is attached to the rotary head opposite of how they were removed.

4.16.4 Loading Drill Pipe



NOTE: Epiroc recommends loading and unloading drill pipe to and from the machine with the tower in either the horizontal or vertical position. Do not load or unload drill pipe with the tower set at an angle.

Horizontally Loading Drill Pipe

WARNING

Energized Machine

Can cause serious injury

- ▶ The machine is energized during this procedure. Take all precautions necessary for a safe work environment.
- ▶ The operator and surrounding personnel must be in constant communication during this procedure.
- ▶ Warn surrounding personnel when the machine is about to operate.

WARNING

Handling Drill Pipes

Can cause serious injury or death

- ▶ Use lifting devices that are adequately sized and in good condition.
- ▶ Use extreme care and follow safe work practices when handling drill pipes.
- ▶ Make sure that the drill pipe catcher wire rope or chain is disconnected and secured.
- ▶ Make sure that all tower and drill pipe handling systems are purged and free of air before commencing drill pipe installation.

Drill pipe can be loaded onto the machine from the ground or from a truck. Either method is acceptable when safe work practices are followed.

The minimum safe personnel requirement for this task is five persons.

The following equipment is needed to load drill pipe:

- One lifting crane with approved capacity to lift the required drill pipe weight.
- Two lifting straps of equal length, with approved capacity to lift the required drill pipe weight.
- One tag line, used to control the movement of the load.
- Two safety harnesses and other required PPE.

1. Level the machine.
2. Make sure that all these tower and drill pipe handling systems are purged and free of air:
 - a. tower (up and down)
 - b. rotary head (up and down)
 - c. carousel (swing and indexing)
 - d. drill pipe support (in and out)

3.

WARNING**Falling Tower**

Tower locking pin disengagement can cause damage to the tower and serious personal injury

- Make sure that all locking pins for the tower are in the locked position.

Raise the tower to the vertical position and press the Tower Vertical Lock  button to lock the tower pinning.

4.

Press the Drill Pipe Support Open  button to open the drill pipe support.

5.

Move the rotary head to the top of the tower. RCS shows that the rotary head is free from the drill string when it has turned counterclockwise for one second at the bottom of the tower.

Step result

→ The rotary head must be above **above carousel top** to unstow the carousel when no drill pipe is attached to the rotary head. The **Carousel**  icon on the **Drilling** screen is green when the carousel can swing, index, and stow.

6.

Press the Carousel Swing Unstow  button to unstow or engage the carousel.

7.

NOTICE**Property Damage**

Can cause damage to the machine

- Do not attempt to move the tower with only one vertical pin unlocked.

Press the Tower Vertical Unlock  button to unlock the tower pinning.

8.

WARNING**Moving Parts**

Sudden uncontrolled movement can cause serious injury.

- Do not stand directly below the drill pipe.
- Do not put hands or fingers in pinch points.

Lower the tower to the horizontal position.

9. Uncouple one side of the lower drill pipe catcher (if equipped), and secure the wire rope or chain.
10. Install both lifting straps to the drill pipe.
11. Install the tag line to the drill pipe approximately 1 meter (3 feet) above the box end.
12. Remove the plastic thread protector plug and cap that is installed on the drill pipe.
13. Apply lubricant to the threads on the ends of the drill pipe.

14.



WARNING

Crushing Hazard

Can cause personal injury.

- ▶ Lifting equipment must be adequately sized, have the correct lifting capacity, and be in good condition.
- ▶ Be careful when you lift heavy components.



WARNING

Crushing Hazard

Can cause severe injury or death.

- ▶ Do not stand in the working area of the work floor crane when it is operating with an overhead load.



WARNING

Moving Parts

Sudden uncontrolled movement can cause serious injury.

- ▶ Do not stand directly below the drill pipe.
- ▶ Do not put hands or fingers in pinch points.

Use the crane to lift the drill pipe, making sure that the drill pipe remains level. If the drill pipe is not level, lower and relocate the lifting strap to level the load.

15. Position the drill pipe into the carousel drill pipe cup and carousel drill pipe locking plate.
 - a. Manually align the carousel cup to the flats on the drill pipe.
 - b. Make sure that the drill pipe undercut does not hang up on the upper carousel lock plate.

- c. Make sure that the drill pipe is secured in the carousel by the cup and the upper carousel lock plate.
- d. Remove the lifting straps and tag line from the drill pipe.
16. Remove personnel from the tower area.
17. Use the Carousel Index Clockwise  button or the Carousel Index Counterclockwise  button to index the carousel to receive the next drill pipe. Personnel can enter the tower area again when indexing is complete.
18. Repeat steps 10 through 17, unless the carousel is full.
19. Reconnect the wire rope or chain on the lower drill pipe catcher, if equipped.
20. Remove personnel from the tower area.

21.

**DANGER****Risk of Electrocution**

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

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

**WARNING****Falling Tower**

Tower locking pin disengagement can cause damage to the tower and serious personal injury

- ▶ Make sure that all locking pins for the tower are in the locked position.

Raise the tower to the vertical position, and press the Tower Vertical Lock  button to lock the tower pinning.

22. Make sure that the carousel is fully extended. Use the Carousel Index Clockwise  button or the Carousel Index Counterclockwise  button to index the carousel to align the drill pipe to the rotary head.
23. Press the Drill Pipe Support Close  button to close the drill pipe support.

24. In Drill mode, use the right main joystick with the top side of the joystick switch pressed to slowly feed down the rotary head to engage the threads on the pin end of the drill pipe.
25. With the left main joystick, press and hold the top side of the joystick switch to use slow clockwise rotation, and tighten the drill pipe securely.
26. Slowly reverse rotation momentarily to release any forward torque pressure after tightening the drill pipe to the rotary head.
27. Raise the rotary head slowly until the drill pipe clears the carousel cup.
28. Press the Carousel Swing Stow  button to move the carousel into the fully stowed position in the tower.
29. Lubricate the threads of the crossover sub, saver, deck bushing, or drill bit.
30. Connect the crossover sub, saver, deck bushing, or drill bit. Lubricate the threads of these components before you connect them.

31.

**WARNING****Moving Parts**

Sudden uncontrolled movement can cause serious injury.

- ▶ Do not stand directly below the drill pipe.
- ▶ Do not put hands or fingers in pinch points.

Use the hoist with a lifting bail, deck crane, or mobile crane to put the crossover sub, saver, deck bushing, or drill bit into the base of the tower and engage the deck fork into the flats.

32. Remove the lifting bail.

33.

**WARNING****Moving Parts**

Sudden uncontrolled movement can cause serious injury.

- ▶ Do not stand directly below the drill pipe.
- ▶ Do not put hands or fingers in pinch points.

Use the hoist with a lifting bail, deck crane, or mobile crane to put the bushing over the pin end of the drill bit sub on top of the deck fork.

34. Connect the drill pipe to the crossover sub, and tighten securely.
35. Press the Deck Fork Disengage  button to disengage the deck fork.

36. Make sure that the deck bushing is fully seated into the base of the tower.
37. Lower the rotary head until the drill bit is touching the ground.
38. Press the Drill Pipe Support Open  button to open the drill pipe support.
39. Drill down the length of the drill pipe.
40. Press the Deck Fork Engage  button to engage the deck fork onto the pin end of the drill pipe.

Step result

→ Engagement is shown on the **Drilling** screen.

41. Disconnect the rotary head spindle sub from the drill pipe in the hole.
42. Raise the rotary head above the carousel. RCS shows that the rotary head is free from the drill string after the rotary head moves up and counterclockwise rotation stops.



NOTE: The rotary head must be above the **above carousel top position** to unstow the carousel.

Step result

→ The **Carousel**  icon on the **Drilling** screen is green when the carousel can swing, index, and stow.

43. Repeat steps 22 through 28.
44. Connect the second drill pipe to the drill pipe in the sliding deck wrench. Lubricate the threads as needed.
45. Tighten the second drill pipe to the first drill pipe.
46. Press the Deck Fork Disengage  button to retract the deck fork from the drill pipe.
47. Open the drill pipe support using the Drill Pipe Support Open  button.
48. Keep the drill pipe support engaged and feed up so that the RCS does not show that the drill bit is in the hole.
49. Remove the equipment from the machine area.

Vertically Loading Drill Pipe Using the Hoist

WARNING

Energized Machine

Can cause serious injury

- ▶ The machine is energized during this procedure. Take all precautions necessary for a safe work environment.
- ▶ The operator and surrounding personnel must be in constant communication during this procedure.
- ▶ Warn surrounding personnel when the machine is about to operate.

WARNING

Handling Drill Pipes

Can cause serious injury or death

- ▶ Use lifting devices that are adequately sized and in good condition.
- ▶ Use extreme care and follow safe work practices when handling drill pipes.
- ▶ Make sure that the drill pipe catcher wire rope or chain is disconnected and secured.
- ▶ Make sure that all tower and drill pipe handling systems are purged and free of air before commencing drill pipe installation.

WARNING

Moving Parts

Sudden uncontrolled movement can cause serious injury.

- ▶ Do not stand directly below the drill pipe.
- ▶ Do not put hands or fingers in pinch points.

WARNING

Falling Drill Pipe

Can cause personal injury or death

- ▶ The lifting bail must be securely connected to the drill pipe before doing any movement of the drill pipe.

WARNING

Suspended Load

Can cause severe injury or death

- ▶ Do not stand in the working area of a crane or hoist when it is operating with an overhead load.
- ▶ Stay away from suspended loads.



NOTE: Do not leave both leveling jack and hoist functions active at the same time.



