JT20

Operator's Manual

CE

Issue 3.0

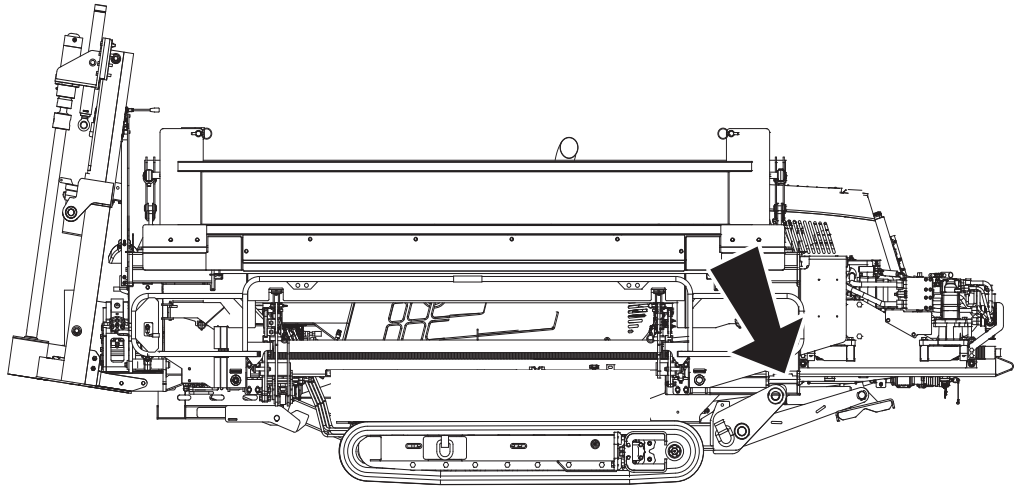
053-2633

Overview

Chapter Contents

Serial Number Location

Record serial numbers and date of purchase in spaces provided. Drilling unit serial number is located as shown.



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Item	
date of manufacture	
date of purchase	
drilling unit serial number	
trailer serial number	
engine serial number	

Intended Use

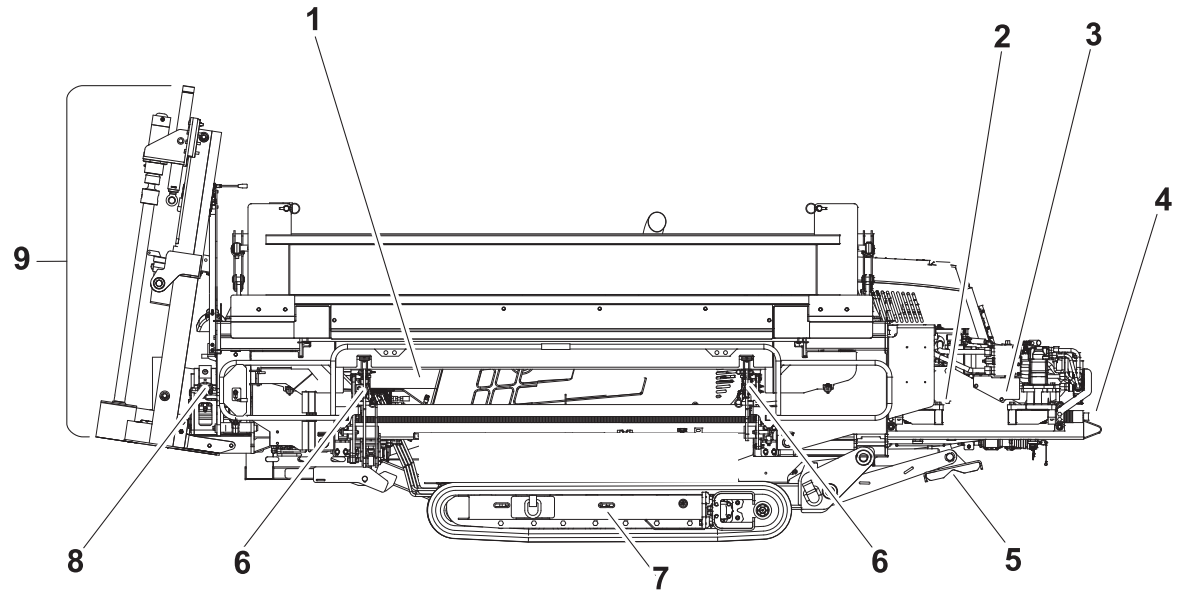
The JT20 is a self-contained horizontal directional drilling unit designed to install buried cable and pipe at distances to 400' (122 m) depending on soil conditions and is intended for operation in ambient temperatures from 0° to 115°F (-18° to 46°C). Use in any other way is considered contrary to the intended use.

The JT20 can be used with Ditch Witch® drilling fluid units and Subsite® Electronics locating equipment. It should be operated, serviced, and repaired only by persons familiar with its particular characteristics and acquainted with the relevant safety procedures.

Equipment Modification

This equipment was designed and built in accordance with applicable standards and regulations. Modification of equipment could mean that it will no longer meet regulations and may not function properly or in accordance with the operating instructions. Modification of equipment should only be made by competent personnel possessing knowledge of applicable standards, regulations, equipment design functionality/requirements and any required specialized testing.

Unit Components



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1. Operator's station
2. Spindle
3. Carriage
4. Drill frame
5. Stabilizer
6. Pipeloader
7. Tracks
8. Vise wrenches
9. Anchoring system

FCC Statement - Internal Transmitter

U.S.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by **The Charles Machine Works, Inc.** could void the user's authority to operate the equipment.

Canada

This device complies with Industry Canada *license-exempt* RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

N 16819

RF Exposure Statement

In order to comply with RF exposure requirements during normal operation, this device must be held in front of the body horizontally. The antenna must be vertical in line with the body with at least 4" (100 mm) separation distance from the body.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures"{

Reorient or relocate the receiving antenna.

Increase the separation between the equipment and the receiver.

Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

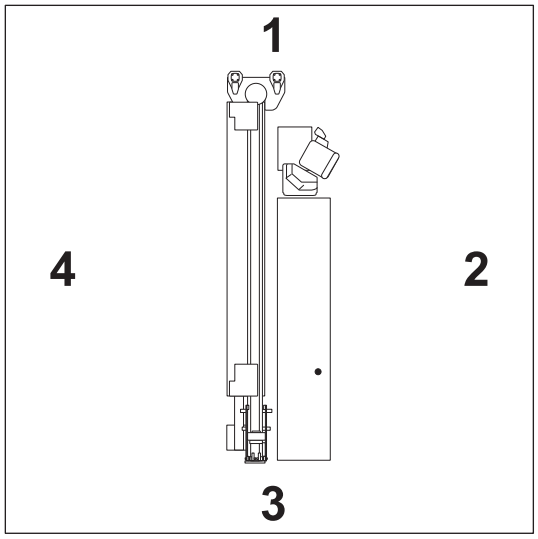
Consult the dealer or an experienced radio/TV technician for help.

This device complies with Health Canada's Safety Code. The installer of this device should ensure that RF radiation is not emitted in http://hc-sc.qc.ca/ewh-sem/pub/radiation/radio_guide-lignes_direct-eng.php

Operator Orientation

IMPORTANT: Top view of unit is shown.

1. Front of unit
2. Right side of unit
3. Rear of unit
4. Left side of unit



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About This Manual

This manual contains information for the proper use of this machine. See the beige **Operation Overview** pages for basic operating procedures. Cross references such as "See page 50" will direct you to detailed procedures.

Bulleted Lists

Bulleted lists provide helpful or important information or contain procedures that do not have to be performed in a specific order.

Numbered Lists

Numbered lists contain illustration callouts or list steps that must be performed in order.

Foreword

This manual is an important part of your equipment. It provides safety information and operation instructions to help you use and maintain your Ditch Witch® equipment.

Read this manual before using your equipment. Keep it with the equipment at all times for future reference. If you sell your equipment, be sure to give this manual to the new owner.

If you need a replacement copy, contact your Ditch Witch dealer. If you need assistance in locating a dealer, visit our website at **www.ditchwitch.com** or write to the following address:

The Charles Machine Works, Inc.
Attn: Marketing Department
PO Box 66
Perry, OK 73077-0066
USA

The descriptions and specifications in this manual are subject to change without notice. The Charles Machine Works, Inc. reserves the right to improve equipment. Some product improvements may have taken place after this manual was published. For the latest information on Ditch Witch equipment, see your Ditch Witch dealer.

Thank you for buying and using Ditch Witch equipment.

JT20
Operator's Manual

Issue number 3.0/OM-4/16
Part number 053-2633

Contents

Operation Overview

Chapter Contents

Planning

1. Gather information about jobsite. See page 61.
2. Inspect jobsite. See page 62.
3. Classify jobsite. See page 64.
4. Plan bore path. See page 67.
5. Check supplies and prepare equipment. See page 76.
6. Load equipment. See page 84.

Setting Up at Jobsite

1. Prepare jobsite. See page 75.
2. Unload drilling unit from trailer. See page 87.
3. Assemble drill string. See page 97.
4. Position drilling unit and drill frame. See page 93.
5. Assemble strike system. See page 117.
6. Anchor drilling unit. See page 115.
7. Connect fluid system. See page 93.
8. Calibrate tracker with beacon that will be installed in beacon housing. See tracker operator's manual.

Drilling

1. Start system. See page 94.
2. Engage DrillLok™/tracker control if desired. See page 127.
3. Drill first pipe. See page 99.
4. Record bore path. See page 106.
5. Enable automated pipeloader system. See page 99.
6. Add pipe. See page 100.
7. Drill remaining pipes in pipe box.
   - Correct direction. See page 102.
   - Engage cruise control. See page 147.
   - Shift pipe box. See page 139.
8. Add up to a single column of drill pipe to empty box (see page 139) to complete bore.
9. Surface drill head. See page 106.

Backreaming

1. Assemble backream string. See page 108.
2. Start drilling unit and adjust throttle.See page 80.
3. Set drilling fluid flow. Check that fluid flows through all nozzles. See page 123.
4. Remove pipe from bore. See page 109.
5. Remove up to a single column of drill pipe from full box (see page 130) to complete backream.
6. Remove pullback device. See page 111.

Backreaming Tips

- Plan backreaming job before drilling. Plan bore path as straight as possible. Check bend limits of pullback material. Check that appropriate pullback devices are on hand.
- Keep all bends as gradual as possible.
- Drilling fluid quality is a key factor in backreaming success. Contact your Ditch Witch® dealer for information on testing water, selecting additives, and mixing drilling fluid.
- Backreaming requires more fluid than drilling. Make sure enough fluid is used.

Leaving Jobsite

1. Remove downhole tools. See page 111.
2. Remove anchors. See page 115.
3. Rinse unit and downhole tools. See page 158.
4. Disassemble strike system and disconnect from fluid system. See page 158.
5. Stow tools. See page 158.
6. Load unit onto trailer. See page 84.

Storing Equipment

1. For cold weather storage, antifreeze drilling unit. See page 156.
2. For long-term storage, disconnect battery disconnect switch.

Safety

Chapter Contents

Guidelines

Follow these guidelines before operating any jobsite equipment:

- Complete proper training and read operator's manual before using equipment.
- Mark proposed path with white paint and have underground utilities located before working. In the US or Canada, call 811 (US) or 888-258-0808 (US and Canada). Also contact any local utilities that do not participate in the One-Call service. In countries that do not have a One-Call service, contact all local utility companies to have underground utilities located.
- Classify jobsite based on its hazards and use correct tools and machinery, safety equipment, and work methods for jobsite.
- Mark jobsite clearly and keep spectators away.
- Wear personal protective equipment.
- Review jobsite hazards, safety and emergency procedures, and individual responsibilities with all personnel before work begins. Safety videos are available from your Ditch Witch® dealer or at www.ditchwitch.com/safe.
- Fully inspect equipment before operating. Repair or replace any worn or damaged parts. Replace missing or damaged safety shields and safety signs. Contact your Ditch Witch dealer for assistance.
- Use equipment carefully. Stop operation and investigate anything that does not look or feel right.
- Do not operate unit where flammable gas may be present.
- Only operate equipment in well-ventilated areas.
- Contact your Ditch Witch dealer if you have any question about operation, maintenance, or equipment use.
- Complete the equipment checklist located at www.ditchwitch.com/safe.

California Proposition 65 Warning

This product may contain chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

- battery posts, terminals and related accessories
- engine exhaust
- ethylene glycol

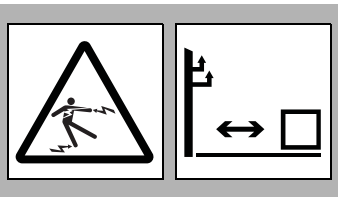
Emergency Procedures

WARNING Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.

Before operating any equipment, review emergency procedures and check that all safety precautions have been taken.

EMERGENCY SHUTDOWN - Turn ignition switch to stop position or push remote engine stop button (if equipped).

Electric Strike Description



DANGER Electric shock. Contacting electric lines will cause death or serious injury. Know location of lines and stay away.

When working near electric cables, remember the following:

- Electricity follows all paths to ground, not just path of least resistance.
- Pipes, hoses, and cables will conduct electricity back to all equipment.
- Low voltage current can injure or kill. Many work-related electrocutions result from contact with less than 440 volts.

Most electric strikes are not noticeable, but indications of a strike include:

- power outage
- smoke
- explosion
- popping noises
- arcing electricity

If any of these occur, or if strike alarm sounds or flashes, assume an electric strike has occurred.

If an Electric Line is Damaged

If you suspect an electric line has been damaged and you are **on drilling unit or bonded equipment**, DO NOT MOVE. Remain on drilling machine and take the following actions. The order and degree of action will depend on the situation.

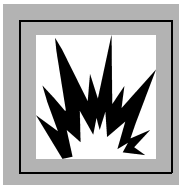
- Warn people nearby that an electric strike has occurred.
- Have someone contact electric company.
- Reverse drilling direction and try to break contact. Do not touch drill pipe with hands or hand-held tools.
- Press electric strike system self test button.
    - If alarm sounds again, stay where you are and wait for electric company to shut off power.
    - If alarm does not sound and there is no other indication of a strike, wait at least one full minute before moving away from equipment. Utility might use automatic reclosers which will restart current flow. If alarm sounds again while waiting, stay where you are until electric company shuts off power.
    - If alarm does not sound but all lights in strike indicator are on, assume strike is continuing and stay where you are until electric company shuts off power.
- Do not resume drilling or allow anyone into area until given permission by electric company.

If you suspect an electric line has been damaged and you are **off drilling unit or bonded equipment**, DO NOT TOUCH ANY EQUIPMENT connected to drilling unit. Take the following actions. The order and degree of action will depend on the situation.

- Stay where you are unless you are wearing electric insulating boots. If you leave, do not return to area or allow anyone into area until given permission by electric company.

If a Gas Line is Damaged


WARNING Fire or explosion possible. Fumes could ignite and cause burns. No smoking, no flame, no spark. 275-419 (2P)



WARNING Explosion possible. Serious injury or equipment damage could occur. Follow directions carefully.

If you suspect a gas line has been damaged, take the following actions. The orders and degree of action will depend on the situation.

- Immediately shut off engine(s), if this can be done safely and quickly.
- Remove any ignition source(s), if this can be done safely and quickly.
- Warn others that a gas line has been cut and that they should leave the area.
- Leave jobsite as quickly as possibSSle.
- Immediately call your local emergency phone number and utility company.
- If jobsite is along street, stop traffic from driving near jobsite.
- Do not return to jobsite until given permission by emergency personnel and utility company.

If a Fiber Optic Cable is Damaged

Do not look into cut ends of fiber optic or unidentified cable. Vision damage can occur. Contact utility company.

If Machine Catches on Fire

Perform emergency shutdown procedure and then take the following actions. The order and degree of action will depend on the situation.

- Immediately move battery disconnect switch (if equipped and accessible) to disconnect position.
- If fire is small and fire extinguisher is available, attempt to extinguish fire.
- If fire cannot be extinguished, leave area as quickly as possible and contact emergency personnel.

Safety Alert Classifications

These classifications and the icons defined on the following pages work together to alert you to situations which could be harmful to you, jobsite bystanders or your equipment. When you see these words and icons in the book or on the machine, carefully read and follow all instructions. YOUR SAFETY IS AT STAKE.

Watch for the three safety alert levels: **DANGER**, **WARNING** and **CAUTION**. Learn what each level means.

DANGER indicates a hazardous situation that, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.

WARNING indicates a hazardous situation that, if not avoided, could result in death or serious injury.

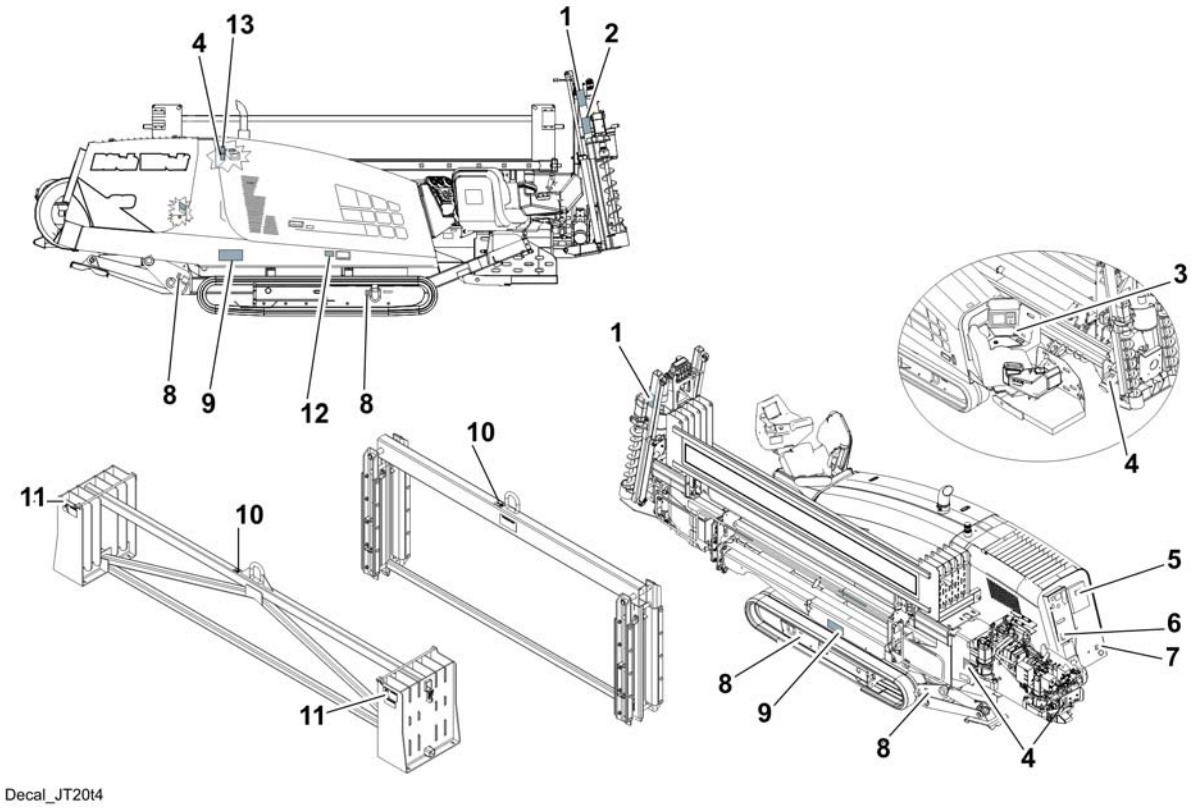
CAUTION indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

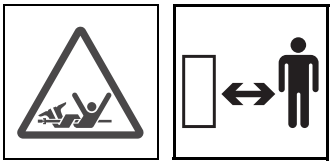
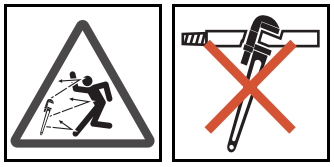
Watch for two other words: ***NOTICE*** and **IMPORTANT**.

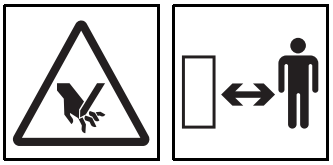
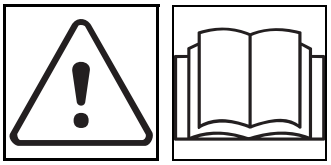
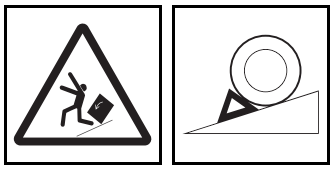
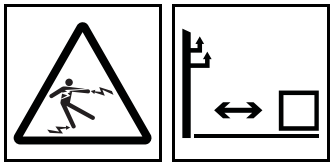
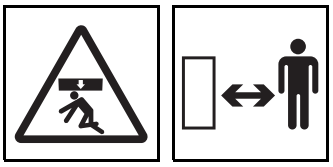
NOTICE indicates information considered important, but not hazard-related (e.g., messages relating to property damage).

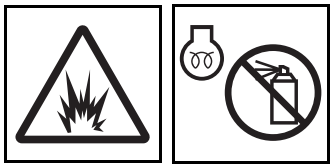
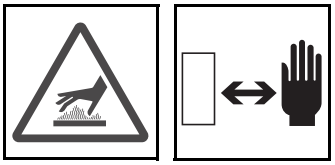
IMPORTANT can help you do a better job or make your job easier in some way.