NOTE: If the machine has the drill deck control box (DDCB), the drill deck guardrail cannot be opened during operation. Use a mobile crane to load the drill pipe.

Drill pipe can be loaded onto the machine from the ground or from a truck. Either method is acceptable when safe work practices are followed.

The minimum safe personnel requirement for this task is three persons.

A lifting bail is required to load drill pipe vertically.

1. Level the machine.
2. Make sure that all of these tower and drill pipe handling systems are purged and free of air:
 - a. tower (up and down)
 - b. rotary head (up and down)
 - c. carousel (swing and indexing)
 - d. drill pipe support (in and out)
3. Lay the drill pipe on the ground in a parallel direction to the undercarriage with the pin end approximately 1 meter (3 feet) from the drilling end dust curtain door.
4. Thread the lifting bail onto the pin end hand tight as far as possible.
5. Make sure that the lifting bail is completely connected onto the pin thread.
6. Remove the plastic thread protector plug installed in the box end of the drill pipe.
7. Open the access gate in the drill deck guardrail at the drill end of the machine.



NOTE: If the machine has the drill deck control box, the drill deck guardrail cannot be opened during operation. Use a mobile crane to load the drill pipe.

8. Make sure that the machine is in Setup mode.

9. Press the Dust Flaps Down  button to lower the dust flap.
10. Make sure that the rotary head is at the top of the tower.
11. Press the Activate Cab Hoist  button to activate the hoist. Use the left main joystick to operate the hoist.
 - a. Press and hold the joystick switch on the left main joystick to activate the joystick.
 - b. Push the left main joystick away from you to lower the wire rope.
 - c. Pull the left main joystick toward you to raise the wire rope.
12. Use the left main joystick to lower the hoist safety hook to the lifting bail on the drill pipe.
13. Attach the safety hook to the lifting bail loop.
14. Press the Activate Cab Hoist  button to deactivate the hoist.
15. Press the Activate Leveling Jacks  button to activate the leveling jacks.
- 16.



DANGER

Risk of Electrocution

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

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

Using the left multifunction joystick, push down on the joystick switch and pull the left multifunction joystick toward you to retract the drill end leveling jacks to their minimum position and lower the drill end of the machine.

17. Using the left multifunction joystick, push down on the joystick switch and push the left multifunction joystick away from you to extend the non-drill end leveling jacks to their maximum position and raise the non-drill end of the machine.

Step result

→ The machine is now at its minimum height on the drill end and its maximum height on the non-drill end. Drill pipe can be raised with the hoist without damaging the machine.

18. Press the Activate Leveling Jacks  button to deactivate the leveling jacks.
19. Press the Drill Pipe Support Open  button to retract the drill pipe support to the stowed position.

20. Press the Activate Cab Hoist  button to activate the hoist.

21.

WARNING

Falling Drill Pipe

Can cause personal injury or death

- ▶ The lifting bail must be securely connected to the drill pipe before doing any movement of the drill pipe.

WARNING

Suspended Load

Can cause severe injury or death

- ▶ Do not stand in the working area of a crane or hoist when it is operating with an overhead load.
- ▶ Stay away from suspended loads.

Use the left main joystick to raise the drill pipe slowly.

22. When the drill pipe is raised to a level that lets the box end of the drill pipe clear the drill deck, press the Activate Cab Hoist  button to deactivate the hoist.
23. Press the Activate Leveling Jacks  button to activate the leveling jacks.
24. Use the left multifunction joystick to lower the non-drill end of the machine slowly to let the drill pipe swing across the deck and rest against the drill table.
25. When the drill pipe is resting against the drill table, press the Activate Leveling Jacks  button to deactivate the leveling jacks.
26. Press the Activate Cab Hoist  button to activate the hoist.

27.

WARNING

Falling Drill Pipe

Can cause personal injury or death

- ▶ The lifting bail must be securely connected to the drill pipe before doing any movement of the drill pipe.

WARNING

Suspended Load

Can cause severe injury or death

- ▶ Do not stand in the working area of a crane or hoist when it is operating with an overhead load.
- ▶ Stay away from suspended loads.

Use the left main joystick to raise the drill pipe to a height that clears the drill table.

28. Press the Activate Cab Hoist  button to deactivate the hoist.
29. Press the Activate Leveling Jacks  button to activate the leveling jacks.
30. Use the left multifunction joystick to lower the non-drill end of the machine and level the machine.
31. Press the Activate Leveling Jacks  button to deactivate the leveling jacks.
32. Press the Activate Cab Hoist  button to activate the hoist.

WARNING

Falling Drill Pipe

Can cause personal injury or death

- ▶ The lifting bail must be securely connected to the drill pipe before doing any movement of the drill pipe.

WARNING

Suspended Load

Can cause severe injury or death

- ▶ Do not stand in the working area of a crane or hoist when it is operating with an overhead load.
- ▶ Stay away from suspended loads.

Use the left main joystick to raise the drill pipe so that the box clears the carousel cup by approximately 50 millimeters (2 inches).

34. Press the Activate Cab Hoist  button to deactivate the hoist.

35. Press the Carousel Index Counterclockwise  button to index the carousel to an empty position.
36. Press the Carousel Swing Out  button to extend the carousel to the load position.

37.

WARNING

Moving Parts

Sudden movement of parts can cause serious injury.

- ▶ Do not stand directly below the drill pipe.
- ▶ Do not put hands or fingers in pinch points.

Press the Activate Cab Hoist  button to activate the hoist.

38.

WARNING

Falling Drill Pipe

Can cause personal injury or death

- ▶ The lifting bail must be securely connected to the drill pipe before doing any movement of the drill pipe.

WARNING

Suspended Load

Can cause severe injury or death

- ▶ Do not stand in the working area of a crane or hoist when it is operating with an overhead load.
- ▶ Stay away from suspended loads.

Stand next to the drill pipe and guide it into the carousel. Set the drill pipe fully into the upper lock section of the carousel.

Step result

➔ The bottom of the drill pipe is aligned with the carousel cup.

39. Align the wrench flats on the drill pipe with the cup flats on the carousel. Lower the drill pipe into the carousel cup. Release all tension from the hoist wire rope.
40. Use the left main joystick to lower the hoist wire rope to give approximately 305 millimeters (12 inches) of slack.

41. Press the Tower Vertical Unlock  button to disengage the vertical tower locking pins.

42.

NOTICE

Property Damage

Can cause damage to the machine

- ▶ Do not attempt to move the tower with only one vertical pin unlocked.

Make sure that both vertical locking pins are unlocked.

43.



DANGER

Risk of Electrocution

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

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

Press and hold the joystick switch on the right main joystick. Pull the right main joystick toward you to lower the tower.

44. Release the right main joystick when the tower is in the horizontal position.
45. Exit the cab.
46. Make sure that the carousel is not drifting and that the lifting bail is free.

47.



WARNING

Fall Hazard

Can cause personal injury

- ▶ Put on fall-protection equipment when you work from a man basket.
- ▶ Examine all lifting equipment before you start any maintenance task.

 CAUTION**Falling or Slipping Hazard**

Personnel could fall or slip off the tower

- Use correct personal fall protection equipment.

Use appropriate personal protective equipment and climb into the tower.

48.

 WARNING**Falling Drill Pipe**

The drill pipe could fall off if not held securely causing personal injury or death.

- Make sure that the drill pipe is secured in both the upper and lower sections of the carousel before removing the lifting bail.

Remove the lifting bail.

49. Exit the tower and return to the cab.

50.

NOTICE**Damage to Tower**

Can cause damage to the tower structure

- Hard contact between the tower base and the tower support structure can damage the tower. Use the right main joystick to slow the tower when getting near the vertical stop blocks.

Press and hold the joystick switch on the right main joystick. Pull the right main joystick toward you to raise the tower.

51. Use the right main joystick to slow the tower as it approaches the vertical stop blocks.

52.

**WARNING****Falling Tower**

Tower locking pin disengagement can cause damage to the tower and serious personal injury

- ▶ Make sure that all locking pins for the tower are in the locked position.

Release the right main joystick when the tower is vertical. Press the Tower Vertical Lock  button to lock the tower in the vertical position.

53. Repeat steps 4 through 36 to load more drill pipe into the carousel.



NOTE: Do not load the last drill pipe into the carousel using these steps.

54. Do the following to load the last drill pipe:

- a. Pick up the drill pipe as described in steps 4 through 22.
- b. Lower the drill pipe into the deck bushing.
- c. Use the leveling jacks to raise the machine to its maximum height.
- d. Lower the drill pipe into the deck bushing until the drill pipe rests on the ground.
- e. Remove the lifting bail.
- f. Lubricate the pin threads with lubricant.
- g. Lower the rotary head and connect the last drill pipe onto the rotary head spindle.
- h. Feed up to the top stops to give clearance at the bottom of the tower.
- i. Use a lifting bail and the hoist, deck crane, or mobile crane to put the crossover sub, saver, or drill bit into the tower base and engage the deck fork into the flats.
- j. Remove the lifting bail.
- k. Use a lifting bail and the hoist, deck crane, or mobile crane to put the bushing over the pin end of the drill bit sub on top of the deck fork.
- l. Lower the rotary head and connect the drill pipe onto the crossover sub, saver, or drill bit.
- m. Press the Deck Fork Disengage  button to disengage the deck fork.
- n. Make sure that the deck bushing is fully seated into the base of the tower.
- o. Feed up so that the RCS does not show that the drill bit is in the hole.

4.17 Machine Shutdown Procedures

4.17.1 Shutting Off the Machine

Follow this procedure to shut off a diesel engine during normal conditions.