Machine Safety Alerts



1		**DANGER** Rotating shaft will cause death or serious injury. Stay away. 270-1506, 275-197
2		**DANGER** Moving tools will kill or injure. Never use pipe wrenches on drill string. 273-278
3		**WARNING** Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment. 274-050; 274-724 (2P)

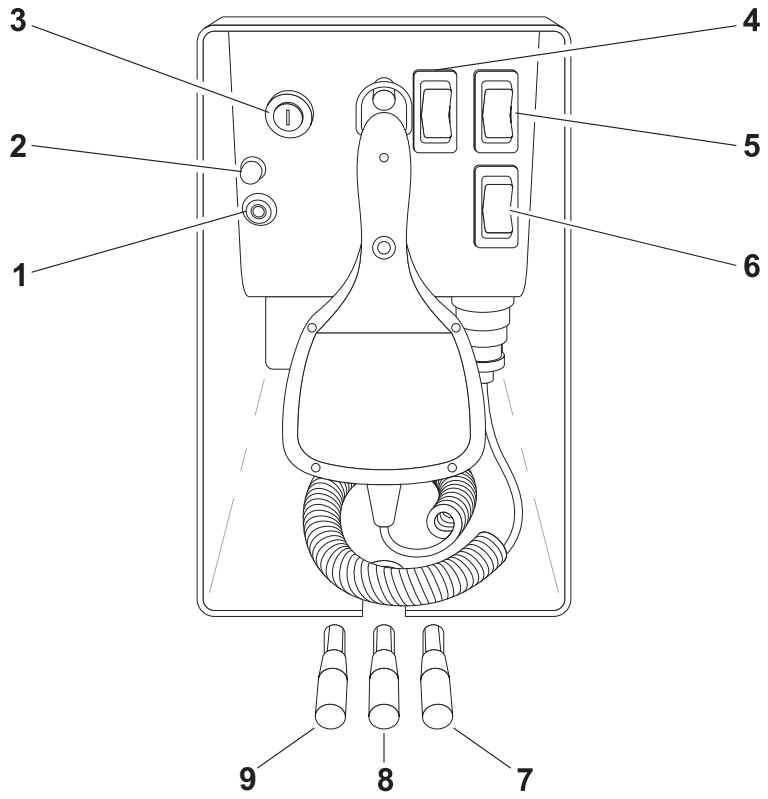
4		**WARNING** Moving parts could cut off hand or foot. Stay away. 275-184, 273-546
5		**WARNING** Read operator's manual. Follow safety rules and know how to use all controls. Your safety is at stake. 273-475
6		**WARNING** Do not park machine on slope unless chocked or blocked. 275-383
7		**WARNING** Pressurized fluid or air could pierce skin and cause severe injury. Refer to operator's manual for proper use. 270-6035
8		Tiedown location. See Transport chapter for more information.
9		**DANGER** Electric shock will cause death or serious injury. Stay away. 274-049
10		Lift point. See Transport chapter for more information. 274-442
11		**WARNING** Crushing weight could cause death or serious injury. Stay away. 275-326, 701-326

12		**WARNING** Fire or explosion possible. Do not use starter fluid. 273-459 (2P), 274-206 (2P), 700-206 (2P)
13		**CAUTION** Hot parts may cause burns. Do not touch until cool or wear gloves. 275-355 (2-P), 273-423 (2-P)

Controls

Chapter Contents

Set-Up Console



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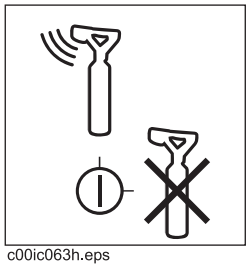
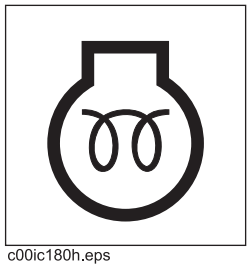
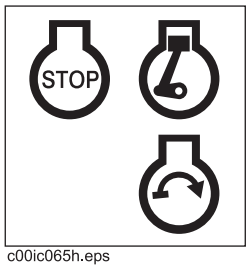
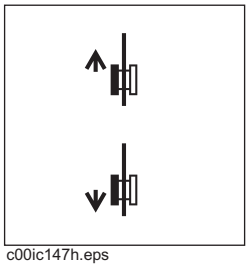
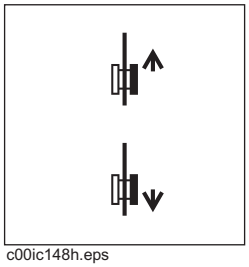
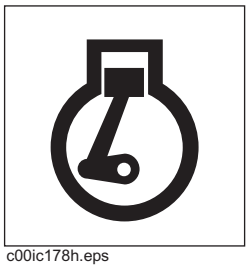
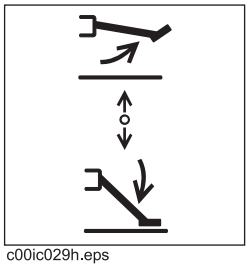
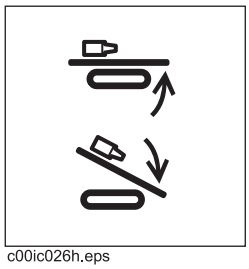
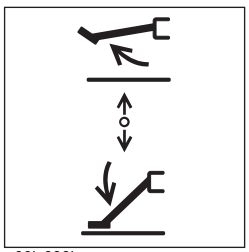
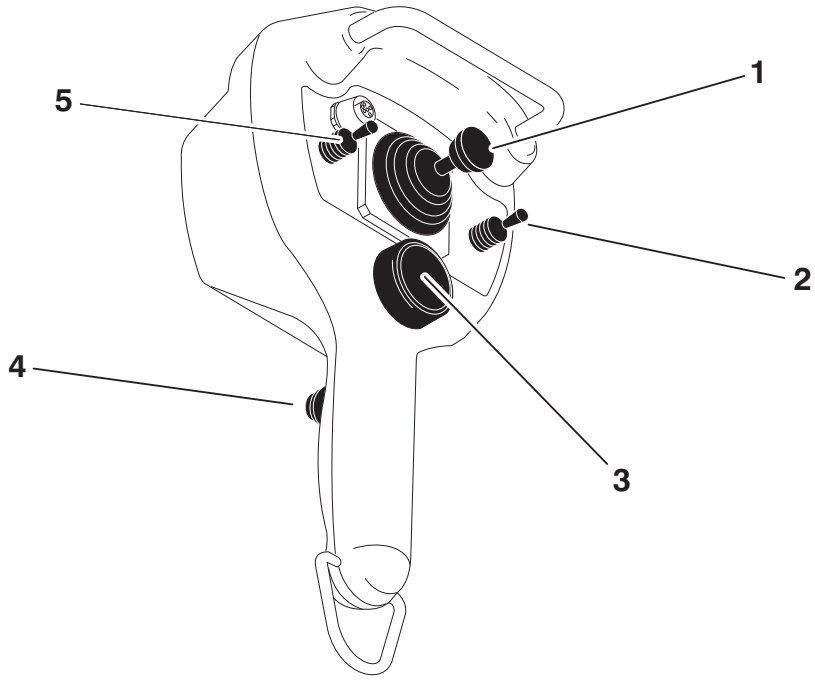
1. DrillLok™/tracker control key
2. Cold start wait indicator
3. Ignition switch
4. Left track switch
5. Right track switch
6. Engine shutdown override switch
7. Right stabilizer control
8. Frame tilt control
9. Left stabilizer control

Item	Description	Notes
1. DrillLok™/tracker control key  c00ic063h.eps	To allow tracker operator to stop thrust and rotation, move key to enable position (up). To override DrillLok/tracker control mode, move key to disable position (right).	Remove key and keep in tracker operator's possession.
2. Cold start wait indicator  c00ic180h.eps	Lights when intake air pre-heater is operating. Wait until light goes off before starting engine.	
3. Ignition switch  c00ic065h.eps	To start engine, insert key and turn clockwise. To stop engine, turn key counterclockwise.	Restart engine with ignition switch after it has been turned off with remote engine stop switch. If wrenches are engaged when engine is stopped with ignition switch, wrenches will release and then engage when unit is started.
4. Left track switch  c00ic147h.eps	To move forward, press top. To move backward, press bottom.	Use track switches only if tethered control is inoperable.

Item	Description	Notes
5. Right track switch  c00ic148h.eps	To move forward, press top. To move backward, press bottom.	Use track switches only if tethered control is inoperable.
6. Engine shutdown override switch  c00ic178h.eps	If engine shutdown indicator comes on, press to delay engine shutdown for 30 seconds.	This control allows a temporary override of engine shutdown. ***NOTICE:*** After 30 seconds, engine will again shut down unless fault condition has been cleared on diagnostic gauge. See "Electronic Controlled Engine Overview" on page 149.
7. Right stabilizer control  c00ic029h.eps	To raise, pull up. To lower, push down.	Lower left and right stabilizers to the ground to stabilize unit and then adjust for side-to-side stability. After unit is level, adjust for entry angle.
8. Frame tilt control  c00ic026h.eps	To raise front end of drill frame, pull up. To lower front end of drill frame, push down.	
9. Left stabilizer control  c00ic030h.eps	To raise, pull up. To lower, push down.	Lower left and right stabilizers to the ground to stabilize unit and then adjust for side-to-side stability. After unit is level, adjust for entry angle.

Tethered Ground Drive Controller



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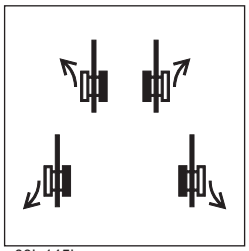
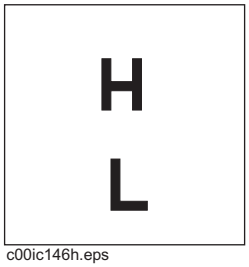
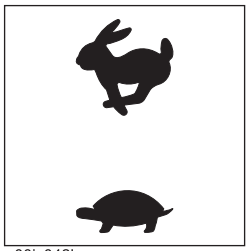
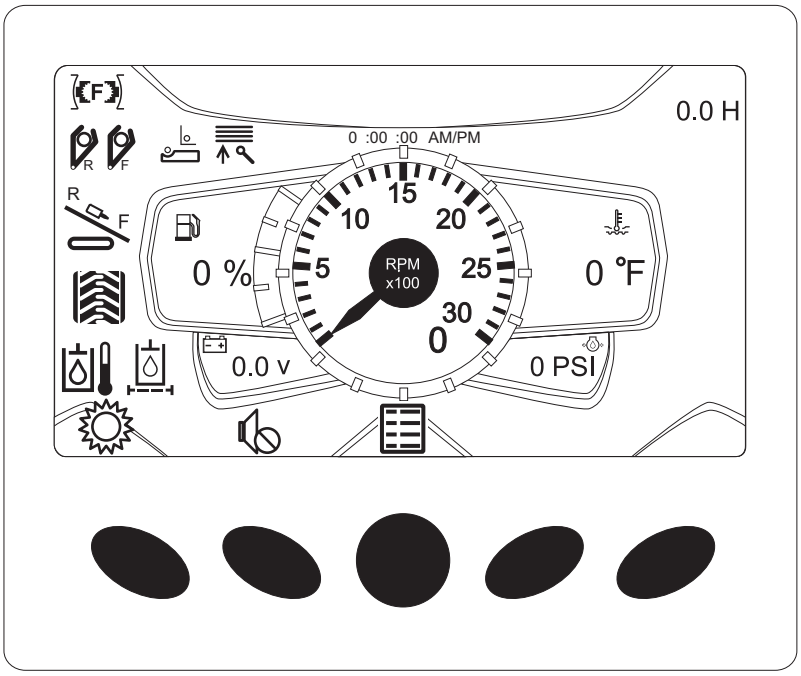
1. Speed/direction control
2. Power mode switch
3. Remote engine stop
4. Operator presence switch
5. Throttle switch

Item	Description	Notes
1. Speed/direction control  c00ic145h.eps	To move forward, push. To move backward, pull. To steer, move left or right.	Operator presence switch must be pressed and operator seat must be empty for control to work.

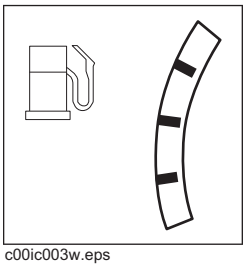
Item	Description	Notes
2. Power mode switch  c00ic146h.eps	To select normal driving mode (high), push. To select loading and unloading mode (low), pull. To disable ground drive, return to center.	
3. Remote engine stop	To stop engine, press red button.	To restart engine, turn ignition switch off and then back on.
4. Operator presence switch	To operate ground drive with tethered controller, press. To disable controller, release.	
5. Throttle switch  c00ic042h.eps	To increase engine speed, push. To decrease engine speed, pull.	Throttle switch at operator's station must be in center position for this switch to control speed.

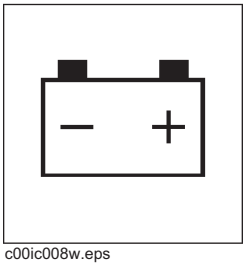
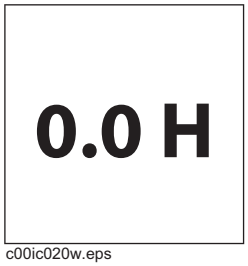
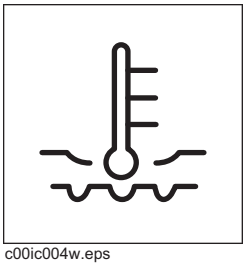
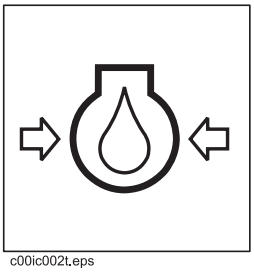
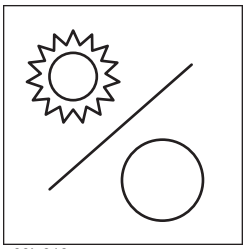
Left Control Console

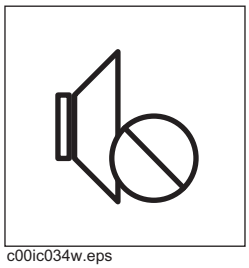
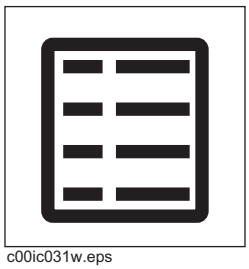
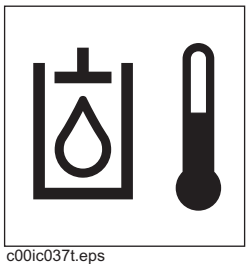
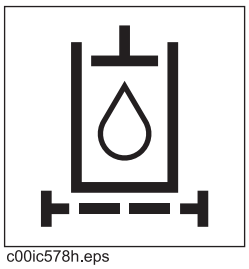
Engine Display

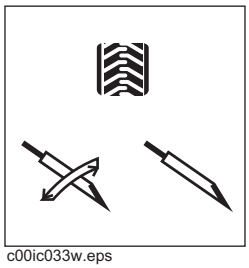
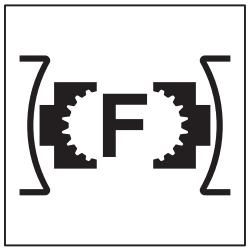
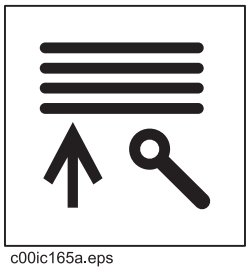
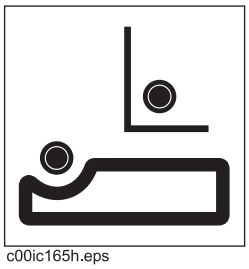


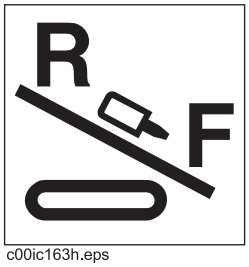
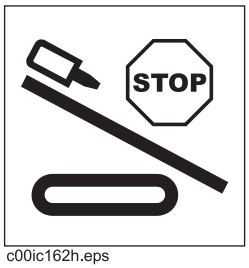
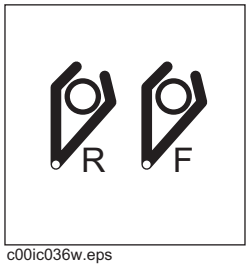
j38om048w.eps

Item	Description	Notes
Tachometer	Displays engine speed.	
Fuel gauge  c00ic003w.eps	Displays amount of fuel remaining in tank.	See "Approved Fuel" on page 164.

Item	Description	Notes
Voltmeter display  c00ic008w.eps	Shows system voltage.	Normal voltage is 13-14V with engine running.
Hour meter  c00ic020w.eps	Displays number of hours engine has been running.	
Engine temperature indicator  c00ic004w.eps	Lights when engine coolant temperature is too high.	Normal coolant temperature is 160-230°F (71-110°C).
Engine oil pressure gauge  c00ic002t.eps	Lights when engine oil pressure is too low.	
Day/Night mode key  c00ic010w.eps	Press from main screen (gauges) to toggle between day and night modes.	Use soft key directly below icon to toggle between day and night mode.

Item	Description	Notes
Sound indicator  c00ic034w.eps	Indicates if notification alert sound is off or on.	Use soft key directly below icon to toggle sound on or off.
Main menu icon  c00ic031w.eps	Use soft key directly below icon to access main menu.	
Hydraulic fluid temperature  c00ic037t.eps	Lights when hydraulic fluid temperature is too high.	
Hydraulic fluid filter indicator  c00ic578h.eps	Lights when hydraulic filter is restricted.	

Item	Description	Notes
Drill / Drive / Carve mode indicator  c00ic033w.eps	Shows if unit is set to drill mode, drive mode, or carve mode.	
Front wrench status indicator  c00ic164a.eps	If front wrench is closed, light should be on. If front wrench is open, light should be off.	
Pipe lift status indicator  c00ic165a.eps	If pipe lifter is lifted fully and lift pressure switch is engaged, light should be on. If pipe lift pressure switch is not engaged, light should be off.	
Shuttle home status indicator  c00ic165h.eps	If shuttle is retracted, light should be on. If shuttle is not completely retracted, light should be off.	

Item	Description	Notes
Carriage home status indicator  c00ic163h.eps	If carriage is in the home zone at either end of drill frame, light should be on. If carriage is between the home zones at either end of drill frame, light should be off.	
Rear stop status indicator  c00ic162h.eps	If carriage is at very back of drill frame, light should be on. If carriage is away from very back of drill frame, light should be off.	
Pipe box status indicator  c00ic036w.eps	If active pipe column contains pipe, light should be on. If active pipe column does not contain pipe, light should be off.	Check pipe box status lights to see when active column of pipe box is empty. See "Shift Pipe Box" on page 139. One light on and one light off indicates a jammed pipe. See "Correct Misaligned or Jammed Pipe" on page 140.

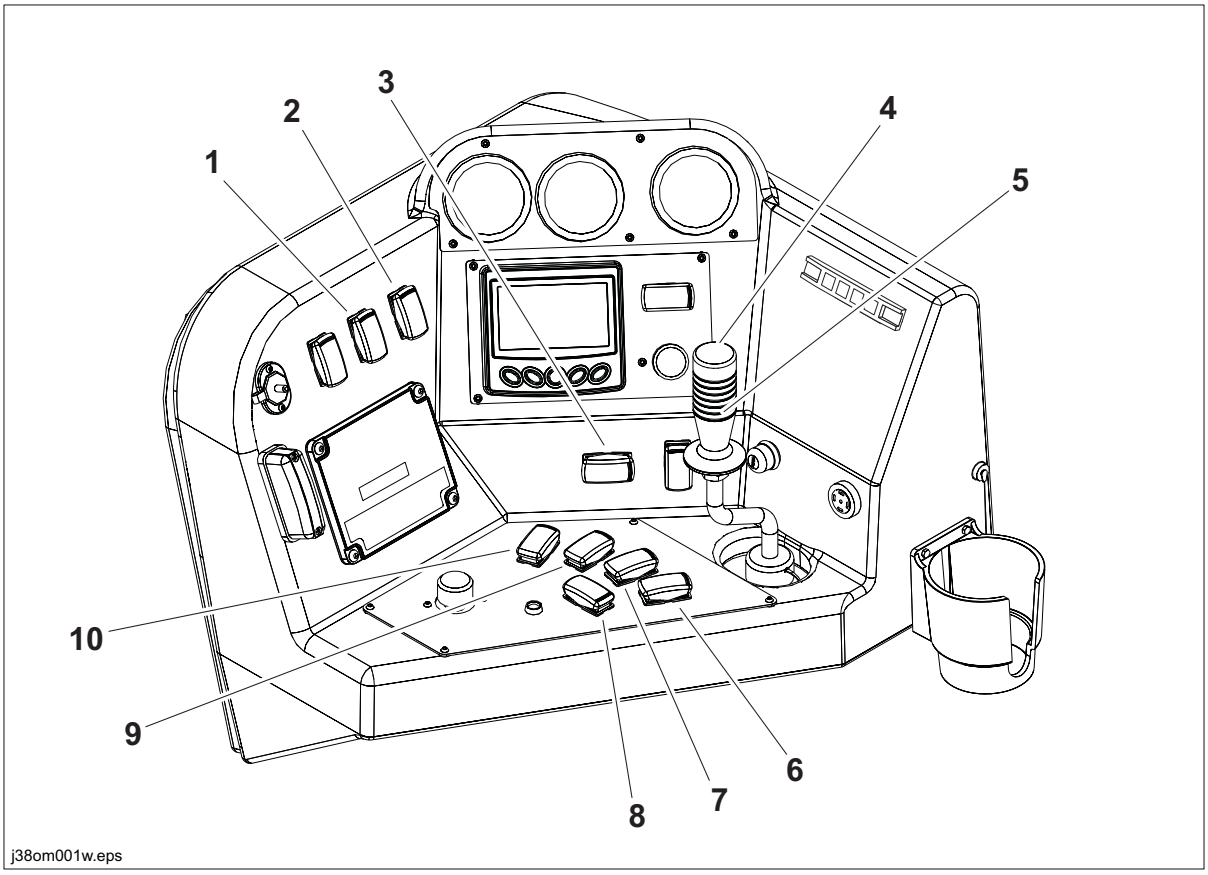
Most engine display functions are self-explanatory. For more information about functions, see the manufacturer's instructions at www.fwmurphy.com.

Engine Display Main Menu

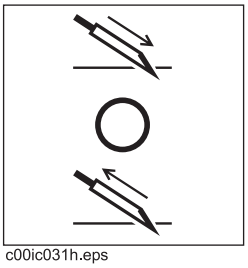
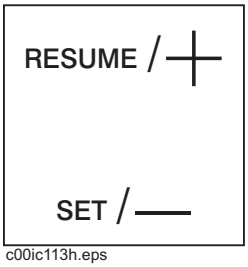
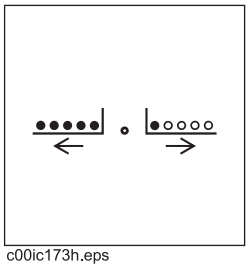
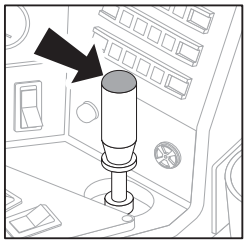
IMPORTANT: Soft key commands change with each menu screen and are displayed next to the key.

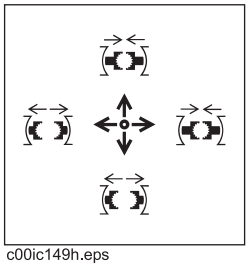
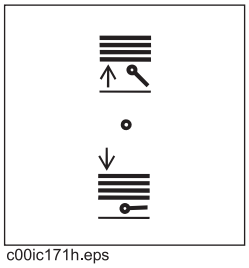
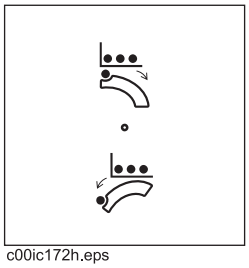
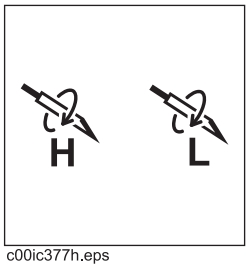
Item	Description	Notes
System settings key	Press to select system settings menu.	System settings menu displays information about the system. Diagnostic information is only available to dealer technicians.
User settings key	Press to select user settings menu.	User settings menu allows user to change the language and unit settings, and to set the time and date.
Main screen key	Press to return to main screen (gauges).	
Engine diagnostics key	Press to select engine diagnostics menu.	For dealer technician use only.

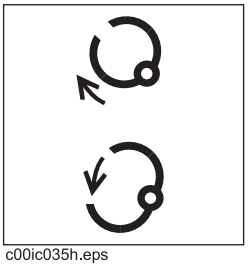
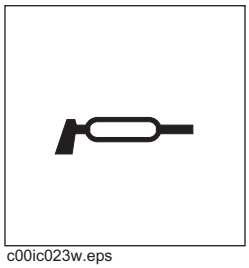
Pipeloading Controls



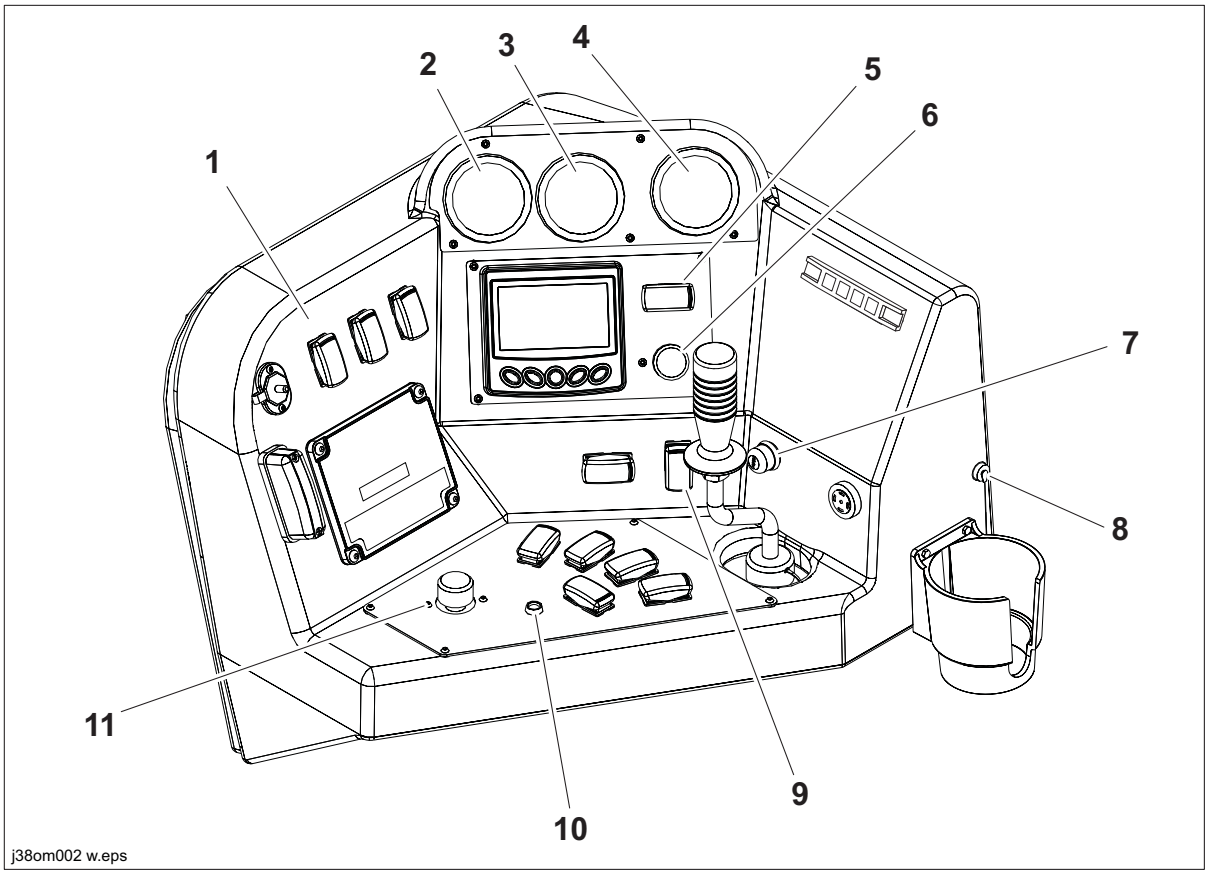
1. Add pipe/manual/remove pipe switch
2. Set/Resume switch
3. Pipe box switch
4. Resume switch
5. Wrench control
6. Pipe lift switch
7. Pipe shuttle switch
8. Two-speed rotation switch
9. Pipe gripper switch
10. Pipe lubricator switch

Item	Description	Notes
1. Add pipe/manual/ remove pipe switch  c00ic031h.eps	To select "add pipe" automated pipeloader function, press top. To use manual pipeloader controls, move to center. To select "remove pipe" automated pipeloader function, press bottom.	See "Add Pipe" on page 100. See "Remove Pipe" on page 109.
2. Set/Resume switch  c00ic113h.eps	To resume operation or increase operation levels, press top. To set operating conditions or reduce operation levels, press bottom.	See "Cruise Control" on page 147.
3. Pipe box switch  c00ic173h.eps	To shift pipe box toward operator, press left side. To shift pipe box away from operator, press right side.	See "Shift Pipe Box" on page 139.
4. Resume switch  c00ic171a.eps	To resume operation, press.	See "Add Pipe" on page 100.

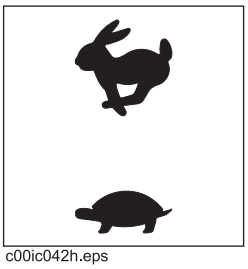
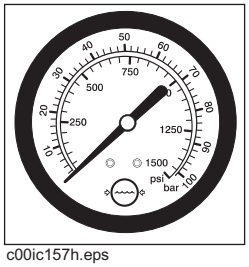
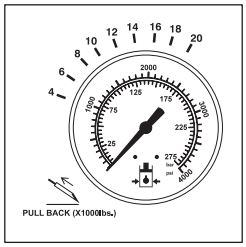
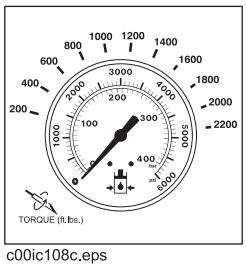
Item	Description	Notes
5. Wrench control  c00ic149h.eps	To clamp front wrench, move to right. To unclamp front wrench, move to left. To clamp and rotate rear (rotating) wrench, push. To unclamp rear (rotating) wrench, pull.	
6. Pipe lift switch  c00ic171h.eps	To raise, press top. To lower, press bottom.	
7. Pipe shuttle switch  c00ic172h.eps	To move toward pipe box, press top. To move toward spindle, press bottom.	
8. Two-speed rotation switch  c00ic377h.eps	To rotate at low speed, high torque, press right. To rotate at high speed, low torque, press left.	

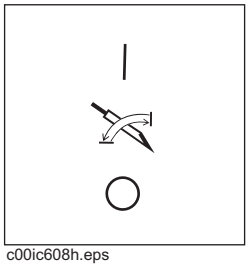
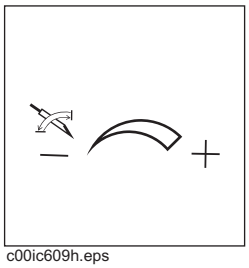
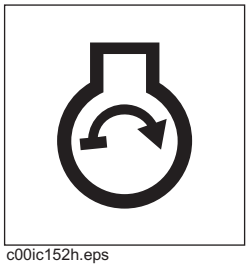
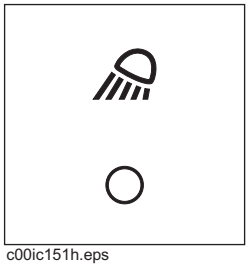
Item	Description	Notes
9. Pipe gripper switch  c00ic035h.eps	To close, press top. To open, press bottom.	
10. Pipe lubricator switch  c00ic023w.eps	To apply joint compound to threads, press forward.	

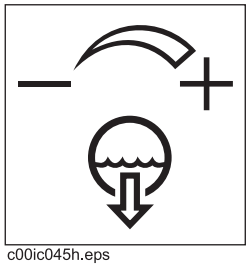
Drilling/Operation Controls



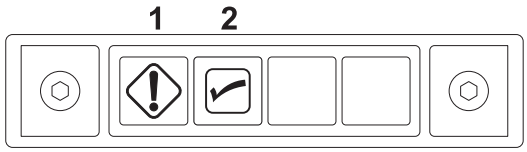
1. Engine throttle switch
2. Drilling fluid pressure gauge
3. Thrust pressure gauge
4. Rotation pressure gauge
5. AutoCarve switch
6. Carve window control
7. Remote engine start switch
8. EDT diagnostic port
9. Console/Work light switch
10. Fluid pump indicator
11. Fluid flow control

Item	Description	Notes
1. Engine throttle switch  c00ic042h.eps	To increase speed, press top. Return switch to center when desired speed is reached. To enable autothrottle mode, press top and leave switch in top position. To decrease speed, press bottom. To disable autothrottle mode, return switch to center after desired speed is reached.	Autothrottle mode slows the engine to low throttle after 15 seconds of inactivity involving thrust, rotation, drilling fluid flow, or pipeloader functions. To return to high speed, activate thrust, rotation, drilling fluid, or an add/remove cycle.
2. Drilling fluid pressure gauge  c00ic157h.eps	Displays drilling fluid pressure supplied by drilling fluid pump.	
3. Thrust pressure gauge  c00ic107c.eps	Displays hydraulic fluid pressure to thrust motor during thrust and pullback. Estimates thrust and pullback force on lines outside gauge.	
4. Rotation pressure gauge  c00ic108c.eps	Displays hydraulic fluid pressure to rotation motor when spindle is turned clockwise. Estimates rotational torque on lines outside gauge.	

Item	Description	Notes
5. AutoCarve switch  c00ic608h.eps	To enable autocarve, press top. To deactivate autocarve, press bottom.	Two-speed thrust is not allowed in AutoCarve mode.
6. Carve window control  c00ic609h.eps	To increase carve window range, turn clockwise. To decrease carve window range, turn counterclockwise.	See "Use AutoCarve" on page 104.
7. Remote engine start switch  c00ic152h.eps	To start engine from operator's station, push button. Release when engine starts.	This button works only when key in set-up console is on, operator is in seat, and battery disconnect switch is closed.
8. EDT Diagnostic report	For use only by qualified technicians.	
9. Console/Work light switch  c00ic151h.eps	To turn on, press top. To turn off, press bottom.	
10. Fluid pump indicator	Lights when fluid pump is on.	

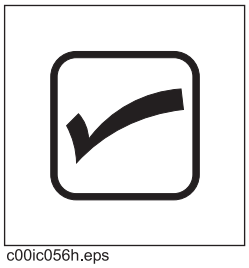
Item	Description	Notes
11. Fluid flow control  c00ic045h.eps	To increase flow, turn clockwise. To decrease flow, turn counterclockwise. To stop flow, turn all the way counterclockwise.	High speed delivers more flow at lower pressure. Low speed delivers less flow at higher pressure.

Unit Status Indicators

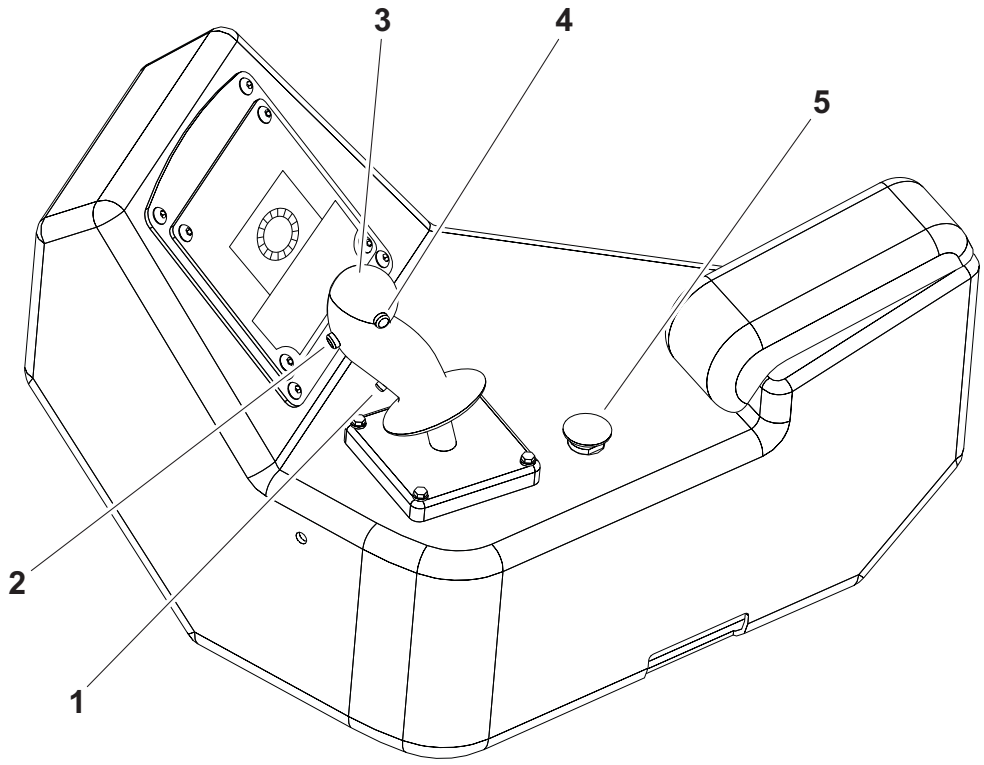


j38om003w.eps

1. Diagnostic light (red)
2. Control cycle light (green)

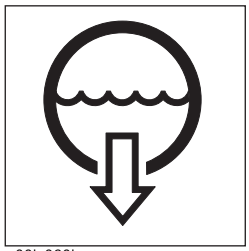
Item	Description	Notes
1. Diagnostic light (red)  c00ic051h.eps	Alerts operator that a diagnostic code has been triggered. If a non-essential diagnostic code is recorded, light flashes on and off for 10 seconds. If an essential diagnostic code is recorded, light flashes on for three seconds and off for half a second.	See "Diagnostic Codes" on page 149.
2. Control cycle light (green)  c00ic056h.eps	Lights when machine automation is controlling a cycle. If system is waiting for an action before starting cycle, light flashes on and off. If control cycle is interrupted, light should flash twice as fast.	

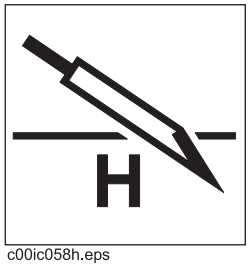
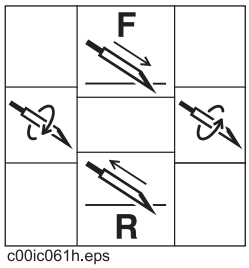
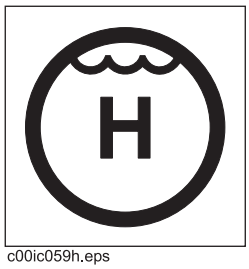
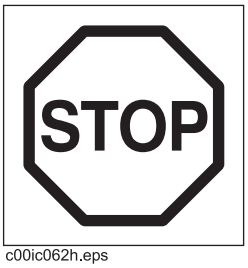
Right Control Console



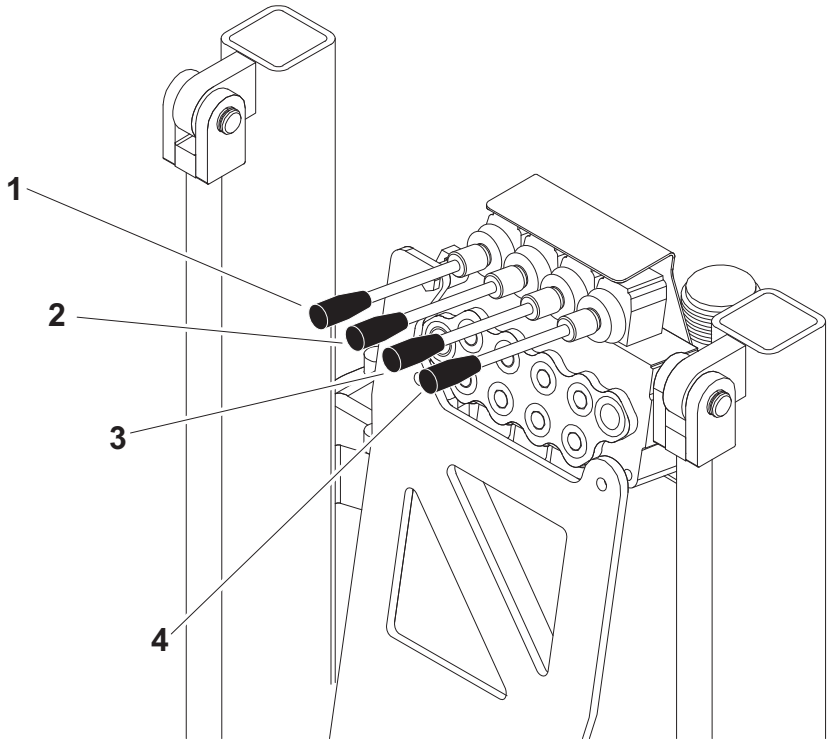
j38om004w.eps

1. Drilling fluid pump switch
2. Dual speed carriage control
3. Carriage control
4. Drilling fluid quick fill switch
5. Remote engine stop switch

Item	Description	Notes
1. Drilling fluid pump switch  c00ic060h.eps	To turn on, press once. To turn off, press once.	

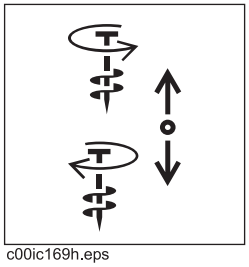
Item	Description	Notes
2. Dual speed carriage control  c00ic058h.eps	To engage high carriage travel speed, push and hold. To return to normal carriage speed, release. To override assisted makeup mode, push and hold.	Use during bore or pullback **when no pipe is in spindle** to save time. ***NOTICE:*** Overriding assisted makeup mode puts pipe threads in jeopardy. If frequent overriding is necessary, see your Ditch Witch® dealer for pipeloader adjustment.
3. Carriage control  c00ic061h.eps	To move carriage forward, push. To move carriage backward, pull. To rotate spindle counterclockwise (breakout), move right. To rotate spindle clockwise (makeup), move left.	
4. Drilling fluid quick fill switch  c00ic059h.eps	To override fluid control setting for full pump flow, press and hold. To return fluid flow to flow control setting, release.	
5. Remote engine stop switch  c00ic062h.eps	To stop engine, press. To restart engine, press remote engine start switch on console, or turn ignition off and then back to start.	If this switch is used to stop drilling unit, be sure to turn ignition switch off if machine will be left unattended for long periods of time. Battery discharge can occur. If wrenches are engaged when remote stop is pressed, wrenches will remain engaged but could gradually open.