1. Move the rotary head to the top of the tower.



NOTE: The rotary head must be above the upper limit switch above the drill pipe support so that the drill bit is above any ground water and above any hole fall-in risk that may happen when the compressor is shut off.

2. Press the Air Regulation On/Off  button to shut off the drill air.
3. Switch off the non-essential systems, if necessary.
4. Press the Engine Speed High/Low  button to reduce engine speed to the low-idle setting.
5. Operate the diesel engine in a low-idle cool-down cycle for 5 minutes. Continue monitoring the engine and compressor parameters during the shutdown procedures.



NOTE: The manufacturers of diesel engines that are equipped with a turbocharger recommend operating the engine at idle for 3 to 5 minutes before shutting down. This prolongs the life of the turbocharger.

6. After 5 minutes in the low-idle cycle, turn the key switch to OFF to shut off the engine.
7. If you are leaving the machine or are done for the day, switch off both isolation switches.

4.17.2 Shutting Off the Machine with the RCS Start/Stop Button

The RCS engine **Start/Stop**  button is available on the **Setup** screen.

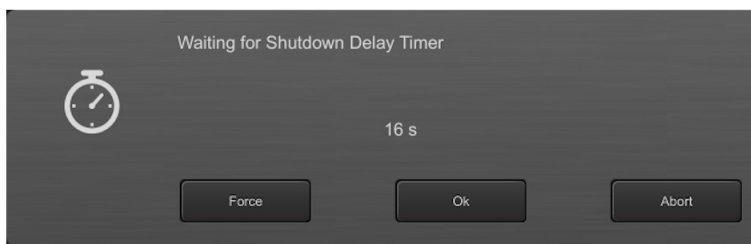
An engine stop delay is available within the RCS. For the engine stop delay to function, the key switch should remain in the ON position and the RCS powered on. Once the engine has shut off, the RCS can be shut off with the key switch.



NOTE: Operating the RCS with the engine off will drain the batteries. Do not operate the RCS for extended amounts of time with the key switch in the ON position and the engine switched off.

The following occurs when the operator selects the **Start/Stop**  button:

- The engine speed reduces to low idle, returns to the Setup state, and disables the RCS controls.
- The **Waiting for Shutdown Delay Timer** system message shows on the screen.



- Selecting **Force** stops the engine immediately.
- Selecting **Abort** cancels the engine stop process and returns the machine to operation.
- Selecting **Ok** closes the system message during the countdown so that the operator can continue to view other screens on the RCS.

4.17.3 Shutting Off the Machine in Emergency Situations

NOTICE

Machine Damage

The emergency stopping procedure for the machine can be abrupt. This abrupt stop can damage the machine due to potentially high-stress loading on its components.

- ▶ Use emergency stopping only in hazardous situations, or when a hazardous situation is likely to arise.
- ▶ If the operator or other personnel are not in immediate danger and the preservation of the equipment is the primary concern, the operator should try to shut the machine down under normal conditions to prevent damage to the machine.

There are two types of emergency shutdowns; one is by the operator pushing the emergency stop button and the other is when one of the shutdown devices on the machine has registered an out-of-limit condition.

If the operator or other personnel are in immediate danger, or if an emergency arises that is not under control of the shutdown devices, such as a fire or other outside caused problem, initiate an emergency stop with the following procedure.

1. Push in the E-Stop button.
2. Exit the machine.



NOTE: Every attempt should be made by the operator to shut off the machine during a normal shutdown, if possible, to prevent damage to the machine.

The operator should be able to avoid a shutoff condition by monitoring the computer display screen frequently. The display screen shows the operating temperatures or pressure of each of the systems being monitored.

4.17.4 Shutting Off the Machine During a Breakdown or Incident

1. Stop the machine.
2. Secure the machine.
3. Isolate machine power.
4. Notify personnel of the incident.
5. Remove personnel from hazard zones.
6. Protect the machine from use until it is in good working order.

4.18 Special Conditions of Use

4.18.1 Cold-Weather Conditions

- Refer to the Maintenance manual for information regarding cold-weather lubricants, hydraulic fluids, coolants, and the like.
- Use winter grade diesel fuel for operations at subzero temperatures.
- Cold-weather starting aids are flammable. Be careful when using starting aids and use only if needed.
- Remove batteries and store in a warm area to about 20 °C (68 °F).
- Do and obey warm-up procedures upon start-up before operating the machine.

4.18.2 Hot-Weather Conditions

- Monitor temperature gauges.
- Keep the cooling fins on the radiator and oil cooler clean and free from accumulated dirt.

4.18.3 Wet and Muddy Conditions

- Clean the machine of accumulated material and thoroughly grease all lubrication points. Refer to the Maintenance manual for information regarding lubricants, hydraulic fluids, coolants, fuel, and the like.

4.18.4 Dusty Conditions

- Keep the air cleaner elements clean and free from dirt accumulation.
- Wear a protective mask.

4.18.5 High Altitude Conditions

- Be aware that engine power is reduced in high-altitude conditions.
- Keep the cooling fins on the radiator and oil cooler clean and free of dirt accumulation.

4.18.6 Inclement Weather

- Refer to the Safety Manual for information on inclement weather, including lightning.
- Obey local mine-site requirements.

- Stop drilling, lower the tower, and park the machine when winds reach 72 km/h (45 mph) or higher.

4.19 Preservation and Storage

Observe the following guidelines when storing the machine for short periods of time:

- Replace and secure all weatherproof covers.
- Change all lubricants and fluids that may have deteriorated with use. Refer to the Maintenance manual for information regarding lubricants, hydraulic fluids, coolants, fuel, and the like.
- Make sure that the storage site is not subject to flooding or other natural hazards.
- Switch on the engine and operate all of the drill functions at regular intervals.

5 Transport

5.1 Lifting the Machine

5.1.1 Lifting the Machine without the Tower

Use four chains with a minimum lifting load limit of 27,216 kilograms (60,000 pounds).

WARNING

Suspended Load

Can cause severe injury or death

- ▶ Do not stand in the working area of a crane or hoist when it is operating with an overhead load.
- ▶ Stay away from suspended loads.

Precondition

- ✓ The tower rest, deck ladder, and ladder support are removed from the machine.
- ✓ A sufficient lifting device is equipped with the lifting rod and four chains that lift the machine evenly.

1. Make sure that no loose items remain on the machine.

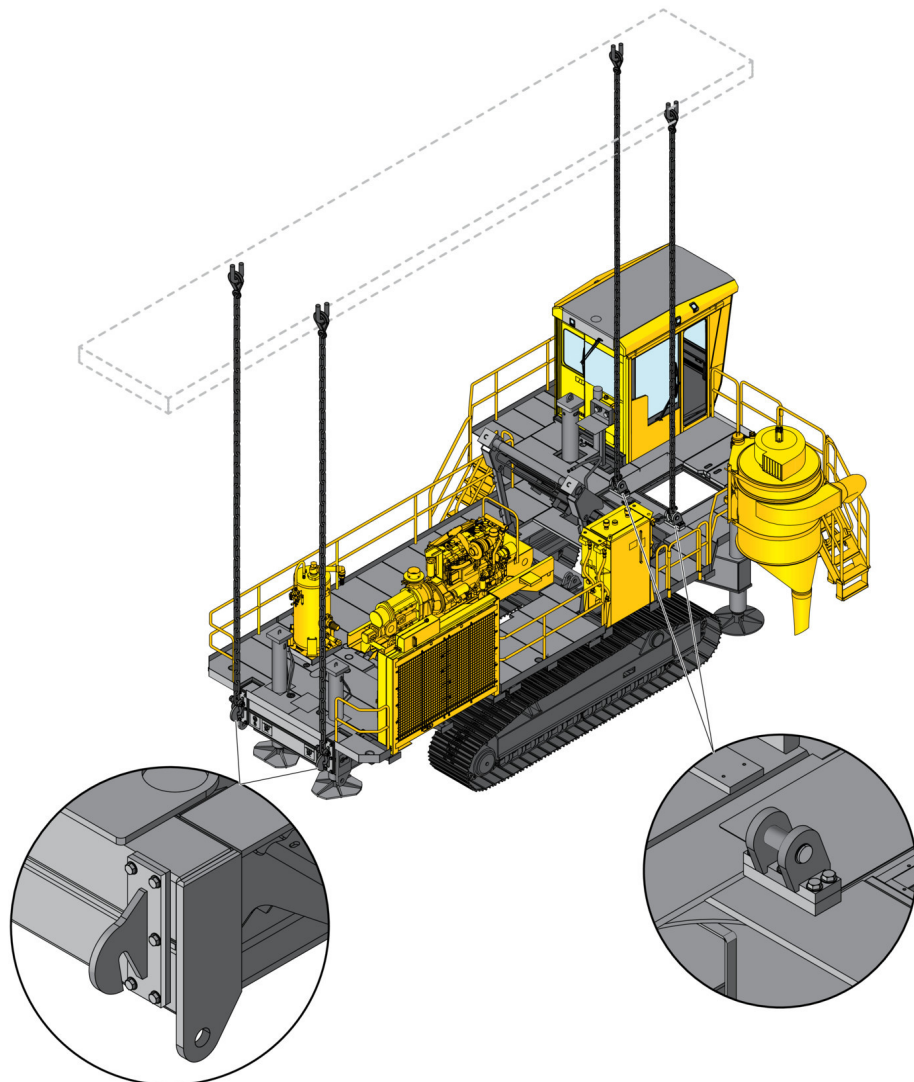
2. **WARNING**

Crushing Hazard

Can cause personal injury.