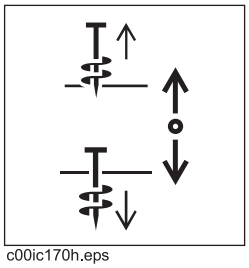
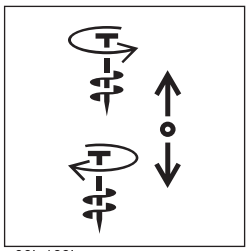
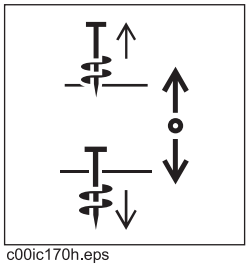
Anchoring System Console



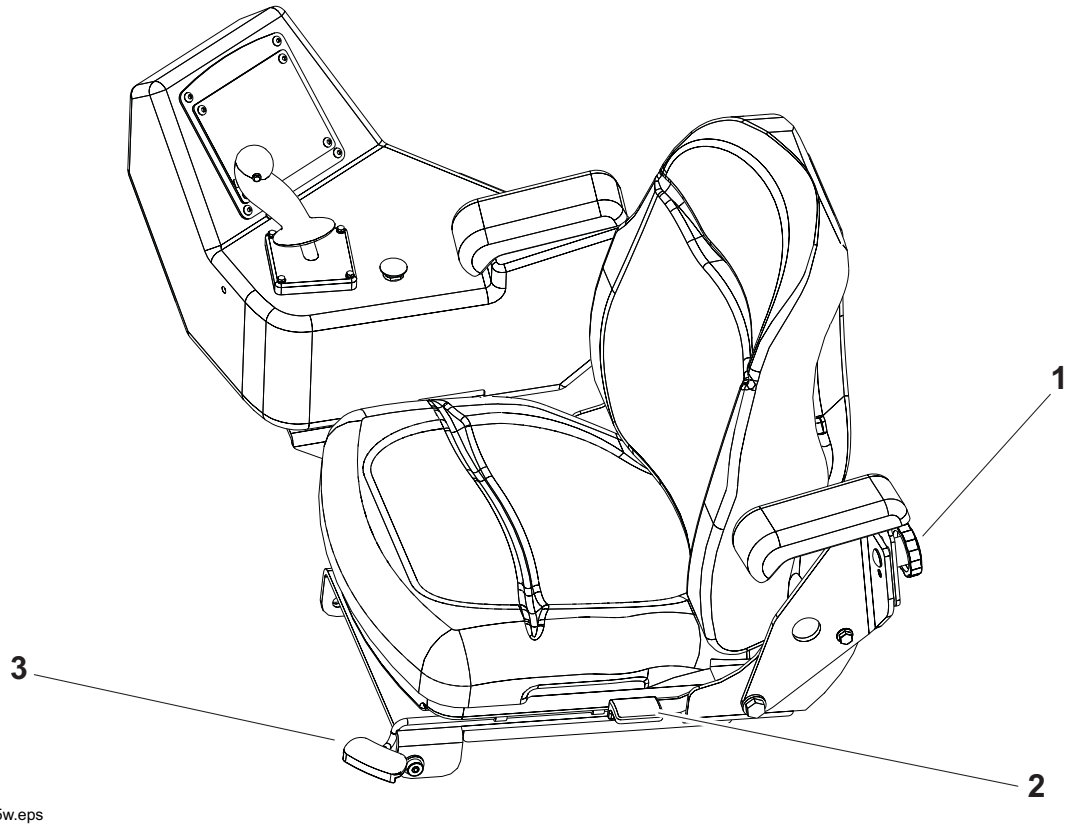
j10om015h.eps

1. Left rotation control
2. Left thrust control
3. Right rotation control
4. Right thrust control

Item	Description	Notes
1. Left rotation control  c00ic169h.eps	To drive anchor, push down. To remove anchor, pull up.	Stand on platform when operating anchor controls.

Item	Description	Notes
2. Left thrust control  c00ic170h.eps	To move anchor down, push down. To move anchor up, pull up.	Stand on platform when operating anchor controls.
3. Right rotation control  c00ic169h.eps	To drive anchor, push down. To remove anchor, pull up.	Stand on platform when operating anchor controls.
4. Right thrust control  c00ic170h.eps	To move anchor down, push down. To move anchor up, pull up.	Stand on platform when operating anchor controls.

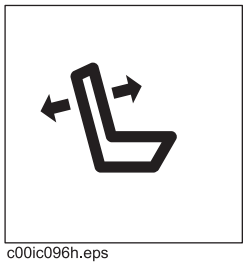
Seat/Armrest



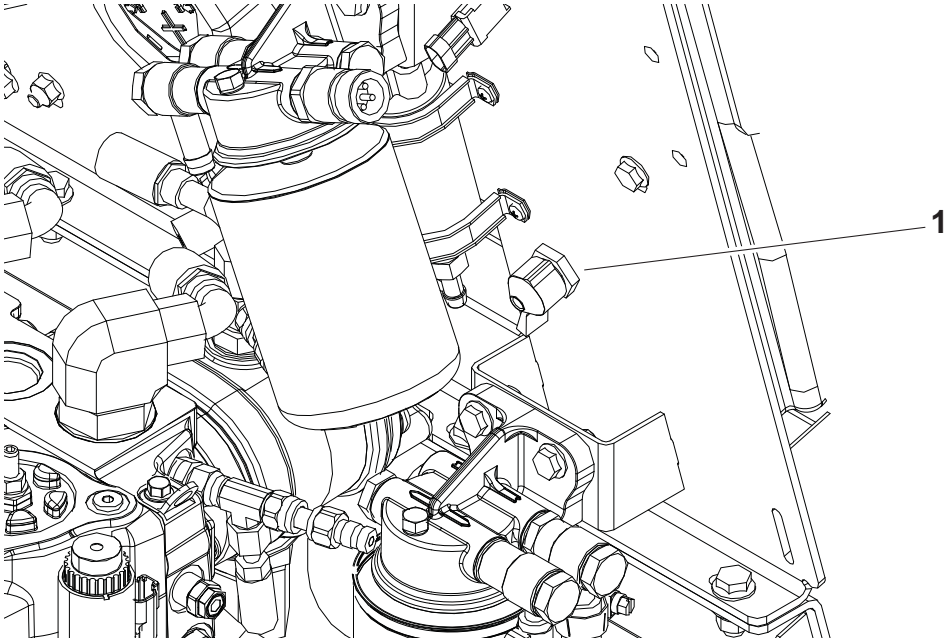
j38om005w.eps

1. Armrest adjustment
2. Seat recline control
3. Seat slide control

Item	Description	Notes
1. Armrest adjustment	To adjust armrest position, unscrew knob, move armrest to new position, and screw knob in.	

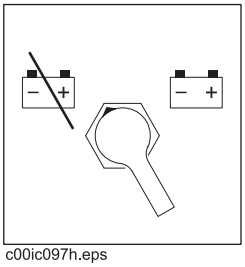
Item	Description	Notes
2. Seat recline control  c00ic096h.eps	To recline or raise seatback, lift. To lock seatback in position, release.	
3. Seat slide control  c00ic095h.eps	To slide forward or backward, move left. To lock seat in position, move right.	

Battery

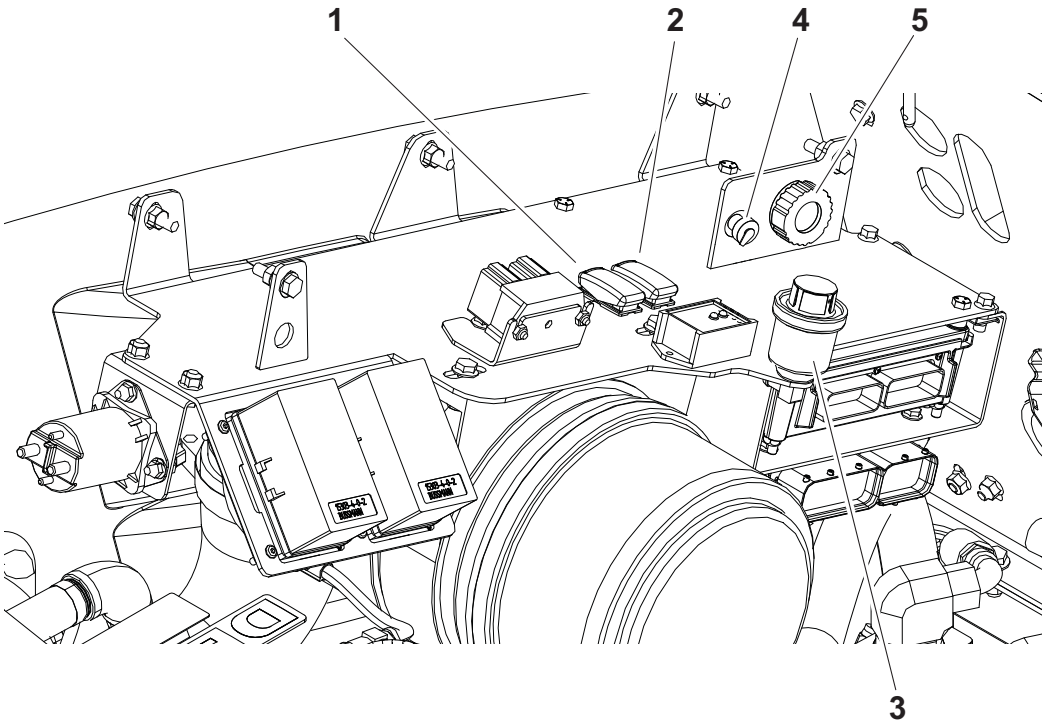


j38om006w.eps

1. Battery disconnect switch

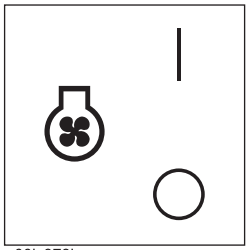
Item	Description	Notes
1. Battery disconnect switch  c00ic097h.eps	To connect, move clockwise. To disconnect, move counterclockwise.	

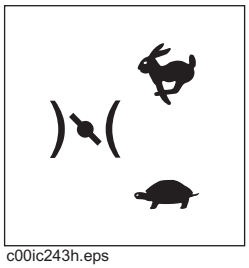
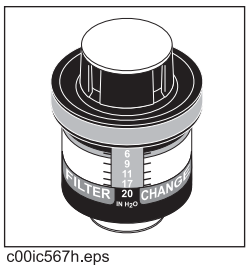
Engine Compartment Controls



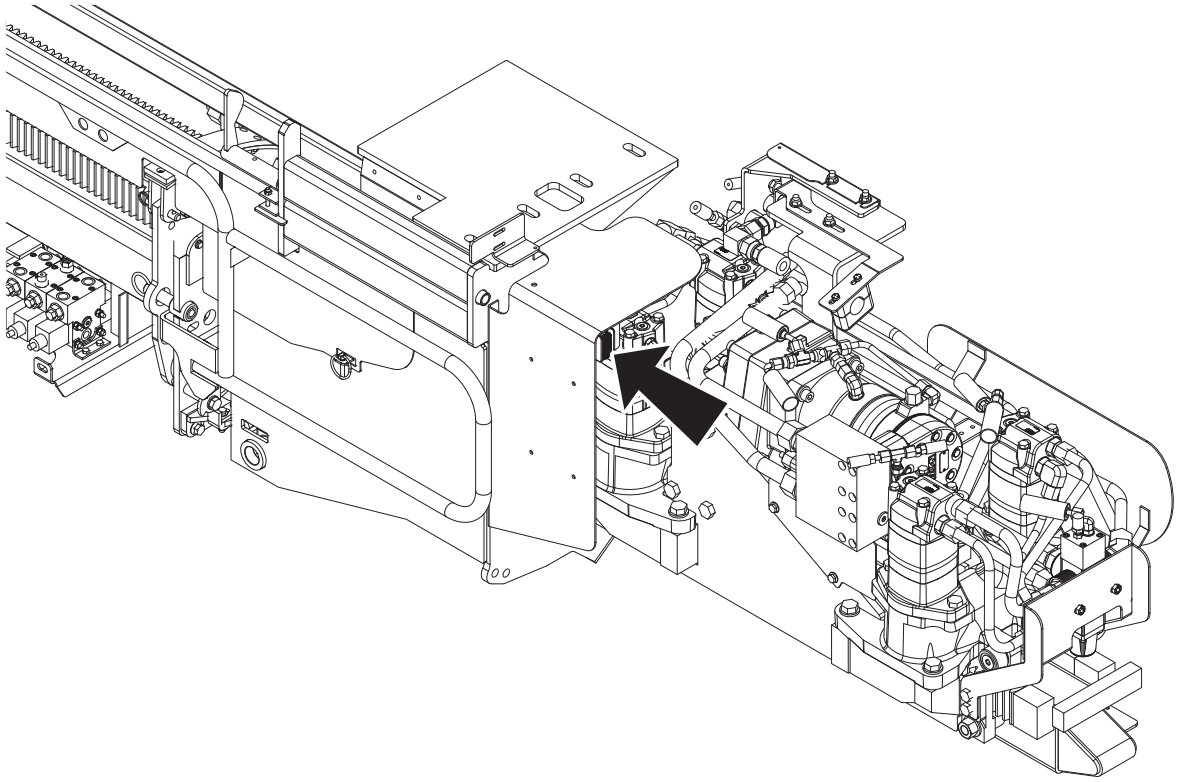
j38om007w.eps

1. High/auto fan speed switch
2. Throttle switch
3. Air filter restriction indicator
4. Machine controller diagnostic port
5. J1939 CAN diagnostic port, engine

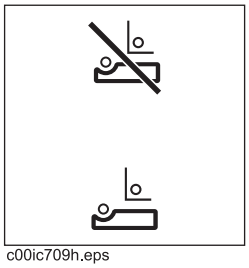
Item	Description	Notes
1. High/auto fan speed switch  c00ic378h.eps	For high speed, press top. For automatic speed, press bottom.	If switch is on high speed, fan will run at full speed all the time. If switch is on auto speed, fan speed will vary in relation to engine temperature.

Item	Description	Notes
2. Throttle switch  c00ic243h.eps	To increase engine speed, press top. To decrease engine speed, press bottom. To further increase or decrease speed, press additional times (or hold until desired speed is reached).	Use this switch only if throttle switch on console does not work.
3. Air intake restriction indicator  c00ic567h.eps	Shows air intake restriction.	Replace the air filter elements when the indicator reaches the red zone. See "Change Air Filter" on page 184.
4. Diagnostic port, controller	For use only by qualified technicians.	
5. J1939 CAN diagnostic port, engine	For use only by qualified technicians.	

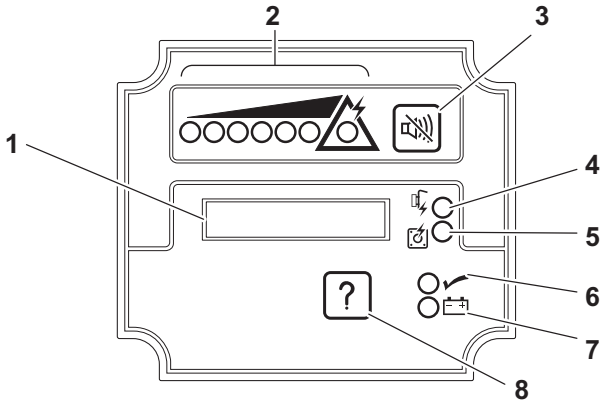
Miscellaneous Controls



j38om006h.eps

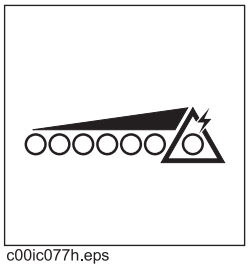
Item	Description	Notes
Shuttle Lockout Switch  c00ic709h.eps	To prevent shuttle operation, press top. To allow shuttle operation, press bottom.	Use when loading and unloading extra drill pipe with auxiliary loaders.

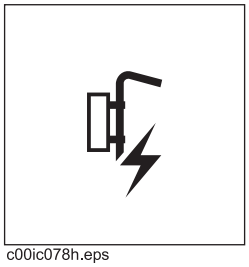
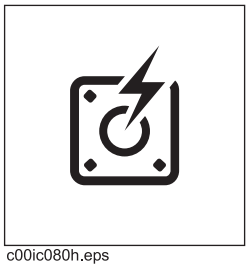
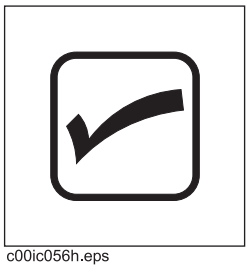
ESID

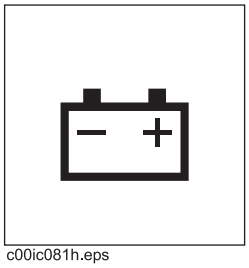


j07om042h.eps

1. Alphanumeric display
2. Strike indicator
3. Alarm interrupt button
4. Voltage problem indicator
5. Current problem indicator
6. OK indicator
7. Electrical power supply indicator
8. Self test button

Item	Description	Notes
1. Alphanumeric display	Displays amount of current and voltage being detected as a percentage of strike condition. The line with the "V" shows voltage reading and the line with the "A" shows current reading.	
2. Strike indicator  c00ic077h.eps	Red lights come on as values in display increase. Light in triangle represents strike warning condition and will trigger alarm(s) and strobe(s). **IMPORTANT:** System can go from one or two lights to an electric strike immediately.	If system is activated, assume a strike has occurred. ***NOTICE:*** The ESID does not indicate proximity to electric lines. System will activate only when voltage and/or amperage detected at the drilling unit are above threshold minimum limits.

Item	Description	Notes
3. Alarm interrupt button  c00ic078h.eps	To turn off strike audio alarm at drilling unit, press.	
4. Voltage problem indicator  c00ic078h.eps	Blinking red light indicates a voltage sensor problem.	See "Troubleshoot Strike System" on page 119.
5. Current problem indicator  c00ic080h.eps	Blinking red light indicates a current sensor problem.	See "Troubleshoot Strike System" on page 119.
6. OK indicator  c00ic056h.eps	Green light means system self test detected no problems. Strike system is ready to operate.	

Item	Description	Notes
7. Electrical power supply indicator  c00ic081h.eps	Green light means control box has sufficient electrical power for operation. Strike system is ready to operate if OK indicator is also on.	
8. Self test button  c00ic075h.eps	To start manual self test, press. To reset system after a strike has been detected, press.	Checks all systems and circuits. ***NOTICE:*** See "If an Electric Line is Damaged" on page 16.

Prepare

Chapter Contents

Gather Information

A successful job begins before the bore. The first step in planning is reviewing information already available about the job and jobsite.

Review Job Plan

Review blueprints or other plans and make sure you have taken bore enlargement during backreaming and pullback into account. Check for information about existing or planned structures, elevations, or proposed work that may be taking place at the same time.

Notify One-Call Services

Mark proposed path with white paint and have underground utilities located before working.

- In the US or Canada, call 811 (US) or 888-258-0808 (US and Canada). Also contact any local utilities that do not participate in the One-Call service.
- In countries that do not have a One-Call service, contact all local utility companies to have underground utilities located.

Examine Pullback Material

Ask for a sample of the material you will be pulling back. Check its weight and stiffness. Contact the manufacturer for bend radius information. Check that you have appropriate pullback devices.

Arrange for Traffic Control

If working near a road or other traffic area, contact local authorities about safety procedures and regulations.

Plan for Emergency Services

Have the telephone numbers for local emergency and medical facilities on hand. Check that you will have access to a telephone.

Inspect Site

Identify Hazards

Inspect jobsite before transporting equipment. Check for the following:

- overall grade or slope
- changes in elevation such as hills or open trenches
- obstacles such as buildings, railroad crossings, or streams
- signs of utilities on jobsite and perimeter, such as:
  - "buried utility" notices
  - utility facilities without overhead lines
  - gas or water meters
  - junction boxes
  - drop boxes
  - light poles
  - manhole covers
  - sunken ground
- traffic
- access
- soil type and condition
- water supply
- sources of locator interference (rebar, railroad tracks, etc.)

Have an experienced locating equipment operator sweep area within 20' (6 m) to each side of bore path to verify previously marked line and cable locations. Mark location of all buried utilities and obstructions.

Take soil samples from several locations along bore path to determine best bit and backreamer combinations.

Select Start and End Points

Select one end to use as a starting point. Consider the following when selecting a starting point:

Slope

Fluid system should be parked on a level site. Consider how slope will affect drilling unit setup, bending pipe, and fluid flow out of hole.

Traffic

Vehicle and pedestrian traffic must be a safe distance from drilling equipment. Allow at least 10' (3 m) buffer zone around equipment.

Space

Check that starting and ending points allow enough space for gradual pipe bending. See "Minimum Setback" on page 72.

Check that there is enough space to work and to set up electric strike system.

Comfort

Consider shade, wind, fumes, and other site features.

Drill downhill when possible so fluid will flow away from drilling unit.

Classify Jobsite

WARNING Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment. 274-050; 274-724 (2P)

To help avoid injury:

- Wear personal protective equipment including hard hat, safety eye wear, and hearing protection.
- Do not wear jewelry or loose clothing.
- Notify One-Call and companies which do not subscribe to One-Call.
- Comply with all utility notification regulations before digging or drilling.
- Verify location of previously marked underground hazards.
- Mark jobsite clearly and keep spectators away.

Remember, jobsite is classified by hazards in place -- not by line being installed.

Select a Classification

Jobsites are classified according to underground hazards present.

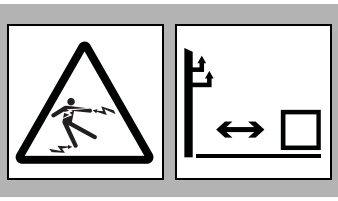
If working...	then classify jobsite as...
within 10' (3 m) of a buried electric line	electric
within 10' (3 m) of a natural gas line	natural gas
in concrete, sand, or granite which is capable of producing crystalline silica (quartz) dust	crystalline silica (quartz) dust
within 10' (3 m) of any other hazard	other

NOTICE: If you have any doubt about jobsite classification, or if jobsite might contain unmarked hazards, take steps outlined previously to identify hazards and classify jobsite before working.

Apply Precautions

Once classified, precautions appropriate for jobsite must be taken. Follow U.S. Department of Labor regulations on excavating and trenching (Part 1926, Subpart P) and other similar regulations.

Electric Jobsite Precautions

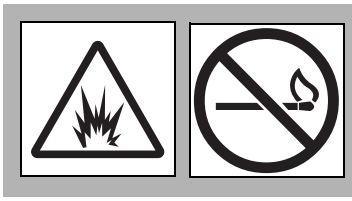


DANGER Electric shock will cause death or serious injury. Stay away. 274-049

In addition to using a directional drilling system with an electric strike system, use one or both of these methods.

- Expose line by careful hand digging or soft excavation. Use beacon to track bore path. If utility must be crossed, tracker operator must watch the drill head during drilling and backreaming. The tracker operator must have communication with the drill operator or DrillLok® system must be enabled with the DrillLok key in the tracker operator's possession.
- Have service shut down while work is in progress. Have electric company test lines before returning them to service.

Natural Gas Jobsite Precautions

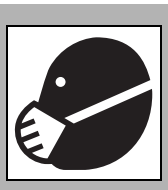


WARNING Fire or explosion possible. Fumes could ignite and cause burns. No smoking, no flame, no spark.

In addition to using positioning equipment upwind from gas lines, use one or both of these methods.

- Expose lines by careful hand digging or soft excavation. Use beacon to track bore path.
- Have gas shut off while work is in progress. Have gas company test lines before returning them to service.

Crystalline Silica (Quartz) Dust Precautions



⚠ CAUTION Breathing crystalline silica dust may cause lung disease. Cutting, drilling, or working materials such as concrete, sand, or rock containing quartz may result in exposure to silica dust. Use dust control methods or appropriate breathing protection when exposed to silica dust.

To help avoid injury:

- Use water spray or other means to control dust.
- Refer to U.S. Department of Labor Occupational Safety and Health Administration guidelines to learn more about appropriate breathing protection and permissible exposure limits.

Crystalline silica dust is a naturally occurring substance found in soil, sand, concrete, granite, and quartz. Breathing silica dust particles while cutting, drilling, or working materials may cause lung disease or cancer.

Other Jobsite Precautions

You may need to use different methods to safely avoid other underground hazards. Talk with those knowledgeable about hazards present at each site to determine which precautions should be taken or if job should be attempted.

Plan Bore Path

Plan the bore path, from entry to end, before drilling begins. The Ditch Witch® **Trac Management System Plus** is available for planning your bore path. This special software can be run in the field using a laptop computer equipped with Windows® 95 or higher operating system. See your Ditch Witch dealer for details.

If not using Trac Management System Plus, mark the bore path on the ground with spray paint or flags, or record it on paper for operator reference.

For complicated bores, consult an engineer. Have the jobsite surveyed and bore path calculated. Be sure the engineer knows minimum entry pitch, bend limits of drill pipe, bend and tension limits of pullback material, pipe lengths, and location of all underground utilities.

For less complicated bores, plan the bore based on four measurements:

- recommended bend limit
- entry pitch
- minimum setback
- minimum depth

IMPORTANT: See the following pages for more information about these measurements. If not using Trac Management System Plus, see "Bore Path Calculator" on page 73 and use these measurements to help plan your bore.

Recommended Bend Limits

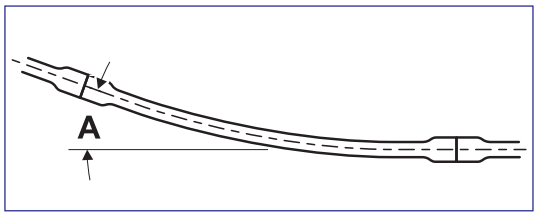
Ditch Witch® drill pipes are designed to bend slightly during operation. Slight bending allows for steering and correcting direction. Bending beyond recommended limits will cause damage that might not be visible. This damage adds up and will later lead to sudden drill pipe failure.

IMPORTANT: Consider recommended bend limits during any bend, not just during bore entry.

Pipe Pitch

Ditch Witch drill pipe is tested to bend at a maximum percent pitch.

Make sure pitch (A) changes no more than 9.4% over the full length of each Power Pipe® HD pipe, no more than 9.2% for Ditch Witch Forged HD pipe and no more than 9.3% for Forged pipe.

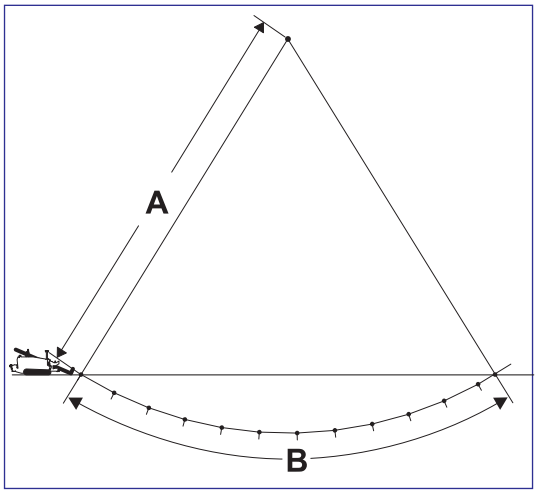


j07om003c.eps

NOTICE: Bending drill pipe more sharply than recommended will damage pipe and cause failure over time. Changes in pitch must be **equally distributed** over the length of a pipe. Maximum changes in pitch within 1-2' (300-600 mm) of pipe create sharp bends that will damage pipe.

Monitor the pitch of each pipe with the remote display on the operator's console.

Bend Radius



j07om078h.eps

JT20 Power Pipe® HD drill pipes have a tested minimum bend radius of 107' (32.6 m). This means that a 90-degree bend in the bore path:

- has a radius (A) of 107' (32.6 m)
- requires approximately 168' (51.2 m) of drill pipe (B).

JT20 Ditch Witch® Forged HD drill pipes have a tested minimum bend radius of 109' (33.2 m). This means that a 90-degree bend in the bore path:

- has a radius (A) of 109' (33.2 m)
- requires approximately 171' (52.1 m) of drill pipe (B).

JT20 Forged drill pipes have a tested minimum bend radius of 108' (32.9 m). This means that a 90-degree bend in the bore path:

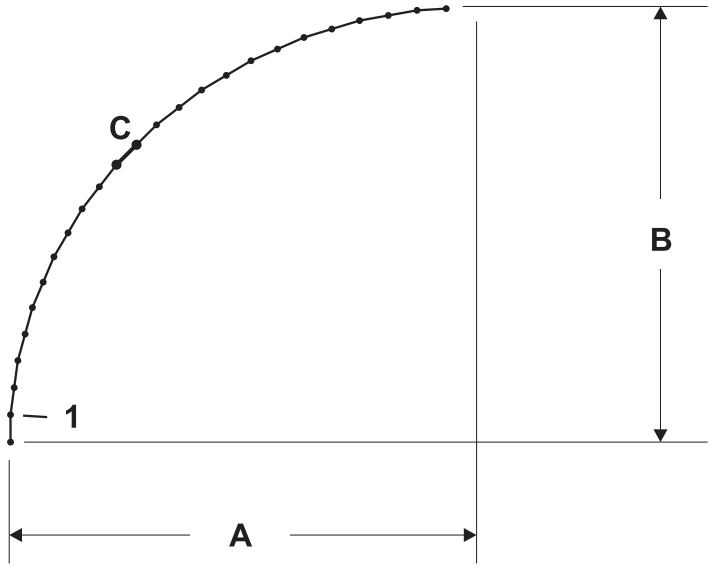
- has a radius (A) of 108' (32.9 m)
- requires approximately 170' (51.8 m) of drill pipe (B).

NOTICE: Bending drill pipe more sharply than recommended will damage the pipe and cause failure over time.

- If bend radius is reduced, drill pipe life is reduced.
- If bend radius is increased, drill pipe life is increased.

IMPORTANT: Use the charts on the next page to keep bends within safe limits.

Pipe-By-Pipe Bend Limits



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Power Pipe® HD

Pipe (C)	Forward (B)	Deflection (A)	Pipe (C)	Forward (B)	Deflection (A)
1	10 ft 0 in (3.0 m)	0 ft 5.6 in (0.1 m)	**10**	86 ft 1 in (26.2 m)	43 ft 5 in (13.2 m)
2	19 ft 11 in (6.1 m)	1 ft 10 in (0.6 m)	**11**	91 ft 8 in (27.9 m)	51 ft 9 in (15.8 m)
3	29 ft 7 in (9 m)	4 ft 2 in (1.3 m)	**12**	96 ft 5 in (29.4 m)	60 ft 6 in (18.4 m)
4	39 ft 1 in (11.9 m)	7 ft 5 in (2.2 m)	**13**	100 ft 4 in (30.6 m)	69 ft 9 in (21.3 m)
5	48 ft 2 in (14.7 m)	11 ft 6 in (3.5 m)	**14**	103 ft 4 in (31.5 m)	79 ft 3 in (24.2 m)
6	56 ft 11 in (16 m)	16 ft 5 in (5 m)	**15**	105 ft 6 in (32.1 m)	89 ft 0 in (27.1 m)
7	65 ft 1 in (19.8 m)	22 ft 1 in (6.7 m)	**16**	106 ft 8 in (32.5 m)	98 ft 11 in (30.2 m)
8	72 ft 9 in (22.2 m)	28 ft 7 in (8.7 m)	**17**	107 ft 0 in (32.6 m)	107 ft 0 in (32.6 m)
9	79 ft 9 in (24.3 m)	35 ft 8 in (10.9 m)			

Ditch Witch® Forged HD

Pipe (C)	Forward (B)	Deflection (A)	Pipe (C)	Forward (B)	Deflection (A)
1	10 ft 0 in (3.0 m)	0 ft 5.6 in (0.1 m)	**10**	86 ft 7 in (26.4 m)	42 ft 9 in (13 m)
2	19 ft 11 in (6.1 m)	1 ft 10 in (0.6 m)	**11**	92 ft 3 in (28.1 m)	50 ft 11 in (15.5 m)
3	29 ft 8 in (9 m)	4 ft 1 in (1.2 m)	**12**	97 ft 2 in (29.6 m)	59 ft 8 in (18.2 m)
4	39 ft 1 in (11.9 m)	7 ft 3 in (2.2 m)	**13**	101 ft 4 in (30.9 m)	68 ft 9 in (20.9 m)
5	48 ft 2 in (14.7 m)	11 ft 3 in (3.4 m)	**14**	104 ft 7 in (31.9 m)	78 ft 3 in (23.8 m)
6	57 ft 0 in (17.4 m)	16 ft 1 in (4.9 m)	**15**	106 ft 11 in (32.6 m)	87 ft 11 in (26.8 m)
7	65 ft 3 in (19.9 m)	21 ft 9 in (6.6 m)	**16**	108 ft 5 in (33 m)	97 ft 10 in (29.8 m)
8	73 ft 0 in (22.3 m)	28 ft 1 in (8.6 m)	**17**	109 ft 0 in (33.2 m)	107 ft 9 in (32.6 m)
9	80 ft 1 in (24.4 m)	35 ft 1 in (10.7 m)	**18**	109 ft 0 in (33.2 m)	109 ft 0 in (33.2 m)

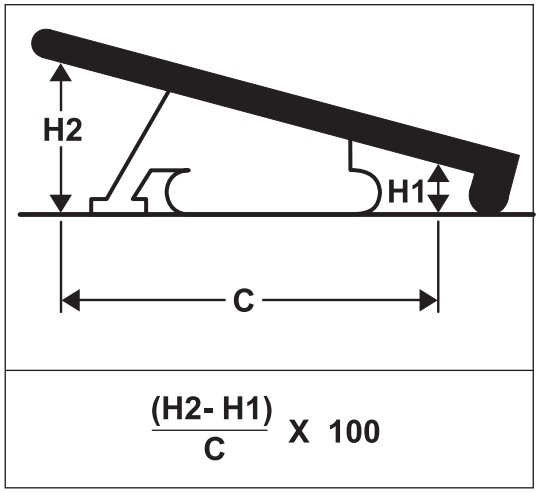
Forged

Pipe (C)	Forward (B)	Deflection (A)	Pipe (C)	Forward (B)	Deflection (A)
1	10 ft 0 in (3.0 m)	0 ft 5.6 in (0.1 m)	**10**	86 ft 4 in (26.3 m)	43 ft 1 in (13.1 m)
2	19 ft 11 in (6.1 m)	1 ft 10 in (0.6 m)	**11**	91 ft 11 in (28 m)	51 ft 4 in (15.6 m)
3	29 ft 7 in (9 m)	4 ft 2 in (1.3 m)	**12**	96 ft 10 in (29.5 m)	60 ft 1 in (18.3 m)
4	39 ft 1 in (11.9 m)	7 ft 4 in (2.2 m)	**13**	100 ft 10 in (30.7 m)	69 ft 3 in (21.1 m)
5	48 ft 3 in (14.7 m)	11 ft 4 in (3.5 m)	**14**	104 ft 0 in (31.7 m)	78 ft 9 in (24 m)
6	57 ft 0 in (117.4 m)	16 ft 3 in (4.9 m)	**15**	106 ft 3 in (32.4 m)	88 ft 6 in (27 m)
7	65 ft 2 in (19.9 m)	21 ft 11 in (6.7 m)	**16**	107 ft 7 in (32.8 m)	98 ft 4 in (30 m)
8	72 ft 11 in (22.2 m)	28 ft 4 in (8.7 m)	**17**	108 ft 0 in (32.9 m)	108 ft 0 in (32.9 m)
9	79 ft 11 in (24.4 m)	35 ft 5 in (10.8 m)			

Entry Pitch

Entry pitch is the slope of the drill frame compared with the slope of the ground. Determine entry pitch one of two ways:

1. **With Pitch Beacon**
   - Lay pitch beacon on the ground and read pitch.
   - Lay pitch beacon on drill frame and read pitch.
   - Subtract ground pitch from drilling unit pitch.
2. **With Measurements**
   - Measure from the ground to front end of drill frame (H1).
   - Measure from the ground to back end of frame (H2).
   - Subtract (H1) from (H2). Record this number.
   - Measure the distance between front and back points (C).
   - Divide (H2-H1) by (C), then multiply by 100. This is your pitch.



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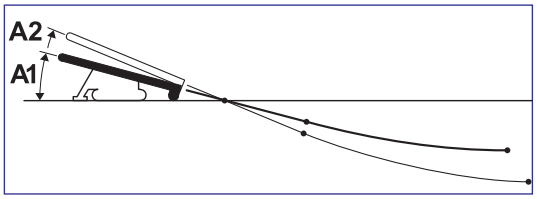
IMPORTANT: A shallow entry pitch (A1) allows you to reach horizontal sooner and with less bending. Increasing entry pitch (A2) makes bore path longer and deeper.



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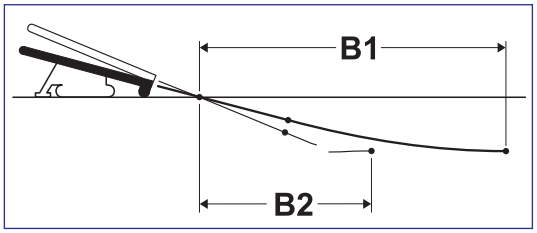
Minimum Setback

Setback is the distance from the entry point to where pipe becomes horizontal (B1).

NOTICE: If setback is too small (B2), you will exceed bend limits and damage the pipe.



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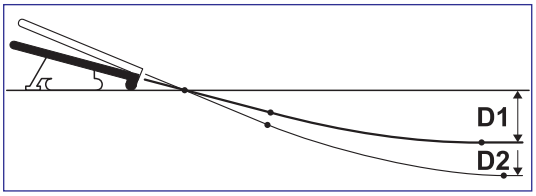
Minimum Depth



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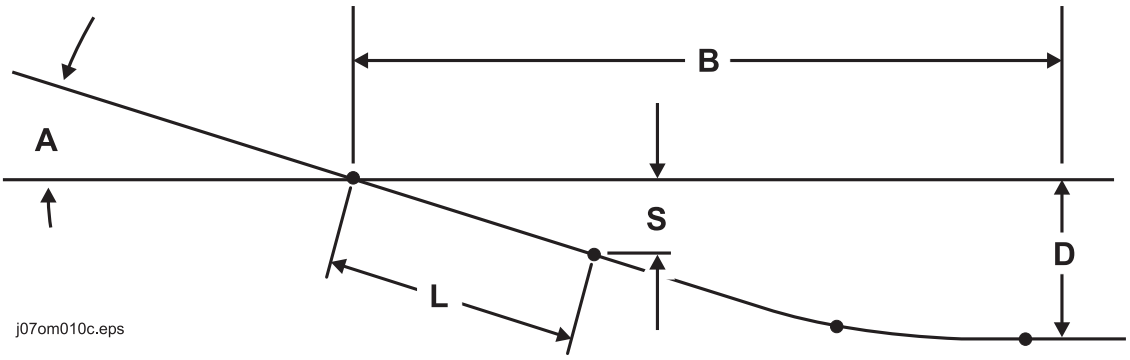
Because you must bend pipe gradually, entry pitch and bend limits determine how deep the pipe will be when it becomes horizontal. This is called the **minimum depth**.

- To reduce minimum depth (D1), reduce entry pitch. This also decreases setback.
- To increase minimum depth (D2), increase entry pitch. This also increases setback.

Bore Path Calculator

Entry pitch, setback, and minimum depth work together with bend limits to determine the bore path. To find the setback (B) and entry pitch (A) that will take you to the desired minimum depth (D), use the chart below.



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IMPORTANT: Numbers in table based on **drill pipe minimum bend radius**, beacon housing, EZ-Connect, connector, transition sub, and 1/3 of first drill pipe (L, totaling 8' 8" [2.6 m]) in the ground before steering.

Power Pipe® HD

Minimum depth (D)	Entry pitch (A)	Setback (B)	Depth to begin steering (S)
3 ft 3 in (1 m)	-18%	27 ft 6 in (8.4 m)	1 ft 7 in (0.48 m)
3 ft 10 in (1.2 m)	-20%	29 ft 6 in (9 m)	1 ft 9 in (0.53 m)
4 ft 5 in (1.3 m)	-22%	31 ft 6 in (9.6 m)	1 ft 11 in (0.58 m)
5 ft 0 in (1.5 m)	-24%	33 ft 5 in (10.2 m)	2 ft 1 in (0.64 m)
5 ft 8 in (1.7 m)	-26%	35 ft 4 in (10.8 m)	2 ft 3 in (0.69 m)

Ditch Witch® Forged HD

Minimum depth (D)	Entry pitch (A)	Setback (B)	Depth to begin steering (S)
3 ft 4 in (1 m)	-18%	27 ft 11 in (8.5 m)	1 ft 7 in (0.48 m)
3 ft 10 in (1.2 m)	-20%	29 ft 11 in (9.1 m)	1 ft 9 in (0.53 m)
4 ft 5 in (1.3 m)	-22%	31 ft 11 in (9.7 m)	1 ft 11 in (0.58 m)
5 ft 1 in (1.5 m)	-24%	33 ft 11 in (10.3 m)	2 ft 1 in (0.64 m)
5 ft 9 in (1.8 m)	-26%	35 ft 10 in (10.9 m)	2 ft 3 in (0.69 m)

Forged

Minimum depth (D)	Entry pitch (A)	Setback (B)	Depth to begin steering (S)
3 ft 3 in (1 m)	-18%	27 ft 8 in (8.4 m)	1 ft 7 in (0.48 m)
3 ft 10 in (1.2 m)	-20%	29 ft 8 in (9 m)	1 ft 9 in (0.53 m)
4 ft 5 in (1.3 m)	-22%	31 ft 8 in (9.7 m)	1 ft 11 in (0.58 m)
5 ft 0 in (1.5 m)	-24%	33 ft 8 in (10.3 m)	2 ft 1 in (0.64 m)
5 ft 8 in (1.7 m)	-26%	35 ft 7 in (10.8 m)	2 ft 3 in (0.69 m)

Prepare Jobsite


WARNING Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment. 274-050; 274-724 (2P)

To help avoid injury,

- If jobsite classification is in question or if the possibility of unmarked electric utilities exists, classify jobsite as electric.
- Expose lines by hand before digging. Cutting high voltage cable can cause electrocution.
- Remove all vegetation near operator's station. Contact with trees, shrubs, or weeds during electrical strike could result in electrocution.