- ▶ Lifting equipment must be adequately sized, have the correct lifting capacity, and be in good condition.
- ▶ Be careful when you lift heavy components.

Attach the chain to each lifting hook and loading clevis.



Attach the Chains

3. Adjust the chain to allow for an even lift of the machine.



NOTE: The center of gravity is near the middle of the machine. The exact location of the center of gravity varies depending on machine configuration.

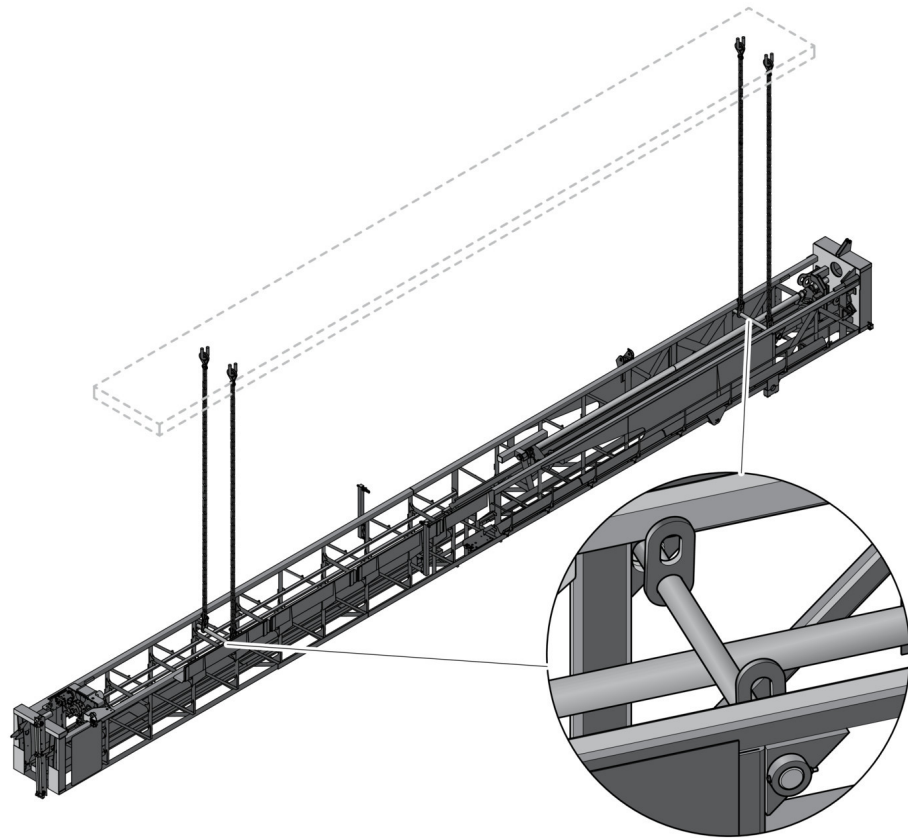
4. Carefully lift the machine. Keep the machine level while it is lifted.

5.1.2 Lifting the Tower

Use four chains with a minimum lifting load limit of 27,216 kilograms (60,000 pounds).

- Precondition**
- ✓ The rotary head is at the top of the tower.
 - ✓ The feed cylinders are fully retracted.
 - ✓ Drill pipe is not in the carousel.
 - ✓ A sufficient lifting device is equipped with the lifting rod and four chains that lift the tower evenly.

1. Make sure that no loose items remain on the tower.
2. Attach both tower hanger tubes to the tower.



Attach the Hanger Tubes

3.



WARNING

Crushing Hazard

Can cause personal injury.

- ▶ Lifting equipment must be adequately sized, have the correct lifting capacity, and be in good condition.
- ▶ Be careful when you lift heavy components.

Attach the chains to the hanger tubes.

4. Adjust the chains to allow for an even lift of the tower.



NOTE: *The center of gravity is near the middle of the tower toward the base.*

- 5.



WARNING

Suspended Load

Can cause severe injury or death

- ▶ Do not stand in the working area of a crane or hoist when it is operating with an overhead load.
- ▶ Stay away from suspended loads.

Carefully lift the tower. Keep the tower level while it is lifted.

5.2 Towing the Machine

5.2.1 Labor Resource (People/Skills)

Service Technician x 2

5.2.2 Personal Protection Equipment



NOTE: *Make sure that all necessary personal protection equipment (PPE) is available and properly used when doing this procedure.*

- Head - Hard hat
- Ears - Hearing protection
- Eyes - Safety glasses
- Hands - Applicable gloves
- Feet - Safety shoes with steel toes
- Safety devices

5.2.3 Technical Data

To select the correct lifting devices, stands, tools, and so forth, this section provides general technical specifications.



NOTE: Due to the variation of machine options and components, actual values can differ from the data below. Data is for reference only.

Machine Technical Data

See the machine-specific manuals for weight, dimensions, and other data relevant to bringing the machine to the work area and doing the task.

Tools

Description	Specification	Quantity
Standard mechanic toolkit		

Support Equipment

Description	Specification
Tow bar	
Temperature gun	

Consumables

Description	Specification	Quantity
Not applicable		

5.2.4 Spare Parts



NOTE: To obtain part numbers for the spare parts listed below, refer to the Spare Parts Catalog for your specific machine model and serial number.

Description	Part Number/Specification	Quantity
Bolt	M8x45	4

5.2.5 Time Required (Standard Planning Hours)

Description	Planned Time (HH:MM)
Towing and observing the machine	08:00

5.2.6 Reference Documentation

Description	Part Number
Safety Manual	Model specific
Spare Parts Catalog	Machine specific (per serial number)
Safety Locks and Tags Minimum Requirements	Model specific Maintenance manual

5.2.7 Before Starting the Task

1. Attach a shield to the towing vehicle to protect the operator from possible tow-line failure.
2. Retract all of the leveling jacks.
3. Retract the dust curtains.
4. Secure the drill pipes.
- 5.



DANGER

Electrocution Hazard

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

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

Lower the tower to the horizontal position.

6. Put all of the controls in the OFF or neutral position.
7. Stop the engine.
8. Attach the safety locks and tags from the machine in accordance with the site-specific procedures.



NOTE: Refer to Safety Locks and Tags Minimum Requirements in the Maintenance manual.

9. Make sure that the machine is in a zero-energy state.

5.2.8 Towing the Machine

WARNING

Burn Hazard

Hot fluids or components can burn.

- ▶ Make sure that the fluids are at a safe working temperature when you service the machine.
- ▶ Do not touch hot fluids or components.



NOTE: When towing a machine that has Cat® or Berco® tracks, refer to the Cat® or Berco® manual for towing requirements and instructions for disengaging the tracks.

1. Install the tow bar to the machine.



NOTE: If a Cat® or Berco® undercarriage is installed on the machine, refer to OEM supplied information to release the brake.



NOTE: If an ACGT® undercarriage is installed on the machine, a technician can manually disengage the brake from the final drive.



NOTE: The transmission on ACGT® tracks has a disengaging gear. The disengaging gear changes the transmission to neutral. Thus the motor and transmission are disengaged without releasing the parking brake.

- 2.

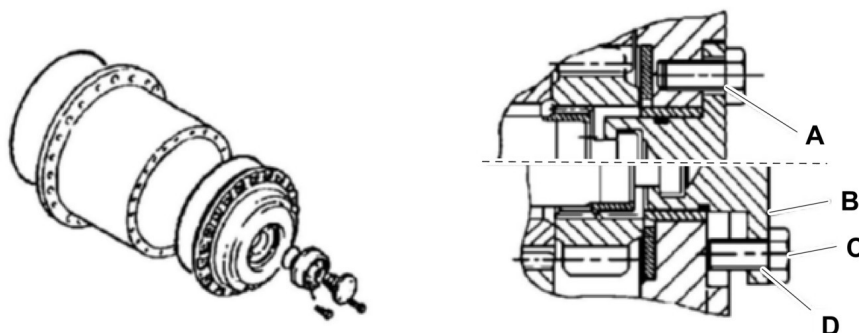
NOTICE

Component Damage

Disengaging the gears can cause damage to the gear teeth.

- ▶ Only disengage and re-engage the gears with the machine at a standstill.

Hold the disengagement flange (item A) in place with two M8x25 bolts. Remove these bolts from the flange.



A	Engaged flange	B	Disengagement flange
C	Disengagement flange	D	Withdrawal hole

3. Insert two M8x45 bolts into the withdrawal holes (item D) in the flange to loosen the disengagement flange to 16 millimeters (5/8 inch) (item B).
4. Insert two M8x45 bolts into the flange to prevent the movement of the gears.
5. Reverse steps 1 through 4 to re-engage the flange.

5.2.9 Observing the Towed Machine

⚠ WARNING

Accidental Movements

Towing a disabled machine incorrectly can cause personal injury or death.

- Tow the machine according to all local requirements and safety procedures.

NOTICE

Component Damage

Exceeding the towing speed can raise the temperature in the drives and the rollers, which can damage the track system.

- Do not tow the machine faster than 2,09 kilometers per hour (1.3 miles per hour).

1. Monitor the temperatures during the towing process. Monitor the roller temperature with a temperature gun. Make sure that the roller temperature is not more than 79.4 °C (175 °F).



NOTE: If the temperatures and towing speed are kept within specifications, towing does not have an adverse effect on the track system.

- 2.



CAUTION

Collision Hazard

Can cause severe injury and property damage

- ▶ Avoid contact between the tower and the towing vehicle when approaching hills and dips.
- ▶ Avoid contact with any outside items around the towing area.