Mark Bore Path

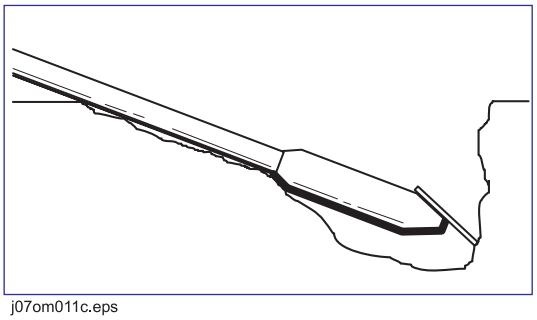
Mark your planned bore path and all located utility lines with flags or paint.

Prepare Entry Point

For bore to be successful, first pipe must be straight as it enters the ground.

To help ensure that the first pipe does not bend, dig a small starting hole so that the first pipe is drilled into a vertical surface.

To prevent bending or straining pipe, position drilling unit for straight entry.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Check Supplies and Prepare Equipment

Check Supplies

- tracking system with spare batteries
- beacons with new and spare batteries
- two-way radios with new and spare batteries
- quick wrench (see page 133)
- transition sub
- anchoring equipment and accessories
- bits, screens, nozzles (see page 128)
- adapters, pipe, beacon housings
- marking flags or paint
- water and additional hoses
- fuel
- drilling fluid additives (see page 123)
- spare fuses
- keys
- backreamers, swivels, pulling devices (see page 130)
- wash down hose and spray gun
- duct tape
- spray lubricant
- tool joint compound (see page 163)
- electrically insulating boots and gloves
- personal protective equipment, such as hard hat and safety glasses
- notepad and pencil

Prepare Equipment

Fluid Levels

- fuel
- hydraulic fluid
- engine coolant
- battery charge
- engine oil

Condition and Function

- filters (air, oil, hydraulic)
- fluid pump
- couplers
- tires and tracks
- pumps and motors
- drilling fluid mixer
- hoses and valves
- water tanks

Assemble Accessories

Fire Extinguisher

If required, mount a fire extinguisher near the power unit but away from possible points of ignition. The fire extinguisher should always be classified for both oil and electric fires. It should meet legal and regulatory requirements.

Drive

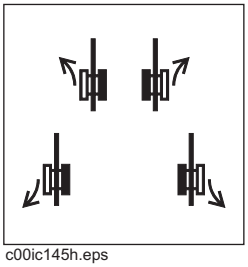
Chapter Contents

Start Unit

1. Insert key.
2. Turn key clockwise. See page 23 for more information.
3. Run engine at low throttle for 5 minutes.

Steer Unit

To steer drilling unit while using tethered ground drive controller, follow instructions for type of steering desired.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To steer while moving forward, push forward and then move to left or right. Drilling unit will gradually turn to left or right.

To steer while moving backward, pull back and then move to left or right. Drilling unit will gradually turn to left or right.

For tight steering in low speed, move control to center position and then to left or right edge. Gradually move control forward or backward along the edge toward a corner. Tracks will counter-rotate and turn drilling unit in a tight circle.

Tips to Reduce Track Wear

Rubber tracks are best suited at soil-based job sites with minimal rock and debris. Sharp objects such as gravel, steel shards, and broken concrete will damage rubber tracks and undercarriage components. Excessive operation on concrete or asphalt will shorten track life. When storing your machine, keep tracks away from rain and direct sunlight.

Wash tracks daily to remove foreign objects and abrasive soil from sprockets and idler rollers. Drive slowly and make wide turns when possible. Regularly check undercarriage components (sprocket, rollers, idler) for wear and damage. Maintain proper track tension. (See "Check Track Tension and Condition" on page 183.)

To prevent premature wear, avoid the following:

- Spinning tracks under heavy load.
- Turning on sharp objects such as stones, stumps and debris.
- Quick turns or "spin" turns on asphalt or concrete.
- Driving over curbs, ledges, and sharp objects.
- Driving with sidewall edges pressed against hard walls, curbs or other objects.
- Driving on slopes.
- Operating on corrosive materials such as salt or fertilizer. Wash immediately.

Shut Down Unit

1. Stop track movement.
2. Lower drill frame and stabilizers to the ground.

IMPORTANT: If frame and stabilizers cannot be lowered, use cylinder locks or other suitable material to block the tracks and frame. Remove cylinder locks or chocks before driving unit.

3. Run engine at low throttle for 3 minutes to cool.
4. Turn key to the stop position.
5. Remove key.

Transport

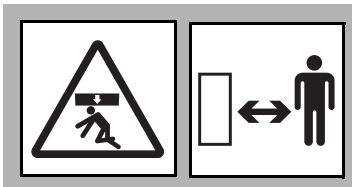
Chapter Contents

Lift

This machine is not configured for lifting. If the machine must be lifted, load machine into a container or onto a platform appropriate for lifting. See "Specifications" on page 191 for weight of machine.

Haul

Load



WARNING Crushing weight could cause death or serious injury. Stay away. 275-326

To help avoid injury:

- Attach trailer to vehicle before loading or unloading.
- Verify that trailer wheels are blocked.
- Load and unload trailer on level ground.
- Load trailer correctly to prevent trailer swaying. Place 10-15% of total vehicle weight (equipment plus trailer) on tongue.

With Tiedown Kit

1. Start drilling unit engine.
2. Using tethered ground drive controller, pull power mode switch into low position.
3. Move drilling unit to rear of trailer and align with ramps.
4. Slowly drive unit onto trailer until track reaches chock.
5. Lower drill frame to drill frame rest.
6. Back unit until front of drill frame is seated in rest.
7. Lower stabilizers to trailer floor.
8. Stop engine.
9. Attach tiedowns at rear of unit where indicated on page 85.

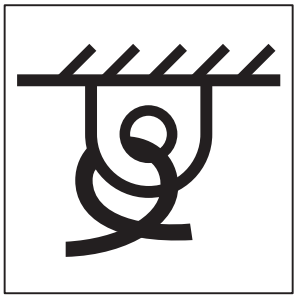
Without Tiedown Kit

1. Start drilling unit engine.
2. Using tethered ground drive controller, pull power mode switch into low position.
3. Move drilling unit to rear of trailer and align with ramps.
4. Slowly drive unit onto trailer until track reaches chock.
5. Lower stabilizers to trailer floor.
6. Lower drill frame to trailer floor.
7. Stop engine when unit is safely positioned on trailer bed for proper tongue weight.
8. Attach tiedowns to drilling unit where indicated on page 85.

Tie Down

Points

Tiedown points are identified by tiedown decals. Securing to trailer at other points is unsafe and can damage machinery.



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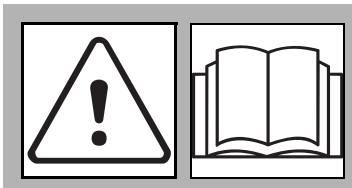
Procedure

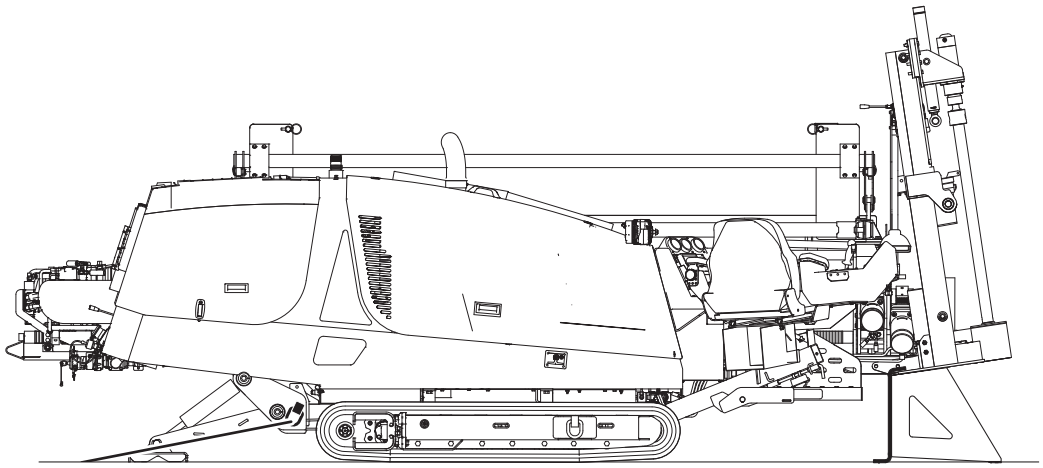


WARNING Read operator's manual. Know how to use all controls. Your safety is at stake. 273-475

To help avoid injury: Ensure that any downhole tool or pipe in tool joint vises is attached to spindle or removed before transport. Wrenches can open after engine shutdown.

With Tiedown Kit

Loop tiedowns around rear tiedown points. Make sure tiedowns are tight before transporting.



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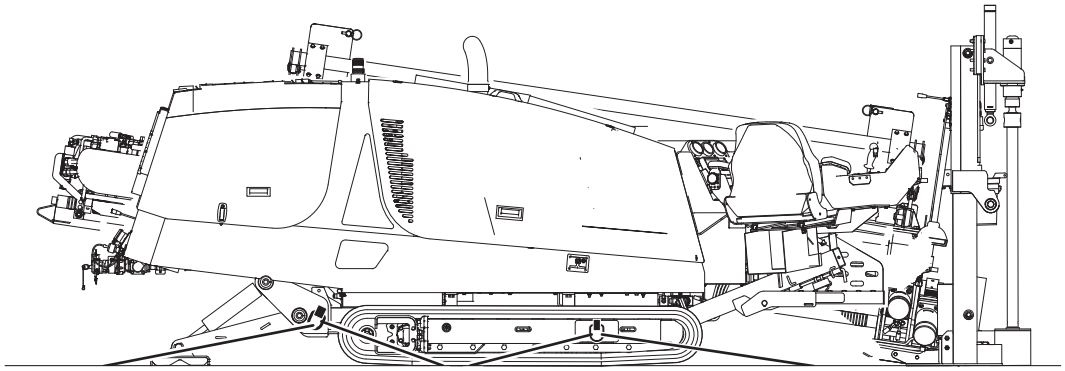
Without Tiedown Kit

Loop tiedowns around unit at tiedown points. Make sure tiedowns are tight before transporting.



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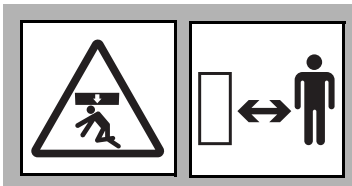
Unload



WARNING Crushing weight could cause death or serious injury. Stay away. 275-326

To help avoid injury:

- Attach trailer to vehicle before loading or unloading.
- Load and unload trailer on level ground.
- Ensure trailer wheels are blocked.

With Tiedown Kit

1. Lower ramps.
2. Remove tiedowns.
3. Start drilling unit engine.
4. Using tethered ground drive controller, pull power mode switch into low position.
5. Raise stabilizers.
6. Move drilling unit forward until track meets chock.
7. Raise drill frame.
8. Slowly back unit down trailer or ramps.

Without Tiedown Kit

1. Lower ramps.
2. Remove tiedowns.
3. Start drilling unit engine.
4. Using tethered ground drive controller, pull power mode switch into low position.
5. Raise stabilizers.
6. Raise drill frame.
7. Slowly back unit down trailer or ramps.

Retrieve

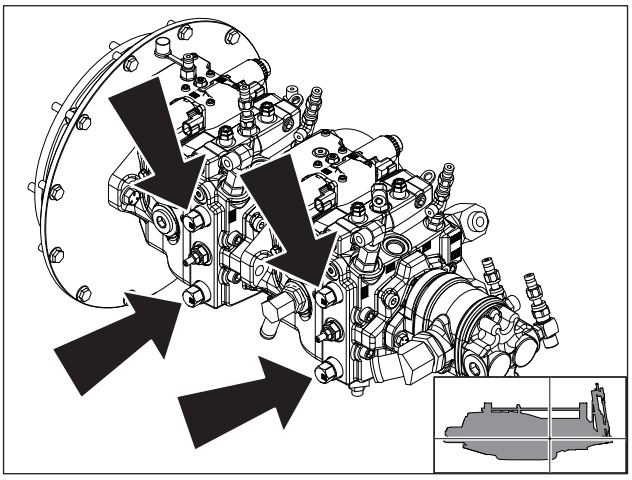
Under normal conditions, drilling unit should not be towed. If unit breaks down and retrieval is necessary:

- Attach chains to indicated tow points facing towing vehicle.
- Open bypass valves.
- Open selector valves.
- Tow for short distances at less than 1 mph (1.6 km/h).
- Use maximum towing force of 1.5 times unit weight.

To open bypass valves for towing, back out hex plugs (shown) three full revolutions.

NOTICE: Unit has no brakes when bypass valves are opened for towing.

To close bypass valves and return to normal operation, return hex plugs to their original position (shown).



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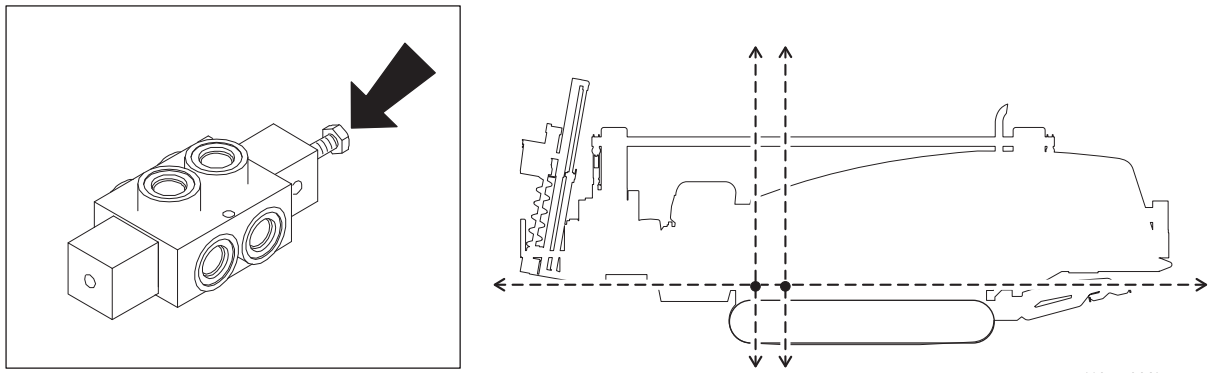
To open selector valves for towing, loosen jam nut and tighten valve screw (shown) until it is fully threaded.



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To close selector valves and return to normal operation, unthread valve screw and tighten jam nut. To attach chains to tow points, determine which points are facing towing vehicle.

To attach chains to tow points, determine which points are facing towing vehicle.

If **back** tow points are facing towing vehicle, loop chains through each tow point and bring them together to a central pull point.

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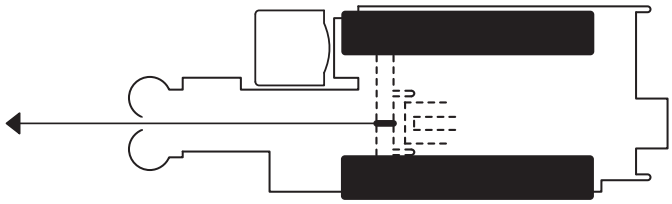
If **front** tow points are facing towing vehicle, loop chain through tow point and pull straight forward.



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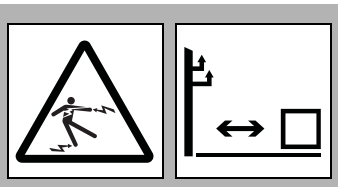
Conduct a Bore

Chapter Contents

Position Equipment

1. Review bore plan and select drilling unit position and fluid unit position.
2. Move equipment into selected positions.

Connect Fluid System



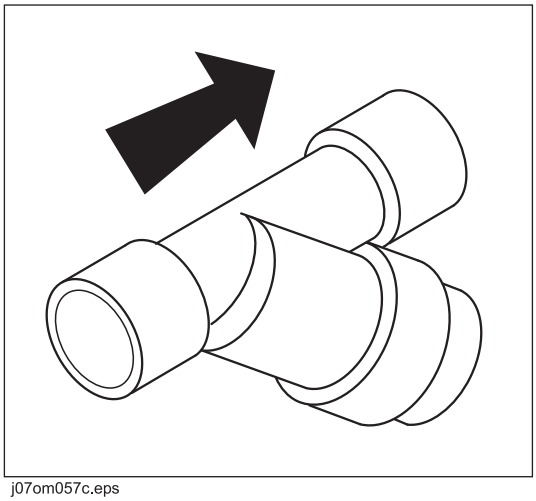
DANGER Electric shock will cause death or serious injury. Stay away. 274-049

To help avoid injury: Do not connect drilling unit to a public or private (business or home) water supply. If an electrical strike occurs while drilling unit is connected to a fluid system, the fluid system will also become electrified.

1. Connect fluid hose from mixing system to drilling fluid pump. A 1.5" (38 mm) or larger, non-collapsible hose is required.
2. Install y-strainer between mixing unit and drilling fluid pump. Position strainer so that drilling fluid flows in the direction of the arrow. In most cases, positioning strainer at outlet of mixing unit gives best results.

IMPORTANT:

- Clean y-strainer regularly.
- Prime the remote drilling fluid pump after switching to a new tank. See page 94.



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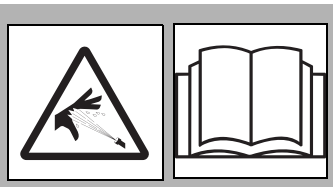
Start System

1. Start drilling unit and remote fluid unit. Allow both engines to warm up.

   IMPORTANT: Ensure that mixture of drilling fluid matches drilling conditions. See "Drilling Fluid" on page 123.

2. Enable DrillLok™/tracker control mode if desired. See "DrillLok™/Tracker Control" on page 127.
3. Press top of drilling unit throttle switch until engine is at full throttle. If you do not want to use autothrottle mode, return switch to center position.

Prime Drilling Fluid Pump



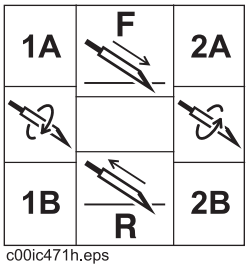
WARNING Pressurized fluid or air could pierce skin and cause severe injury. Refer to operator's manual for proper use. 270-6035

To help avoid injury: Always prime the drilling fluid pump. Failure to prime the drilling fluid pump will cause flow fluctuations, which will make it difficult to control the washwand.

Prime drilling fluid pump each time tank is changed. To prime the pump:

1. Fill drilling fluid hose and connect hose to unit.
2. Operate mixing/transfer pump at full speed for 1 - 3 minutes to discharge air from system.
3. Return mixing/transfer pump to normal operating speed and continue the bore.
4. If drilling fluid pressure surges are observed, repeat step 2.

Operate Carriage Control



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Drilling

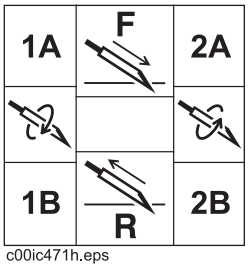
During normal drilling operation, the thrust/rotation joystick controls both operations and allows any combination of the two based on the position of the joystick:

- Push joystick toward 1A for forward thrust with clockwise rotation.

NOTICE: Counterclockwise rotation can unthread pipe in the ground.

- Push joystick toward 2A for forward thrust with counterclockwise rotation.
- Pull joystick toward 2B for reverse thrust, with counterclockwise rotation.
- Pull joystick toward 1B reverse thrust, with clockwise rotation.

Coordinated Make-up



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During pipe change operations when front wrench is closed and carriage is on front or rear home, the thrust/rotation joystick controls the speed and direction of rotation. Thrust speed and direction are set by the machine controller to follow the speed and direction of the rotation. If needed, thrust speed can be increased or decreased slightly by moving the control toward or against the direction of thrust travel. If joystick remains in neutral for rotation, then thrust is controlled normally.

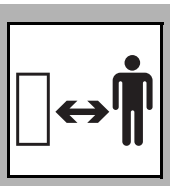
Push joystick toward 1A for clockwise rotation (machine controlled makeup).

Push joystick toward 2B for counterclockwise rotation (machine controlled breakout).

IMPORTANT:

- If the thrust/rotation joystick is moved straight forward or backward so there is no rotation, thrust is controlled by the operator.
- While rotating the operator can adjust thrust speed slightly with joystick.

Clamp Pipe



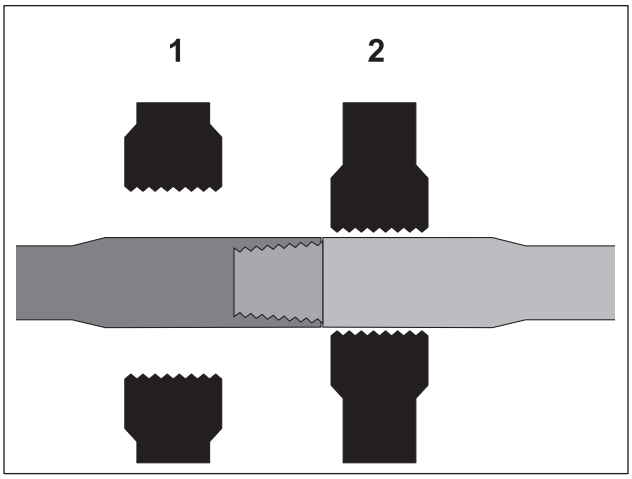
DANGER Turning shaft can kill you or crush arm or leg. Stay away.