Monitor the height difference between the top of the towing vehicle and the bottom of the tower.

5.2.10 After Completing the Task

1. Stop towing.
2. Connect the final drives.
3. Make sure that the final drives are fully engaged and operational.
4. Remove the tow bar from the towing vehicle and the machine. Store the tow bar in a safe place for future use.
5. Remove all tools and trash from the work area.
6. Remove the safety locks and tags from the machine in accordance with the site-specific procedures.



NOTE: Refer to Safety Locks and Tags Minimum Requirements in the Maintenance manual.

6 10-Hour Periodic Maintenance

Refer to the PV-271D Maintenance manual for 10-hour periodic maintenance procedures and maintenance safety information.

10-Hour Periodic Maintenance Tasks

Do a Test of the Overpressure Control System

Do an Inspection of the Air Cleaner Filter Restriction Indicators

Do an Inspection of the Engine and Compressor Air Intake Ducts and Connections

Do an Inspection of the Dust Collector

Clean the Filter Dust Cups

Do an Inspection of the Hydraulic Hoses

Do an Inspection of the Exhaust System

Do an Inspection of the Engine Belts and Tensioner

Drain the Water from the Fuel and Water Separator

Do an Engine Oil Level Check

Do an Engine Coolant Level Check

Do a Fuel Level Check

Do a Compressor Oil Level Check

Drain the Water from the Receiver Tank

Do a Hydraulic Tank Oil Level Check

Do an Inspection of the Hydraulic Oil Filter Restriction Indicators

Do an Inspection of the Rotary Head

Do a Rotary Head Oil Level Check

Lubricate the Gearbox Drive Shaft

Do a Water Injection Pump Oil Level Check

7 Technical Data

7.1 Environmental Rate Factor Changes

7.1.1 Duty

Duty	Drilling Conditions
Light	Sand and gravel
Normal	Soft rock
Heavy	Hard rock

7.1.2 Ambient Temperature

Ambient Temperature Range Without an Arctic Cooler Package

Condition	Range
Nominal	-9 to 52 °C (15 to 125 °F)
Cold	-40 to -9 °C (-40 to 15 °F)

The temperature range for machines that are equipped with an Arctic cooler package is -40 °C (-40 °F) to 37 °C (100 °F).

7.1.3 Service

Service	Description
Excellent	Well prepared benches, scheduled maintenance program, advanced training of operators and mechanics.
Nominal	Good operating conditions, normal maintenance, basic training for operators and mechanics.
Poor	Bad operating conditions, limited maintenance, limited training for operators and mechanics.

7.1.4 Application

Application	Drilling Type
Construction	Nominal
Aggregates	Light
Gold	Heavy
Copper	Heavy
Coal	Nominal
Iron	Heavy

7.2 Operational Limitations

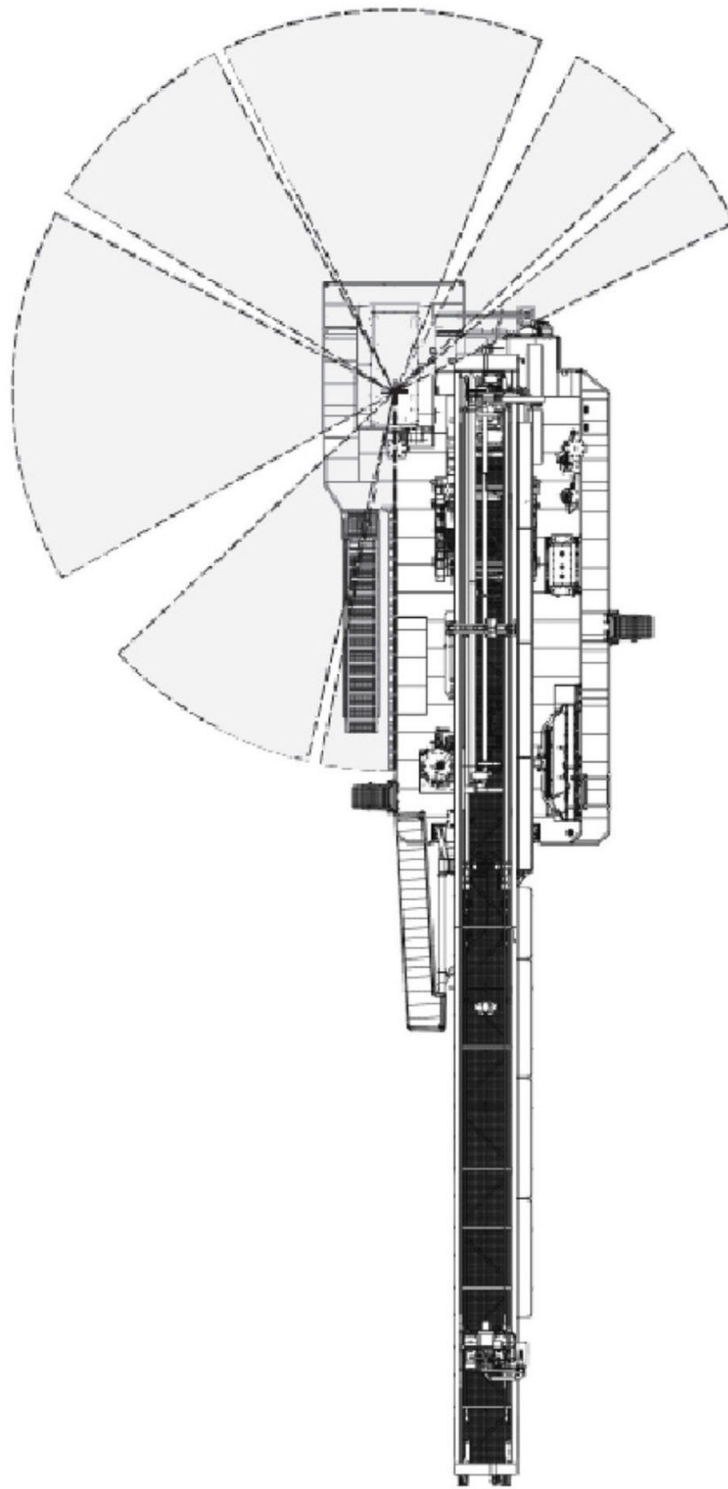
7.2.1 Maximum Slope Angle

The machines are intended for operation on flat, level surfaces. Exceeding the slope or grade limitations of the machine and its configuration can cause the machine to tip over. Always determine the safe operating grade of the machine with the tower up and down. Stay within the limits that are shown in the stability tables of the Safety manual for this machine.

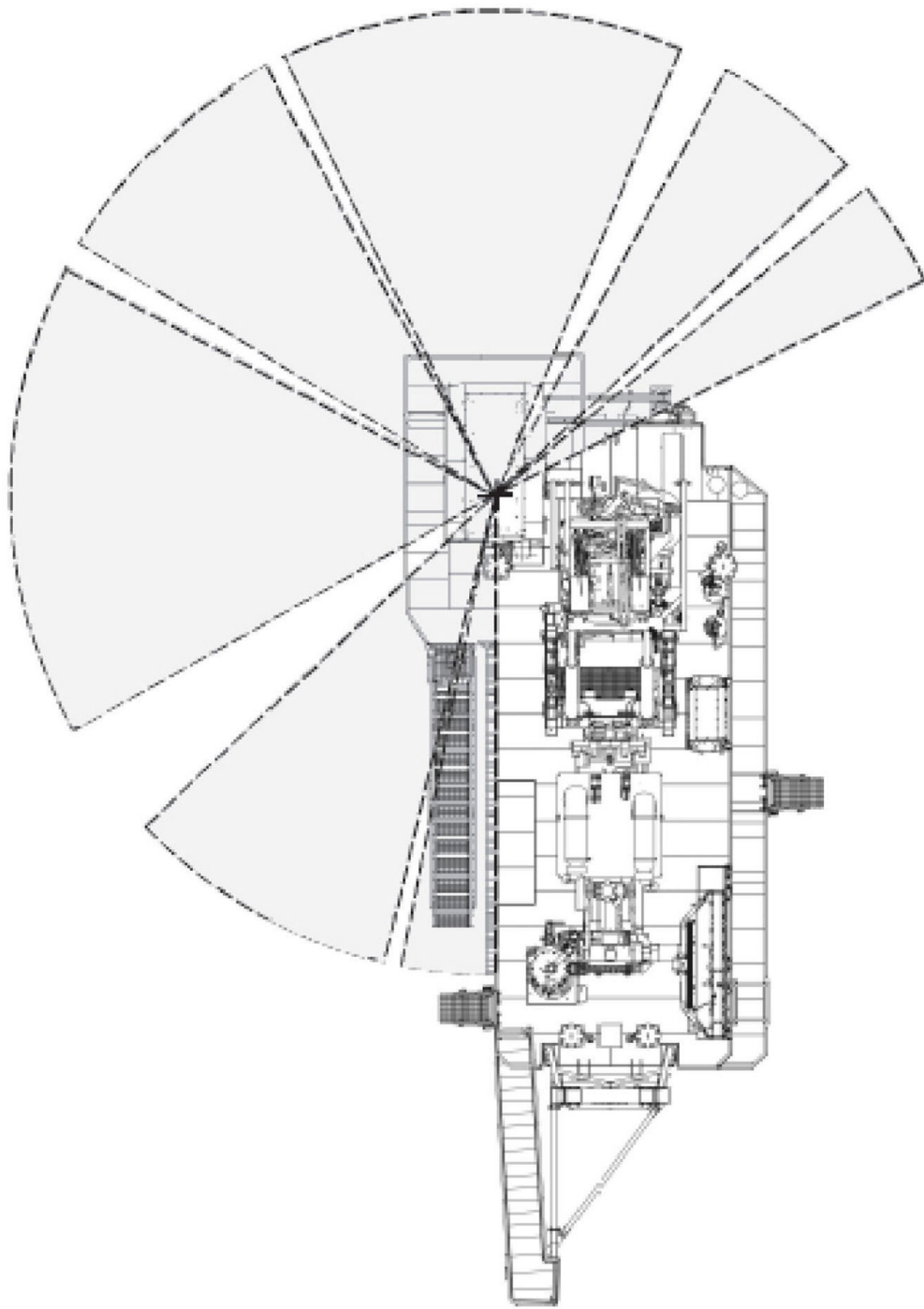
7.2.2 Maximum Ground Pressure

The machines are intended to operate on firm surfaces. Operating the machine on surfaces without a sufficient ground pressure rating can cause the machine to become unstable. Refer to the Safety manual for this machine for the ground pressure required for machine stability.

7.2.3 Visibility



Tower Lowered



Tower Raised

7.2.4 Noise and Vibration

Refer to the Safety manual for this machine to see noise and vibration levels.

7.3 Weights and Dimensions

Dimension	16.76-m (55-ft) Tower	17.98-m (59-ft) Tower
Height (deck to ground)	1 520 mm (60 in)	1 520 mm (60 in)
Height (ground to tower down)	4 910 mm (193.5 in)	4 910 mm (193.5 in)
Height (leveling jack to ground)	380 mm (15.5 in)	380 mm (15.5 in)
Height (oscillation yoke to ground)	510 mm (20 in)	510 mm (20 in)
Height (tower down)	6 840 mm (269 in)	6 840 mm (269 in)
Height (tower up)	27 080 mm (1,066 in)	27 550 mm (1,085 in)
Length (leveling jack centers)	8 110 mm (319.5 in)	8 110 mm (319.5 in)
Length (tower down with automatic wire rope tensioning)	26 850 mm (1,057 in)	27 320 mm (1,075.5 in)
Length (tower up)	16 430 mm (647 in)	16 430 mm (647 in)
Length (undercarriage)	6 480 mm (255 in)	6 480 mm (255 in)
Weight	94 574 kg (208,500 lb)	94 574 kg (208,500 lb)
Width (cab)	1 700 mm (67 in)	1 700 mm (67 in)
Width (leveling jack centers)	3 920 mm (154.5 in)	3 920 mm (154.5 in)
Width (overall)	7 200 mm (284 in)	7 200 mm (284 in)
Width (track inside)	2 460 mm (97 in)	2 460 mm (97 in)
Width (track)	900 mm (35.5 in)	900 mm (35.5 in)
Width (undercarriage)	4 270 mm (168 in)	4 270 mm (168 in)

7.4 Tower

7.4.1 Tower

Specification	16,76-m (55-ft) Tower PV-271 Standard	17,98-m (59-ft) Tower PV-271 Optional and PV-291
Construction	Four main member, open front, rectangular steel tubing	
Tower-Raising Cylinders	Two hydraulic cylinders	
Bore	127 mm (5 in)	
Drill Pipe Diameter	92,5 mm (3.75 in)	

Specification	16,76-m (55-ft) Tower PV-271 Standard	17,98-m (59-ft) Tower PV-271 Optional and PV-291
Stroke	9 829,8 mm (387 in)	10 134,6 mm (399 in)
Drill Pipe Length	7 620 mm (300 in)	

7.4.2 Dust Collector

Specification	Data
Type	No visible emission pleated paper element with pneumatic flushing
Model	7SB
Capacity	198,2 m³/min (7,000 cfm)
Mounting	Post type mounting on top of non-cab side leveling jack
Configuration	Cyclone
Dimensions	3 533,1 mm (139.1 in) height X 1 371,6 mm (54 in) diameter
Filter Elements	9
Inlet Diameter	304,8 mm (12 in)
Air Compressor Size	XL-1900, XL-2600, 1,450 hp
Dust Hood Connection	304,8 mm (12 in) O.D. suction hose
Fan Motor	Hydraulic vane motor, fixed displacement
Fan Motor Displacement	24,6 cc/rev (1.5 in³/rev)
Operating Pressure	206,8 bar (3,000 psi)
Flow Control Valve	Yes
Internal Baffle	Internal baffle between dust collector intake duct and filters
Dust Hood	Rectangular with split curtains and hydraulically-retractable front curtain
Dust Curtain Material	Conveyor belting

7.4.3 Dust Collector Fan Motor

Specification	Measurement
Quantity	1
Type	Fixed displacement, hydraulic spring vane motor
Displacement	24,6 cc/rev (1.5 in³/rev)
Maximum Pressure	172,4 bar (2,500 psi) at 2,500 rpm

7.4.4 Water Injection System

Specification	Rotary Piston Pump	Reciprocal Piston Pump
Size	30,3 L/min (8 gal/min)	50 L/min (13.2 gal/min)
Hydraulic Motor Drive	Fixed displacement	
Displacement	101,6 cc/rev (6.2 in ³ /rev)	
	162,3 cc/rev (9.9 in ³ /rev) optional	
Water Tank Size	1 514,2 L (400 gal)	
	2 506 L (662 gal) optional	
	1 325 L (350 gal) optional	
	2 839,1 L (750 gal) optional	

7.4.5 Hoist

Standard Hoist - 8,000-lb Maximum Load

Layer	Line Pull	Line Speed	Wire Rope Capacity
1	2 502 kg (5,517 lb)	43 m/min (140 ft/min)	18 m (58 ft)
2	2 252 kg (4,966 lb)	48 m/min (156 ft/min)	37 m (122 ft)
3	2 048 kg (4,517 lb)	52 m/min (172 ft/min)	59 m (193 ft)
4	1 876 kg (4,138 lb)	57 m/min (187 ft/min)	82 m (270 ft)
5	1 607 kg (3,545 lb)	62 m/min (203 ft/min)	108 m (353 ft)

CE Hoist - 8,000-lb Maximum Load

Layer	Line Pull	Line Speed	Wire Rope Capacity
1	2 502 kg (5,517 lb)	19 m/min (63 ft/min)	9 m (30 ft)
2	2 252 kg (4,966 lb)	21 m/min (70 ft/min)	19 m (65 ft)
3	2 048 kg (4,517 lb)	23 m/min (77 ft/min)	30 m (100 ft)



NOTE: These numbers are based on theoretical efficient and straight line pulls. System inefficiencies will reduce the actual load that can be lifted.

7.4.6 Hoist Motor

Specification	Measurement
Quantity	1
Type	Fixed displacement
Displacement	32,8 cc/rev (1.2 in ³ /rev)

7.4.7 Rotary Head

Specification	Measurement
Reduction	PV-270: 15.227:1 PV-291: 14.706:1
Rotation Motors	Two variable displacement, axial piston hydraulic motors
Rotation Power	PV-270: 135 kW (181 hp) (100% efficiency) PV-291: 175 kW (235 hp) (100% efficiency)
Rotation Torque	PV-270: 11 800 Nm (8,703 ft-lb) (occurs at 0 to 105 rpm) PV-291: 14 914 Nm (11,000 ft-lb) (occurs at 0 to 112 rpm)
Rotation Speed	0 to 150 rpm at minimum displacement
Head Guides	Replaceable, Nylatron (moly-disulfide)

7.4.8 Rotation Motor

Specification	Measurement
Quantity	2
Type	Variable displacement, axial piston hydraulic motor
Displacement	98,3 cc/rev (6 in ³ /rev)
Speed Range	0 to 150 rpm
Rotation Torque	PV-270: 11 795 Nm (8,700 ft-lb) PV-291: 14 914 Nm (11,000 ft-lb)
Rotation Power	PV-270: 135 kW (181 hp)

Specification	Measurement
	PV-291: 175 kW (235 hp)
Speed Control	Infinitely adjustable throughout range, maximum speed set by manual adjustment of motor displacement

7.4.9 Feed System Wire Rope Tensioner Motor

Specification	Measurement
Quantity	2
Type	Fixed displacement
Displacement	80,3 cc/rev (4.9 in ³ /rev)

7.4.10 Feed System

Specification	16,76-m (55-ft) Tower PV-271 Standard	17,98-m (59-ft) Tower PV-271 Optional and PV-291
Design	Hydraulic cylinder driven wire rope feed	
Maximum Hole Depth	32 m (105 ft)	18 m (59 ft)
Drill String	Consists of the rotary head spindle, shock sub/crossover sub or spindle sub, drill pipe, drill bit sub or stabilizer, and the drill bit	
Feed Cylinders	2 dual-rod, dual-piston hydraulic cylinders	
Weight on Drill Bit	PV-270: 0 - 39 019 kg (0 - 75,000 lb) PV-291: 0 - 40 823 kg (0 - 85,000 lb)	
Hole Diameter	171 - 270 mm (6.75 - 10.63 in)	
Cylinder Bore	127 mm (5 in)	
Cylinder Rod Diameter	95,25 mm (3.75 in)	
Stroke	9 829,8 mm (387 in)	10 134,6 mm (399 in)
Sheave Outside Diameter	PV-270: 596,9 mm (23.5 in) PV-291: 609,6 mm (24.0 in)	
Hydraulic Pulldown (Feed Force)	PV-270: 0 - 31 751 kg (0 - 70,000 lb) PV-291: 0 - 38 555 kg (0 - 80,000 lb)	
Hydraulic Pullback Force	0 - 15 876 kg (0 - 35,000 lb)	
No. of Pulldown Sheaves	4	