To help avoid injury: Only clamp pipe at reinforced end. Clamping anywhere else on the pipe will weaken the pipe. Pipe can later break, even when operating under normal loads.

NOTICE: Wrenches can open after engine shutdown. Ensure that any downhole tool or pipe in tool joint vises is attached to spindle or removed before transport.

Clamp on pipe when joint is centered between wrenches (1 and 2). Always clamp on the larger diameter areas on either side of the tool joint face.

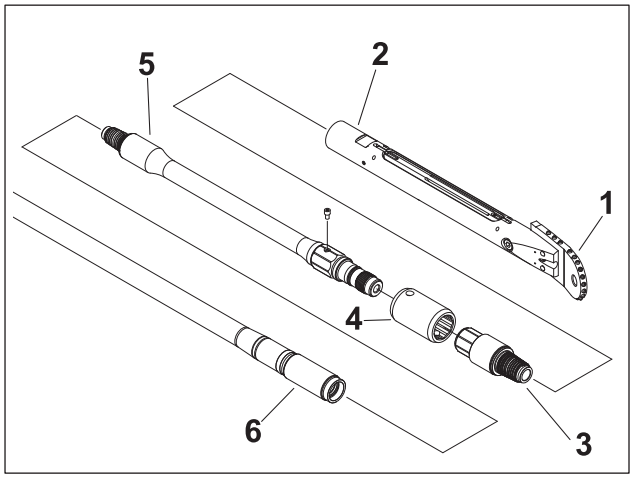
NOTICE: Clamping pipes on top of female threads can damage threads. Only clamp female pipe ends behind the threads.



DrillPipe_Clamp.eps

Assemble Drill String

1. bit
2. beacon housing
3. adapter
4. collar
5. transition sub
6. JT20 drill pipe



EZ_Connects.eps

Prepare Beacon Housing

1. Select nozzles and bit.

IMPORTANT: A variety of nozzles and bits are available to suit your particular job conditions. See your Ditch Witch® dealer for more information.

2. Insert nozzle into beacon housing.
3. Attach bit to beacon housing.
4. Install beacon, following beacon instructions for:
   - battery replacement
   - beacon positioning.
5. Install beacon housing lid.
6. Follow beacon instructions to check beacon operation.
7. Follow tracker instructions to calibrate beacon.

Attach Transition Sub

1. Remove blocks from pipe guides.
2. Pull transition sub into front wrench.
3. Close wrench.
4. Lube joints.
5. Use machine torque to tighten joint fully.

Attach Beacon Housing

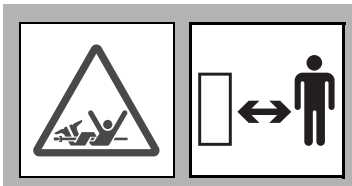
Use machine torque to attach beacon housing.

1. Pull beacon housing into front wrench.
2. Close wrench.
3. Use machine torque to tighten joint fully.

Connect Drill Pipe

1. Start drilling unit engine.
2. Align drill pipe in front wrench.
3. Clamp tool joint in front wrench. See "Clamp Pipe" on page 96.
4. Disconnect from pipe:
   - Rotate spindle counterclockwise until threads on pipe segments are disengaged from each other. Carriage will move backward as pipe rotates counterclockwise.
   - Stop rotation and move carriage backward until it stops on the rear stop switch.
5. Load pipe:
   - Make sure pipe box is positioned correctly.
   - Open grippers or make sure they are open.
   - Grippers open as pipe is lowered.
   - Close grippers around pipe.
   - Lubricate pipe threads at front wrench.
   - Move pipe to spindle.
   - Raise pipe lifters.
6. Connect pipe:
   - Move carriage forward until spindle meets back end of pipe joint. Rotate spindle clockwise until pipe begins to spin. Relax grippers slightly.
   - Move carriage forward until pipe joints meet at front wrench.
   - Rotate spindle clockwise. Carriage will move forward as pipe threads tighten.
   - Rotate clockwise until spindle stops turning, and joint is fully tightened.
   - Open grippers.
   - Retract shuttles fully.
   - Open front wrench.

Drill First Pipe



DANGER Turning shaft can kill you or crush arm or leg. Stay away.

To help avoid injury:

- Keep everyone at least 10' (3 m) away from turning drill string.
- Push rod or pipe slowly. Forcing can bend string. Do not use bent rod or pipe.

WARNING Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment. 274-050; 274-724 (2P)

1. Turn on drilling fluid.
2. Set flow control to desired flow/pressure. See "Start System" on page 94.
3. Turn drill bit to starting position.
4. Slowly move carriage forward. Drill in downhole tools and 1/3 of first pipe before steering.
5. Monitor gauges.

Enable Automated Pipeloader System

Add Pipe	Remove Pipe
1. Open front wrench, retract shuttles, and set engine at full throttle for add pipe function to work.	1. Open front wrench, retract shuttles, and set engine at full throttle for remove pipe function to work.
2. Press top of add pipe/manual/remove pipe switch. Green control cycle light will come on.	2. Press bottom of add pipe/manual/remove pipe switch. Green control cycle light will come on.
3. Grippers will open, pipe will be lowered, and then green control cycle light will flash.	3. Grippers will open, pipe will be lowered and lifted off shuttles, and then green control cycle light will flash.

IMPORTANT: If you leave the seat **during** an add or remove pipe cycle, switch to manual control and finish pipe cycle. Then switch back to add pipe or remove pipe. If you leave the seat **between** add or remove pipe cycles, re-enabling system is not needed.

Add Pipe

1. Press top of drilling unit throttle switch until engine is at full throttle.
2. Enable automated pipeloader system (automated pipeloader control only). See "Enable Automated Pipeloader System" on page 99.
3. Break joint at saver sub.

Manual Pipeloader Controls	Automated Pipeloader Control
• Clamp pipe joint. • Locate drill head. • Engage front wrench until pipe is clamped and pressure develops. • Slowly move carriage back until movement stops. • Slowly rotate spindle counterclockwise. Carriage will move back as threads separate. • After threads are fully separated, stop rotation and move carriage to back of frame.	• Clamp pipe joint. • Locate drill head. • Engage front wrench until pipe is clamped and pressure develops. • Slowly move carriage back until movement stops. • Slowly rotate spindle counterclockwise. Carriage will move back as threads separate. • After threads are fully separated, stop rotation and move carriage to back of frame. • While carriage is moving, green control cycle light will come on. Grippers will grip and then green control cycle light will flash.

4. Load pipe:

Manual Pipeloader Controls	Automated Pipeloader Control
• Make sure shuttle stop is properly positioned on pipeloader and lift arms are completely lowered. • Close grippers. • Lube pipe threads. • Move pipe to spindle. • Raise pipe lifters.	• Make sure shuttle stop is properly positioned on pipeloader. • When carriage is at back of drill frame, press RESUME. Green control cycle indicator lights, pipe is moved to spindle, front threads are lubed, pipe in box is lifted, and then green control cycle light will flash.

5. Connect pipe to saver sub:

Manual Pipeloader Controls	Automated Pipeloader Control
IMPORTANT: Always rotate clockwise unless breaking pipe joint. Rotating counterclockwise will separate joints.	**IMPORTANT:** Always rotate clockwise unless breaking pipe joint. Rotating counterclockwise will separate joints.
• Move carriage forward until saver sub meets pipe. • Rotate spindle until threads begin to tighten. Carriage will continue to advance. • Relax grippers.	• Move carriage forward until saver sub meets pipe. • Rotate spindle until threads begin to tighten. Carriage will continue to advance. • Press RESUME. Green control cycle light will come on. Grippers will relax and then green control cycle light will flash

6. Connect new pipe to drill string:

Manual Pipeloader Controls	Automated Pipeloader Control
• Stop rotating and slowly move pipe forward until it contacts pipe in front wrench. • To fully torque joint, slowly rotate pipe until spindle stops turning. • Open wrench. • Open grippers fully. • Retract shuttles against shuttle stop. • Lower pipe lifters.	• Stop rotating and slowly move pipe forward until it contacts pipe in front wrench. • Press RESUME. Green control cycle light will come on, grippers will open, shuttles will retract, pipe lifters will lower, and then green control cycle light will flash. • While previous sequence is progressing, thread pipes together until spindle stops turning, then fully torque both joints by moving rotation control briefly to left limit.

7. Press and hold quick fill fluid pump switch until pipe fills and fluid pressure begins to rise.
8. Rotate spindle.
9. Slowly move carriage forward. Adjust rotation speed control according to bit size and soil conditions.
10. Engage and set cruise control as desired. See "Cruise Control" on page 147.
11. Monitor gauges.
12. Locate drill head with tracker at least every half-length of pipe.

Correct Direction

Correcting direction is a skill operators gain with experience and knowledge of equipment and soil conditions. These instructions cover only basic procedures. For information about specific equipment or jobsites, contact your Ditch Witch® dealer.

To track progress and make corrections, one crew member locates the drill head and sends instructions to the operator. Corrections are made by tracking the drill head, comparing current position to bore plan, and steering drill head as needed.

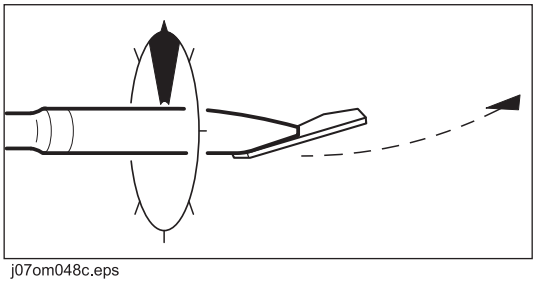
Basic Rules

- Steering ability depends on soil condition; bit, drill head, and nozzle used; roll of drill head; and distance pushed without outer rotation.
- All corrections should be made as gradually as possible. See "Recommended Bend Limits" on page 68.
- Over correcting will cause "snaking." This can damage pipe and will make drilling and pullback more difficult. Begin to straighten out of each correction as early as possible.
- Do not push an entire piece of drill pipe into ground without rotation. This can exceed bend radius and cause pipe failure.

Procedure

1. Locate drill head. Take readings available with your beacon and locating equipment such as:
    - depth
    - pitch
    - left/right information
    - temperature
    - beacon roll
2. Compare position to bore plan. Determine direction drilling should go.
3. Position drill head.
4. Drill in pipe.

Drill Head Position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The drill head position is determined by reading beacon roll. Roll is displayed as a clock face position.

1. Read beacon roll.
2. Slowly rotate pipe until locator displays desired beacon roll.

To change direction:

1. Rotate pipe to clock position you intend to travel.
2. Push pipe into ground.

To move forward without changing direction:

1. Rotate pipe.
2. Push pipe into ground.

Use AutoCarve

AutoCarve helps the operator change direction when thrust stalls in difficult soil conditions. AutoCarve rotates the bit clockwise and counterclockwise to grind away soil, clearing a path to improve steering through tough formations.

Movement	Description
alternating clockwise and counterclockwise rotation	Enables the downhole tool to carve tough soil formations. Rotation speed can be adjusted during autocarving. ***NOTICE:*** To reduce the chance of unthreading pipe sections downhole, rotation pressure is limited during counterclockwise rotation; however, the operator should monitor carve operation and adjust thrust and rotation to prevent unthreading.
carve window	The range of alternating rotation.
thrust	In autocarve mode, initial thrust speed is very slow or fully stopped. Adjust speed anytime during carving.
pullback	Thrust and rotation operate normally when joystick is pulled rearward. High-speed pullback is not available in AutoCarve mode.

Operation

IMPORTANT:

- 2-speed thrust is not allowed in AutoCarve mode.
- AutoCarve mode is disabled while front wrench is closed.
- Adding or removing pipe does not affect AutoCarve position.

1. **Position downhole tool for carving.** Rotate the toolhead to the desired position.
2. **Turn on AutoCarve mode.** Press top of AutoCarve switch.
3. **Begin carving.** Push joystick fully forward then release to neutral to start alternating rotation. Adjust thrust and rotation speed as needed during carving.
4. **Adjust thrust speed.** Press and hold the Resume switch until carriage begins to move forward, then release switch. Press Resume repeatedly to increase thrust speed to desired setting. To reduce thrust speed, press Set switch.
5. **Set carve window.** Use the Carve Window Potentiometer to set the desired range of travel. Adjust as needed while carving.
6. **Adjust rotation speed**. Move joystick fully left of neutral. Press the Set/Resume switch to decrease/ increase rotation speed. Adjust as needed while carving.

   IMPORTANT: For finer adjustment, press the multi-use button while adjusting thrust or rotation. Be aware, however, this also activates the reaming function and will change steering direction unless the tool is stopped at the original position before releasing multi-use button.

7. **Pause carving.** Pull joystick away from neutral.
8. **Resume carving.** Push joystick fully forward then release to neutral to start alternating rotation.
9. **Ream a newly carved section.** After carving a few inches, press and hold the 2-Speed (multi-use) button and move the joystick fully left for maximum rotation. When tool rotates freely, reduce rotation speed and stop at desired carve position. Release 2-Speed button and resume carving.

   IMPORTANT: If full rotation seems restricted and insufficient to ream the hole, move carriage back slightly until full rotation is possible, then move carriage forward while rotating.

10. **Exit carve mode.** Press bottom of AutoCarve switch. Carriage movement and rotation will stop. Continue normal drilling.

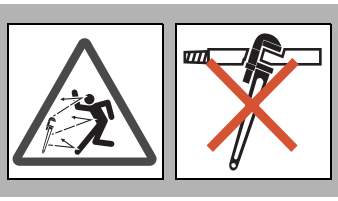
    Note: For quicker setup during a long bore, AutoCarve thrust and rotation settings are retained until the unit is shut down.

Record Bore Path

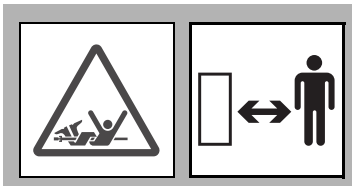
Locate drill head every half-length of pipe. As the job is completed, record the actual data for each drill pipe. List pitch and depth of each joint and a brief description of the procedure. In addition, draw a simple sketch of the site and record depth and rough location of pullback.

The Trac Management System Plus is also available for plotting and tracking your bore path. It utilizes the Subsite® 750 Tracker, 750 Display, a tracking beacon, and special software. The display can store jobs in its memory or the system can be run in the field using a laptop computer equipped with the Windows® 95 or higher operating system. See your Ditch Witch® dealer for details.

Surface Drill Head



DANGER Moving tools will kill or injure. Never use pipe wrenches on drill string. 273-278



DANGER Turning shaft will kill you or crush arm or leg. Stay away.

To help avoid injury:

- Tracker operator and drill operator should maintain two-way communication.
- Keep everyone clear of the exposed drill string.
- No one should enter pit until clear communication is given by the drill operator that the drill unit is shut down. If using DrillLok™/tracker control (See "DrillLok™/Tracker Control" on page 127.), do not enter pit until DrillLok/tracker control is turned off and green light on drill unit is lit.
- Drill operator should be instructed to discontinue drill string rotation as soon as drill bit exits the bore. Use thrust only to extend drill string beyond exit hole.

1. Guide drill head to target pit or up through surface. Make all bends gradual.
2. If using DrillLok/tracker control mode, tracker operator turns off tracker to disable drilling unit thrust/pullback and rotation hydraulics. Tracker operator waits for green light to enter pit and change tools. If not using DrillLok/tracker control mode, tracker operator signals to drilling unit operator to stop engine before changing downhole tools.
3. Turn fluid flow control to off position as soon as drill head emerges.
4. Clean drill head especially around threads.
5. Disconnect EZ-Connect joint or use quick wrench to remove drill head. Keep threads clean.

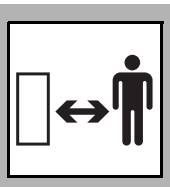
Backream

Sometimes it is necessary to enlarge the pilot hole to accommodate larger product. As a general rule, the final hole should be 1.5 times larger than the diameter of the product being installed. The number of passes needed depends on soil conditions. Do not try to increase hole size too much in one pass. Several passes using successively larger reamers will save wear on machine.


DANGER Moving tools will kill or injure. Never use pipe wrenches on drill string. 273-278


WARNING Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment. 274-050; 274-724 (2P)

To help avoid injury, continue to use strike system during backreaming.

DANGER Turning shaft will kill you or crush arm or leg. Stay away.

To help avoid injury,

- Maintain two-way communication with tracker operator.
- Begin backream only when tracker operator has communicated that everyone is clear of the exposed backream string or has disabled thrust and rotation hydraulics using DrillLok™/tracker control.
- Do not allow anyone to stand to the side of the exposed drill string. Drill string and backreamer can move sideways suddenly if rotated while away from the exit hole.

Assemble Backream String

1. Select backreaming devices. See "Backreamers" on page 136.
2. Determine fluid rate requirements and install appropriate nozzles to provide sufficient flow. See "Backream Fluid Requirements" on page 137 and "Nozzles" on page 134.
3. Attach backreamer to beacon housing if tracking backream.
4. Install beacon, following beacon instructions for:
   - battery replacement
   - beacon positioning
5. Install beacon housing lid. See page 135.
6. Follow beacon instructions to check beacon operation.
7. Follow tracker instructions to calibrate beacon.
8. Use quick wrenches to attach transition sub to drill pipe string.
9. Use quick wrenches to attach backreamer/beacon housing assembly to transition sub.
10. Attach additional pullback devices or product to end of backreamer/beacon housing assembly.

Begin Backream

1. After backream assembly is attached to pipe, tracker operator should:
   - leave pit and stand away from the exposed drill string.
   - if using DrillLok™/tracker control, turn on tracker to enable drilling unit thrust/pullback and rotation.
   - if not using DrillLok/tracker control, communicate to drill operator that backream string is clear.
2. Turn on drill fluid and pressurize drill pipe. Verify that jets are open.
3. Without rotating, slowly pull back until reamer contacts bore hole opening. Do not lodge reamer in hole.
4. Begin slow rotation and pullback.
5. Increase drilling fluid flow and rotation as the backream string enters the ground.
6. If tracking backream, tracker operator may continue tracking when the backream string is no longer visible.

Remove Pipe

1. Enable automated pipeloader system (automated pipeloader control only).
2. Stop carriage when pipes are aligned in wrenches.
3. Clamp pipe in front wrench.
4. Break front joint.
   - Turn rear wrench counterclockwise to break joint.
   - Disengage rear wrench and rotate wrench clockwise.
5. Grip pipe:

Manual Pipeloader Controls	Automated Pipeloader Control
• Open grippers. • Lift pipe off shuttles. • Extend shuttles to spindle position. • Close grippers. • Lower lifters.	• Press RESUME. Green control cycle light will come on, shuttles will extend, grippers will grip fully and relax open, pipe lifters will lower, and then green control cycle light will flash.

6. Separate front joint.
   - Slowly rotate spindle counterclockwise and move carriage back to separate pipe.
   - Continue to move carriage back until pipe is properly positioned in rear wrench.
7. Break rear joint:

Manual Pipeloader Controls	Automated Pipeloader Control
• Engage rear wrench. • Slowly rotate spindle counterclockwise and move carriage back until joint is loosened. **Do not** fully separate joint. • Disengage rear wrench. • Move carriage back until front end of pipe is aligned with front end of pipe box or alignment pin is even with tab on frame. • Close grippers. • Rotate spindle counterclockwise until saver sub is separated from pipe. • Move carriage to back of frame.	• Engage rear wrench. • Slowly rotate spindle counterclockwise and move carriage back until joint is loosened. **Do not** fully separate joint. • Disengage rear wrench. • Move carriage back until front end of pipe is aligned with front end of pipe box or alignment pin is even with tab on frame. • Press RESUME. Green control cycle light will come on, grippers will close and then green control cycle light will flash. • Rotate spindle counterclockwise and move carriage back until saver sub is separated from pipe. • Move carriage to back of frame.

8. Ensure shuttle stop is positioned correctly.

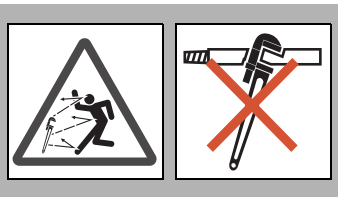
9. Load pipe into pipe box:

Manual Pipeloader Controls	Automated Pipeloader Control
• Move shuttle under pipe box to shuttle stop. • Release grippers and raise lift arms to place pipe in box. • Lube front threads.	• Press RESUME. Green control cycle light will come on. • Shuttles will retract under edge of pipe box and then green control cycle light will flash. • Move carriage forward until it clears end of pipe box. Green control cycle light will come on, shuttles will retract, front threads will be lubed, grippers will release pipe, pipe lifters will raise until pipe is off shuttles, and then green control cycle light will flash.

10. Attach saver sub to next pipe:
    - Move carriage forward until saver sub touches pipe.
    - Rotate spindle just enough to allow saver sub to connect to pipe.
    - Slowly tighten joint to full machine torque.
11. Disengage front wrench to release pipe.