Specification	16,76-m (55-ft) Tower PV-271 Standard	17,98-m (59-ft) Tower PV-271 Optional and PV-291
Pulldown Wire Rope Diameter	PV-270: 25,4 mm (1 in) PV-291: 31,8 mm (1.25 in)	
No. of Pullback Sheaves	4	
Pullback Wire Rope Diameter	25,4 mm (1 in)	
Feed Speed	PV-270: 38 618,7 mm/min (1,520.4 in/min) PV-291: 45 493,9 mm/min (1,791.1 in/min)	
Retract Speed	PV-270: 48 188,9 mm/min (1,897.2 in/min) PV-291: 56 771,2 mm/min (2,235.1 in/min)	

7.4.11 Drill Pipe Handling

Structure	Capacity
Drill Pipe Changer	The carousel is indexed by one hydraulic cylinder. The drill pipe changer is moved into position by two hydraulic cylinders.
Drill Pipe Support	Hydraulic cylinder clamping and actuation to the center of the drill pipe
Primary Breakout	Hydraulic deck fork, actuated from the operator seat
Secondary Breakout	Hydraulic jaw wrench, actuated from the operator seat

7.4.12 Drill Pipes

!	NOTE: Includes one drill pipe below the rotary head and carousel selections for maximum number of drill pipes.
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Drill Pipe Diameter	Max Wall Thickness	Thread	Number of Drill Pipes	Total Length	Total Depth
158,8 mm (6.25 in)	25,4 mm (1 in)	101,6 mm (4 in) BECO	4	7 620 mm (300 in)	32 004 mm (1,260 in)
177,8 mm (7 in)	25,4 mm (1 in)	114,3 mm (4.5 in) BECO	4	7 620 mm (300 in)	32 004 mm (1,260 in)
193,8 mm (7.63 in)	25,4 mm (1 in)	133,4 mm (5.25 in) BECO	4	7 620 mm (300 in)	32 004 mm (1,260 in)

Drill Pipe Diameter	Max Wall Thickness	Thread	Number of Drill Pipes	Total Length	Total Depth
203,2 mm (8 in)	25,4 mm (1 in)	133,4 mm (5.25 in) BECO	4	7 620 mm (300 in)	32 004 mm (1,260 in)
219,2 mm (8.63 in)	25,4 mm (1 in)	152,4 mm (6 in) BECO	4	7 620 mm (300 in)	32 004 mm (1,260 in)
235,0 mm (9.25 in) (PV-291 only)	25,4 mm (1 in)	152,4 mm (6 in) BECO	3	7 620 mm (300 in)	27 660 mm (1,089 in)

7.5 Cabin

Specification	Data
Falling Object Protection	FOPS (falling object protective structure) certified (ISO 3449 Level 2 Test - 500-lb projectile from 17 ft)
Thermal/Sound Insulation	Noise abated (measured to be 66.1 dBA) with doors closed and air conditioner operating at full speed
Cabin Width	1 699,3 mm (66.9 in)
Cabin Length	2 735,6 mm (107.7 in)
Cabin Height	2 270,8 mm (89.4 in)
Doors	2
Heater/Air Conditioner	DTAC side-mounted unit with adjustable vents A/C: 31,000 Btu/hr Heater: 40,000 Btu/hr 2,8 m³/min (100 cfm) fresh air supply; stainless steel components; copper/brass heat exchanger
Pressurizer	Integrated with heater/air conditioner
Pressurization	0.2 inch of water minimum with doors closed
Ventilators	Louver style vents provided to direct air flow for optimal comfort
Cab Glass	Tinted safety glass
Kick Plates	Yes
Wipers	Two wipers with washers standard
Operator Seat	Swivel type, adjustable, high back with arm rests, air ride suspension with RCS controllers and monitor

7.6 Hydraulic System

7.6.1 Hydraulic System

Hydraulic System

Specification	Data
Pump Drive	Four-hole gearbox driven through torsional coupling coupled to engine Gear ratio: 1:1
Main Pumps	Two variable displacement, axial piston, bi-directional pumps for feed, rotation, and propel
Auxiliary Pumps	PV-270: One triple section vane pump for all auxiliary hydraulic functions PV-291: Double section gear pump for auxiliary functions and double section gear pump (Tier 2) or axial piston pump (Tier 4) for cooling fan
Hydraulic Tank Capacity	567,8 L (150 gal)
Hose Management	Stauff type clamps for hoses; hard piping where possible
Hydraulic Fittings	SAE O-ring face seal
Filtration	Two filters in drain line upstream from tank; two filters in return line upstream from supercharge manifold
Filtration Rating	3 micron

Hydraulic System Pumps Pressure

Specification	Measurement
Feed System - Pulldown	PV-270: 234 bar (3,400 psi) PV-291: 310 bar (4,500 psi)
Feed System - Pullback	310 bar (4,500 psi)
Rotation System	PV-270: 310 bar (4,500 psi) PV-291: 345 bar (5,000 psi)
Propel System	PV-270: 310 bar (4,500 psi) PV-291: 345 bar (5,000 psi)
Auxiliary Circuits	207 bar (3,000 psi)

Hydraulic Reservoir

Specification	Measurement
Capacity	567,8 L (150 gal)

7.6.2 Leveling Jacks

Specification	Measurement
Type	Hydraulic cylinder with double holding valves
Quantity	4
Bore x Stroke / Rod Diameter	
Drilling End - 2	177,8 mm (7 in) bore x 1 219,2 mm (48 in) stroke / 133,4 mm (5.25 in) rod diameter
Non-drilling End - 2	152,4 mm (6 in) bore x 1 524 mm (60 in) stroke / 114,3 mm (4.5 in) rod diameter
Double Holding Valves	310,3 bar (4,500 psi)
Approximate Machine Lifting Capacity	
Drill Side	28 350 kg (62,500 lb)
Non-drill Side	22 961 kg (50,620 lb)
Leveling Jack Pad Shape/Area	
Drill Side	Round, 863,6 mm (34 in) diameter
Non-drill Side	Triangular, 489 676,4 mm ² (759 in ²) area
Approximate Pad Bearing Pressure (Maximum)	
Drill Side	4,8 bar (68.9 psi)
Non-drill Side	4,6 bar (66.7 psi)

7.6.3 Pumps

Main Pumps

Specification	Measurement
Quantity	2
Type	Variable displacement, axial piston, bi-directional pumps for feed, rotation, and propel
Displacement	PV-270: 118,8 cc/rev (7.25 in ³ /rev)

Specification	Measurement
	PV-291: 180,3 cc/rev (11.0 in ³ /rev)
Output with Engine Speed at 1,800 rpm - Standard: Pump Speed at 2,317 rpm - Optional: Pump Speed at 1,800 rpm	PV-270: 275,2 L/min (72.7 gal/min) PV-291: 324,4 L/min (85.7 gal/min)
Output with Engine Speed at 2,100 rpm Pump Speed at 2,339 rpm	277,8 L/min (73.4 gal/min)

Auxiliary Pump (Standard)

Specification	Measurement at 1,800 rpm	Measurement at 2,100 rpm
Quantity	1	
Type	Three-section, vane, fixed displacement pump for auxiliary hydraulic functions	Three-section, vane, fixed displacement pump for auxiliary hydraulic functions
Displacement - Section P1	70,3 cc/rev (4.29 in ³ /rev)	65 cc/rev (3.97 in ³ /rev)
Displacement - Section P2	70,3 cc/rev (4.29 in ³ /rev)	65 cc/rev (3.97 in ³ /rev)
Displacement - Section P3	19,8 cc/rev (1.21 in ³ /rev)	63,8 cc/rev (3.89 in ³ /rev)
Output, Pump Speed at 2,286 rpm - Section P1	162,8 L/min (43.0 gal/min)	164,3 L/min (43.4 gal/min)
Output, Pump Speed at 2,286 rpm - Section P2	162,8 L/min (43.0 gal/min)	164,3 L/min (43.4 gal/min)
Output, Pump Speed at 2,286 rpm - Section P3	45,8 L/min (12.1 gal/min)	149,1 L/min (39.4 gal/min)

Auxiliary Pump (Optional)

Specification	Measurement at 1,800 rpm
Quantity	2
Type	Double section fixed displacement gear pump for auxiliary hydraulic functions
Displacement - Section P1	65 cc/rev (3.97 in ³ /rev)
Displacement - Section P2	65 cc/rev (3.97 in ³ /rev)
Output, Pump Speed at 2,286 rpm - Section P1	112,3 L/min (29.7 gal/min)
Output, Pump Speed at 2,286 rpm - Section P2	112,3 L/min (29.7 gal/min)

Tier 4 Fan Pump (Optional)

Specification	Measurement
Type	Variable displacement, axial piston, open loop pump, pressure compensated
Displacement	145 cc/rev (8.8 in ³ /rev)
Output	260,1 L/min (68.9 in ³ /rev)

7.6.4 Cylinders

Leveling Jack Cylinder

Specification		Measurement
Quantity		4
Type		Hydraulic cylinder with double holding valves set at 310 bar (4,500 psi)
Drilling End (2)	Cylinder Bore	177,8 mm (7 in)
	Cylinder Rod Diameter	134,6 mm (5.3 in)
	Cylinder Stroke	1 219,2 mm (48 in)
Non-drilling End - Standard (1)	Cylinder Bore	177,8 mm (7 in)
	Cylinder Rod Diameter	134,6 mm (5.3 in)
	Cylinder Stroke	1 524 mm (60 in)
Non-drilling End - Option (2)	Cylinder Bore	152,4 mm (6 in)
	Cylinder Rod Diameter	114,3 mm (4.5 in)
	Cylinder Stroke	1 524 mm (60 in)

Tower-Raising Cylinder

Specification	Measurement
Quantity	2
Type	Hydraulic cylinder with double holding valves set at 275,8 bar (4,000 psi)
Cylinder Bore	190,5 mm (7.5 in)
Cylinder Rod Diameter	114,3 mm (4.5 in)
Cylinder Stroke	1 976,1 mm (77.8 in)

Tower Pinning Cylinder

Specification	Measurement
Quantity	2
Type	Hydraulic cylinder
Cylinder Bore	190,5 mm (7.5 in)
Cylinder Rod Diameter	38,1 mm (4.5 in)
Cylinder Stroke	152,4 mm (6 in)

Angle Drill Pinning Cylinder

Specification	Measurement
Quantity	2
Type	Hydraulic cylinder
Cylinder Bore	76,2 mm (3 in)
Cylinder Rod Diameter	33 mm (1.3 in)
Cylinder Stroke	254 mm (10 in)

Feed System Wire Rope Tension Cylinder

Specification	Measurement
Quantity	2
Type	Hydraulic cylinder
Cylinder Bore	101,6 mm (4 in)
Cylinder Rod Diameter	50,8 mm (2 in)
Cylinder Stroke	393,7 mm (15.5 in)

Feed Cylinder

Specification	16,76-m (55-ft) Tower PV-271 Standard	17,98-m (59-ft) Tower PV-271 Optional and PV-291
Quantity	2	
Type	Dual rod, dual piston hydraulic cylinder	
Cylinder Bore	127 mm (5 in)	127 mm (5 in)

Specification	16,76-m (55-ft) Tower PV-271 Standard	17,98-m (59-ft) Tower PV-271 Optional and PV-291
Cylinder Rod Diameter	96,5 mm (3.8 in)	96,5 mm (3.8 in)
Cylinder Stroke	9 829,8 mm (387 in)	10 134,6 mm (399 in)

Drill Pipe Changer Cylinder

Specification	Measurement
Quantity	2
Type	Hydraulic cylinder with double holding valves set at 207 bar (3,000 psi)
Cylinder Bore	76,2 mm (3 in)
Cylinder Rod Diameter	38 mm (1.5 in)
Cylinder Stroke	127 mm (5 in)

Drill Pipe Indexing Cylinder

Specification	Measurement
Quantity	1
Type	Hydraulic cylinder with double holding valves set at 207 bar (3,000 psi)
Cylinder Bore	76,2 mm (3 in)
Cylinder Rod Diameter	38 mm (1.5 in)
Cylinder Stroke	127 mm (5 in)

Drill Pipe Support Cylinder

Specification	Measurement
Quantity	1 swing cylinder, 1 clamp cylinder
Type	Hydraulic cylinder with double holding valves set at 207 bar (3,000 psi)
Cylinder Bore	76,2 mm (3 in)
Cylinder Rod Diameter	38 mm (1.5 in)
Cylinder Stroke	154,2 mm (6 in)

Deck Fork Cylinder

Specification	Measurement
Quantity	1
Type	Hydraulic cylinder with double holding valves set at 207 bar (3,000 psi)
Cylinder Bore	38 mm (1.5 in)
Cylinder Rod Diameter	25,4 mm (1 in)
Cylinder Stroke	203,2 mm (8 in)

Breakout Wrench (Clamp) Cylinder

Specification	Measurement
Quantity	1
Type	Hydraulic cylinder with double holding valves set at 207 bar (3,000 psi)
Cylinder Bore	114,3 mm (4.5 in)
Cylinder Rod Diameter	50,8 mm (2 in)
Cylinder Stroke	228,6 mm (9 in)

Breakout Wrench (Rotate) Cylinder

Specification	Measurement
Quantity	1
Type	Hydraulic cylinder with double holding valves set at 207 bar (3,000 psi)
Cylinder Bore	114,3 mm (4.5 in)
Cylinder Rod Diameter	50,8 mm (2 in)
Cylinder Stroke	228,6 mm (9 in)

Breakout Wrench (Swing) Cylinder

Specification	Measurement
Quantity	1
Type	Hydraulic cylinder with double holding valves set at 207 bar (3,000 psi)

Specification	Measurement
Cylinder Bore	114,3 mm (4.5 in)
Cylinder Rod Diameter	50,8 mm (2 in)
Cylinder Stroke	228,6 mm (9 in)

Dust Curtain Cylinder

Specification	Cylinder
Quantity	2
Type	Hydraulic cylinder with double holding valves set at 224 bar (3,249 psi)
Cylinder Bore	88,9 mm (3.5 in)
Cylinder Rod Diameter	45,7 mm (1.8 in)
Cylinder Stroke	254 mm (10 in)

Drill Air Control Cylinder (High-Pressure Option)

Specification	Measurement
Quantity	1
Type	Hydraulic cylinder
Cylinder Bore	63,5 mm (2.5 in)
Cylinder Rod Diameter	38,1 mm (1.5 in)
Cylinder Stroke	127 mm (5 in)

7.7 Power Pack

7.7.1 Engines

See Reference Documentation

See engine manufacturer manual for more information.

7.7.2 Cooling System

Specification	Measurement
Type	Side-by-side radiator, hydraulic oil/compressor oil cooler, engine radiator, and engine charge air cooler
Fans	Hydraulically-driven, 1 371,6 mm (54 in) diameter, 8-blade
Main Fan	Fixed displacement, axial piston motor, 131,1 cc/rev (8 in ³ /rev)
CAC Fan	Fixed displacement, gear driven motor, 11,5 cc/rev (0.7 in ³ /rev)
Rating	52 °C (125 °F) ambient at sea level

7.7.3 CAC Fan Motor

Specification	Measurement
Quantity	1
Type	Fixed displacement, gear driven motor
Displacement	11,5 cc/rev (0.7 in ³ /rev)
Speed Range	0 - 1,950 rpm

7.7.4 Air Compressor

Specification	Low Pressure	High Pressure
Type	Low pressure, single stage, oil flooded asymmetrical rotary screw	High pressure two-stage, over/under, oil flooded asymmetrical rotary screw
Volume	53,8 m ³ /min @ 7,6 bar (1,900 ft ³ /min @ 110 psi)	41,1 m ³ /min @ 24,1 bar (1,450 ft ³ /min @ 350 psi)
	73,6 m ³ /min @ 7,6 bar (2,600 ft ³ /min @ 110 psi)	
Bearing Type	Tapered roller bearing	
Air End Lubrication	Positive, gear oil pump	
Receiver Capacity	143,8 L (38 gal)	
Air Cleaners	Three 3-stage with one primary and one safety element	
Dirt Alarm Indicator	Electrical restriction indicators indicate when filters require service.	

Specification	Low Pressure	High Pressure
Operational RPM	1,800 rpm	
Power Source	Directly driven by diesel engine	

7.7.5 Cooling Fan Motor

Specification	Measurement
Quantity	1
Type	Variable displacement
Displacement	131,1 cc/rev (8.0 in ³ /rev)
Speed Range	0 - 1,200 rpm

7.7.6 Hydraulic Clutch Pump

Specification	Measurement
Quantity	1
Type	Gear pump, right rotation from end shaft
Displacement	27,9 cc/rev (1.7 in ³ /rev)
Output, Engine Speed at 1,980 rpm	54,9 L/min (14.5 gal/min)

7.8 Undercarriage and Propel System

7.8.1 Undercarriage and Propel

Specification	ACGT® 3400 EXT	Cat® 345
Construction	Excavator-style lower with 345-class rollers, sprockets, and tracks	Refer to the OEM manual
Total Length	6 517,6 mm (256.6 in)	
Ground Contact	5 511,8 mm (217 in)	
Mounting	Oscillating walking beam (5° each side; 10° total)	
Rated GVW	81 647 kg (180,000 lb)	
Take Up Adjustment	Grease slack adjustment, spring recoil	
Towing Release	Standard disengagement for towing	

Specification		ACGT® 3400 EXT	Cat® 345
Final Drive Ratio		148:1	
Propel Speed		0 - 1,6 km/hr (0 - 1.0 mph)	
Brake		Plate type, spring applied, hydraulically released	
Parking Brake Static Capacity		800 Nm (590 ft-lb)	
Rollers	Top	3 per side, with sealed for life bearings	
	Bottom	13 per side, with sealed for life bearings	
	Location	Equally spaced between idler and sprocket	
Propel Motors	Type	Hydraulic, axial piston	
	Motor Displacement	0,16 L/rev (9.79 in³/rev)	
	Input hp Rating	126,8 kW (170 hp)	
	Motor Ground Clearance	442 mm (19.4 in)	
	Drive	Hydrostatic, closed loop motor drive, through speed reducer to drive sprocket	
Track Pads	Width	899 mm (35.4 in)	
	Type	Triple bar grouser	
	Ground pressure	0,9 bar (13 psi)	

7.8.2 Propel Motor

ACGT® Propel Motor

Specification	Measurement
Quantity	2
Type	Hydraulic, fixed displacement, axial piston
Displacement	160,6 cc/rev (9.8 in³/rev)
Propel Speed	0 - 1,6 km/hr (0 - 1.0 mph)



NOTE: For Cat® propel motor, refer to the OEM manual.

7.9 Main Frame and Platform

7.9.1 Main Frame

Specification	Measurement
Construction	607 mm (24 in) X 241 kg/m (162 lb/ft) wide flange structural steel I-beam