Remove Pullback Device

The pullback device can be removed when the last pipe is on the frame. It can also be removed when a target pit along the bore path has been reached. Remaining pipe is then pulled back and removed.



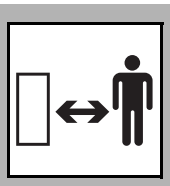
DANGER Moving tools will kill or injure. Never use pipe wrenches on drill string. 273-278

1. Press bottom of drilling unit throttle switch until engine is at low throttle.
2. Turn off drilling fluid.
3. Clean pullback device.
4. Turn drilling unit engine off.
5. Disconnect pullback material.
6. Use quick wrench to remove pullback device.

Systems and Equipment

Chapter Contents

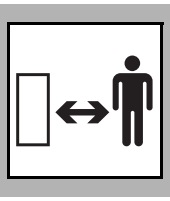
Anchor System

WARNING Crushing weight. If load falls or moves, it could kill or crush you. Use proper procedures and equipment or stay away.

To help avoid injury:

- Drive anchors properly before drilling.
- Stand on platform when operating anchor controls.
- Wear high-top protective boots with legs of pants completely tucked inside.
- Wear protective gloves.
- If you are not driving two anchors to full depth, drive optional ground rod into soil away from drilling unit and connect ground rod to drilling unit.

DANGER Turning shaft can kill you or crush arm or leg. Stay away.

To help avoid injury: Do not replace anchor collar bolt with one longer than original. Clothing could catch on turning shaft.

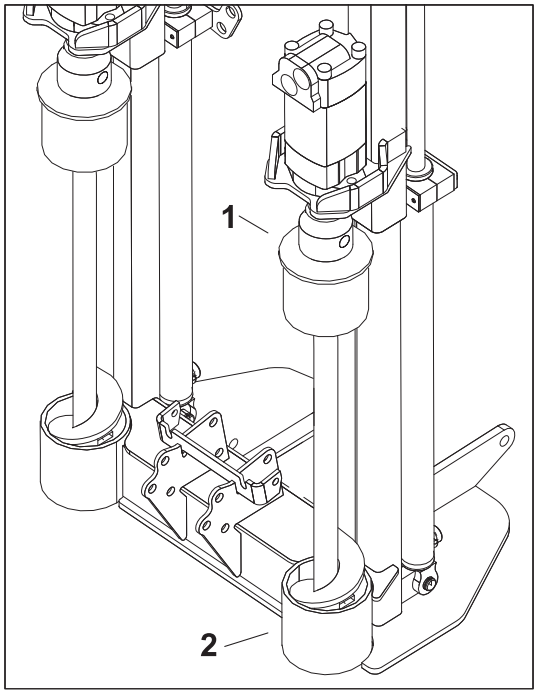
Drive Anchors

IMPORTANT: Carefully time anchor rotation with anchor movement. Properly driven anchors should not auger up soil.

1. Use anchor rotation and thrust controls to drive anchor into ground.

   NOTICE: Centering cap **MUST** be positioned in centering tube to prevent damage to anchor.

2. Carefully position centering cap (1) into centering tube (2) as anchor is being driven into ground.
3. Repeat process for other anchor.



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Remove Anchors

1. Use anchor rotation and thrust controls to slowly remove anchor shaft from ground.
2. Repeat process for other anchor.

Electric Strike System

Any time you drill in an electric jobsite, electric strike system must be properly set up, tested, and used. You must wear protective boots and gloves meeting the following standards:

- Boots must have high tops and meet the electric hazard protection requirements of ASTM F2413 or ASTM F1117 when tested at 14,000 volts. Tuck legs of pants completely inside boots.
- Gloves must have 17,000 AC maximum use voltage, according to ASTM specification D120.

If working around higher voltage, use gloves and boots with appropriately higher ratings.

NOTICE: The strike system does not prevent electric strikes or detect strikes before they occur. **If alarms are activated, a strike has already occurred** and equipment is electrified.

Read and follow "Electric Jobsite Precautions" on page 65. Review safety procedures before each job.

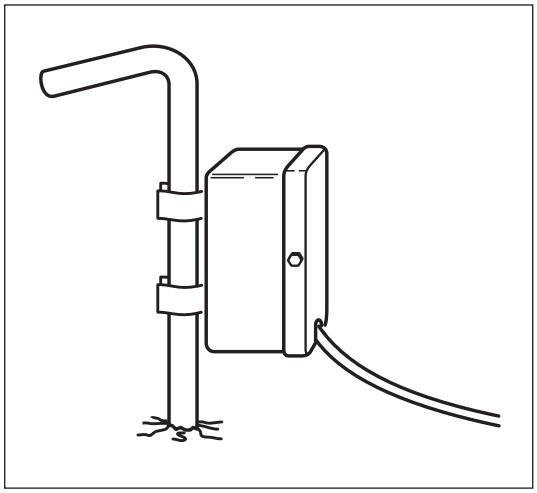
FCC Statement

The Electric Strike System has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, can cause harmful interference to radio communications. Operation of this equipment in a residential area could cause harmful interference which the user will be required to correct at his own expense.

Changes or modifications not expressly approved in writing by The Charles Machine Works, Inc. may void the user's authority to operate this equipment.

Assemble Voltage Detector

1. Drive voltage stake into ground at least 6' (2 m) away from any part of system.
2. Clip voltage limiter to voltage stake.



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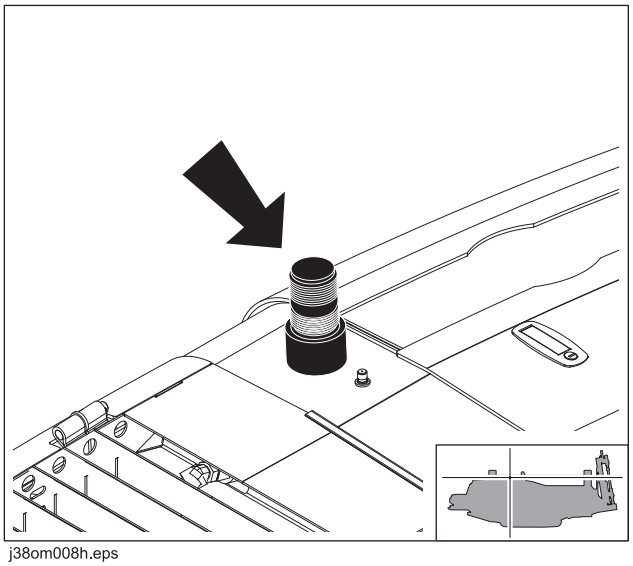
Test Strike System

If system fails any part of this test, see "Troubleshoot Strike System" on page 119 on the following page. Do not drill until test is completed successfully.

1. Turn on drilling unit.
2. ESID control module will perform internal tests which check everything but alarms and strobe.
3. If green OK indicator and electrical power supply indicator lights remain on, press self test button to perform total test of strike system. During this test:
   - All lights should glow.
   - Alphanumeric readout should display numbers.
   - Alarms and strobes (shown) on all connected units should sound.
4. If this test is successful, OK indicator and electrical power supply indicator lights will remain on.
5. Use Electric Strike Simulator to test voltage and current sensors. See page 121.



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Troubleshoot Strike System

When strike system detects a problem, an error code will be displayed. Anytime this happens, press self test button to retest. If error code is still displayed and does not appear in this chart, have control module checked or replaced.

Other problem situations and their possible causes and solutions are listed in the chart below.

Problem	Possible cause	Possible solution
No lights or readings showing after drilling unit key has been on at least one minute	Problems in startup	Push self test button. If problem goes away, retest strike system
	No power to strike system control module	Check drilling unit electric system
		Check that harness from drilling unit to control module is connected
		Check that cable from drilling unit carries more than 10V
	Defective control module	Have control module checked or replaced
Screen is blank	Strike system is not getting adequate power from drilling unit	Check drilling unit electric system
		Check that harness from drilling unit to control module is connected
		Check that harness from drilling unit carries more than 10V
	Defective control module	Have control module checked or replaced
Information on screen is visible during self test but not after test is complete	LCD contrast is not set properly	Contact your Ditch Witch® dealer to adjust contrast
OK indicator is on, but electrical power supply indicator is off	Strike system is not getting adequate power from drilling unit	Check drilling unit electric system
		Check that harness from drilling unit to control module is connected
		Check that harness from drilling unit carries more than 10V
	Defective control module	Have control module checked or replaced
Electrical power supply indicator is on, but OK indicator is off	Problem detected during test	Check for error code and have control module checked or replaced
	Defective control module	Have control module checked or replaced

Problem	Possible cause	Possible solution
Strobe light on drilling unit does not work during total test	Improper connections with control module	Check connections and wiring harness
	Defective strobe light	1. Disconnect strobe and connect to external 12V power source. 2. If strobe does not work, replace it.
	Defective control module	Have control module checked or replaced
Alarm on drilling unit does not work during total test	Improper connections with control module	Check connections and wiring harness
	Defective alarm	1. Disconnect strobe and connect to external 12V power source. 2. If strobe does not work, replace it.
	Defective control module	Have control module checked or replaced
Strobe light and alarm on drilling unit do not work during total test	Improper connections with control module	Check connections and wiring harness
	Defective control module	Have control module checked or replaced
EC2 code displays and current problem indicator is on	Improper connections with control module	Check cable connections on control module and current transformer
	Defective current transformer	1. Disconnect current transformer. 2. Check for 20-40 ohms from pin 1 to pin 4, 20-40 ohms from pin 1 to pin 2, and less than 1 ohm from pin 2 to pin 4.
	Defective current transformer cable	1. Disconnect cable from transformer and control module. 2. Check continuity of cable. 3. If continuity is zero or cable is damaged, replace.
	Defective control module	Have control module checked or replaced
EV1 code displays and voltage problem indicator is on	Improper connection of voltage limiter to ground stake	Check voltage limiter connection to ground stake and verify that ground stake is driven into the ground
	Defective voltage limiter	Have voltage limiter checked or replaced
	Defective control module	Have control module checked or replaced

Problem	Possible cause	Possible solution
EV2 code displays and voltage problem indicator is on	Improper connections with control module	Check cable connection on control module
	Defective voltage limiter	Have voltage limiter checked or replaced
	Defective control module	Have control module checked or replaced

Use Electric Strike Simulator

Use the Electric Strike Simulator (p/n 259-506) to test voltage and current sensors on ESID. If readings are less than indicated here, replace 9V battery in simulator and retest.

Current Test

To test for current at normal levels:

1. Thread one lead wire through current transformer.
2. Clip ends of lead wires together to make one loop.
3. Move simulator switch to "current" and press test button.
4. Watch screen and lights above display on strike system.
   - Three or four lights should turn on.
   - Current "A" should show 30-50% in display.

To test for current at strike levels:

1. Put two or three loops through current transformer.
2. Follow steps above to test.
3. Display should show the following:
   - All lights should turn on.
   - Alarm and strobe should turn on.

   With two loops,
   - Current "A" should be 80-110%.
   - Strike indication might go on and off.

   With three loops,
   - Current should be 130-160%.
   - Strike indication should be continuous.

Voltage Test

1. Place voltage limiter on something insulated from ground and drilling unit (such as dry board or tire), but near frame of drilling unit.
2. Clip one lead to frame.
3. Clip other lead to one voltage limiter mount.
4. Move simulator switch to "voltage" and press test button.
5. Watch screen and lights above display on strike system.
    - All lights should turn on.
    - Alarm and strobe should turn on.
    - Voltage "V" should show 90-110%.

It is normal for simulator voltage levels to drift below strike level. When this happens, light in triangle should go off and alarm and strobe should stop working. If the level drifts above strike level again, light, alarm, and strobe should be turned on again.

Drilling Fluid

CAUTION Improper handling or use of chemicals may result in illness, injury, or equipment damage. Follow instructions on labels and in material safety data sheets (MSDS).

For productive drilling and equipment protection, use these recommended Baroid® products, available from your Ditch Witch® dealer.

- Soda ash
- Quik-Gel® dry powder bentonite (p/n 259-804)
- EZ-Mud® liquid polymer (p/n 259-805)
- Liqui-Trol™ liquid polymer suspension (p/n 259-808)
- Quik-Trol® dry powder polymer (p/n 259-809)
- Bore-Gel® drilling fluid (p/n 259-807)
- Con Det® water-soluble cleaning solution (p/n 259-810)

Guidelines

Match drilling fluid to soil type. This chart is meant as a guideline only. See your local Ditch Witch dealer for soil conditions and drilling fluid recommendations for your area.

Soil type	Drilling fluid recommendation
smooth, flowing sand	bentonite or Bore-Gel + medium chain polymer
coarse sand or light soil	bentonite or Bore-Gel
heavy clay	long chain polymer + Con-Det
swelling clay	long chain polymer + Con-Det
rock	Bore-Gel

Polymer

This drilling fluid additive provides excellent lubrication and increases viscosity in average soils and heavy clay. In swelling clay, polymer can reduce swelling that traps pipe in the bore.

There are two types of polymer:

- long chain such as Baroid EZ-Mud
- medium chain such as Baroid Quik-Trol

Bentonite

Bentonite is a dry powder. When properly mixed with water, it forms a thin cake on bore walls, lubricating the bore, keeping it open, and holding fluid in the bore.

Some things to remember when mixing bentonite:

- Use clean water free of salt, calcium, or excessive chlorine.
- Use water with pH level between 9 and 10.
- Use water with hardness of less than 120 ppm.
- Do not use bentonite containing sand.
- Mix bentonite thoroughly or it will settle in tank.
- Do not mix bentonite to a funnel viscosity of over 50.

For information on measuring funnel viscosity, see "Funnel Viscosity" on page 126.

Mixtures

Bentonite does not mix well in water containing polymer. To use both, mix bentonite first, then add polymer. When adding other products follow the order listed below.

IMPORTANT:

- If chemicals are added in the wrong order, they will not mix properly and will form clumps.
- If tank contains bentonite/polymer mix and more drilling fluid is needed, completely empty tank and start with fresh water before mixing another batch.

General mixing order:

1. Soda ash
2. Bentonite
3. Polymer
4. Con Det®

Bore-Gel® contains premixed bentonite, polymer, and soda ash. Use approximately 15 lb/100 gal (7 kg/380 L) in normal drilling conditions, up to 45 lb/100 gal (21 kg/380 L) in sand or gravel and up to 50 lb/100 gal (23 kg/380 L) in rock.

Basic Fluid Recipes

Soil type	Mixture/100 gal (378 L) of water	Notes
fine sand	35 lb (16 kg) Bore-Gel®	
coarse sand	35 lb (16 kg) Bore-Gel .5 lb (225 g) No-Sag®	Add .5 lb (225 g) of Quik-Trol® for additional filtrate control
fine sand below water table	40 lb (18 kg) Bore-Gel .75 lb (340 g) Quik-Trol	Add .5 - 1 gal (2-4 L) of Dinomul® in high torque situations
coarse sand below water table	40 lb (18 kg) Bore-Gel .75 lb (340 g) Quik-Trol .75 lb (340 g) No-Sag	Add .5 - 1 gal (2-4 L) of Dinomul in high torque situations
gravel	50 lb (23 kg) Bore-Gel .75 lb (340 g) Quik-Trol .75 lb (340 g) No-Sag	Add .5 lb (225 g) of Barolift® to reduce loss of returns
cobble	50 lb (23 kg) Bore-Gel .75 lb (340 g) Quik-Trol .75 lb (340 g) No-Sag	Add .5 lb (225 g) of Barolift to reduce loss of returns
sand, gravel, clay or shale	35 - 40 lb (16-18 kg) Bore-Gel .5 pt (235 mL) EZ-Mud® .5 gal (2 L) Con-Det	Vary mixture according to percentage of sand and clay
clay	.5 lb (225 g) Poly Bore .5 gal (2 L) Con-Det®	Flow rate should be 3-5 parts fluid to 1 part soil. May use .25 - .5 gal (1-2 L) of Penetrol instead of Con-Det
swelling/sticky clay	.75 - 1 lb (340-450 g) Poly Bore .5 - 1 gal (2-4 L) Con-Det	Flow rate should be 3-5 parts fluid to 1 part soil. May use .25 - .5 gal (1-2 L) of Penetrol instead of Con-Det
solid rock (shale)	40 lb (18 kg) Bore-Gel	Use .5 pt (235 mL) of No Sag for large diameter or longer bores
solid rock (other than shale)	40 - 50 lb (18-23 kg) Bore-Gel	Use .5 pt (235 mL) of EZ-Mud in reactive shales
rock/clay mixture	40 - 50 lb (18-23 kg) Bore-Gel .5 pt (235 mL) EZ-Mud	
rock/sand mixture	40 - 50 lb (18-23 kg) Bore-Gel	Use .5 pt (235 mL) of No Sag for large diameter or longer bores
fractured rock	50 lb (23 kg) Bore-Gel .5 - 1lb (225-450 g) No-Sag	Use .5 lb (225 g) of Barolift to reduce fluid loss to formation

Drilling Fluid Requirements

1. Determine drilling conditions and choose appropriate drilling fluid mix.
2. Estimate amount of supplies needed and check availability.
   - Drilling fluid
   - Water supply. If more water than can be carried with the unit will be needed, arrange to transport additional water.
   - Bentonite and/or polymer
3. Check water quality.
   - Use meter or pH test strips to test pH of water. If pH is below 9.0, add 1 lb (454 g) soda ash per tank. Test and repeat until pH is between 9 and 10.
   - Check water hardness using hardness test strips. Treat with soda ash if hardness exceeds 125 ppm.

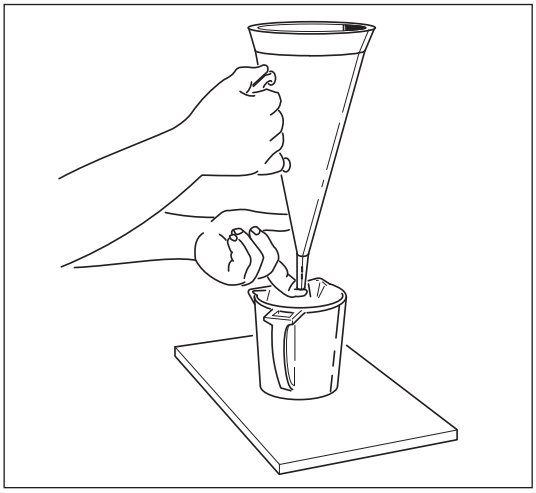
Funnel Viscosity

Viscosity is the measure of internal resistance of a fluid to flow; the greater the resistance, the higher the viscosity. Viscosity of drilling fluids must be controlled.

To determine viscosity, you will need a Marsh funnel (p/n 259-267) and a measuring cup, available from your Ditch Witch® dealer.

IMPORTANT: Make sure Marsh funnel is clean and free of obstruction and that you have a stopwatch available for timing the viscosity.

1. Using wash hose and a clean container, take a fresh sample of drilling fluid. The sample must be at least 1.5 qt (1.4 L).
2. With finger over bottom of funnel, fill with fluid from the container through the screen until fluid reaches the bottom of the screen.
3. Move funnel over 1 qt (.95 L) container.
4. Remove finger from bottom of funnel and use the stopwatch to count the number of seconds it takes for 1 qt (.95 L) of fluid to pass through the funnel. The number of seconds is the viscosity.
5. Thoroughly rinse measuring cup and Marsh funnel.



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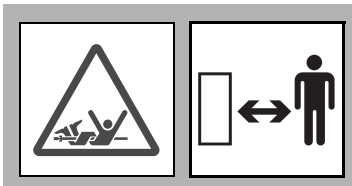
DrillLok™/Tracker Control

Overview



DANGER Rotating shaft will cause death or serious injury. Stay away.

To help avoid injury:

- Use DrillLok/tracker control any time you change downhole tools or during other times when the drill string is exposed.
- If you are not using DrillLok/tracker control, turn off drilling unit before changing downhole tools.

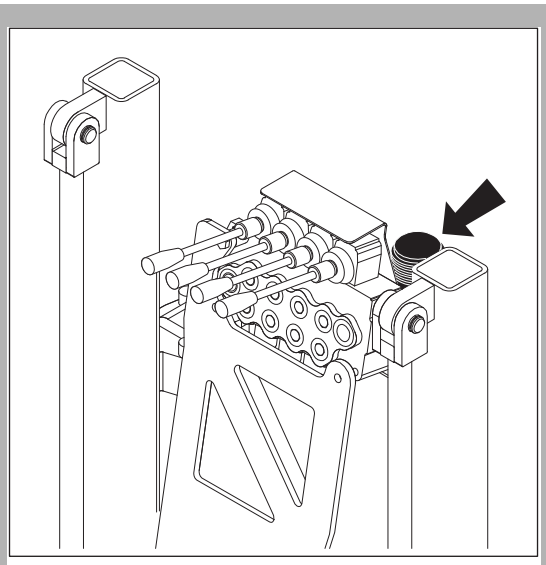
This mode allows the tracker operator to disable hydraulic power to drilling unit thrust and rotation.

NOTICE: This mode does not disable thrust and rotation immediately. Functions are disabled within 16 seconds.

Troubleshooting Tip: If thrust and rotation are not enabled check whether the green DrillLok™/tracker control light (shown), located on drilling unit anchoring console, is on. If it is, thrust and rotation have been disabled by DrillLok/tracker control.

NOTICE: Tracker operator cannot disable thrust and rotation from tracker if DrillLok/tracker control key is installed in drilling unit and turned to the deactivated position.

See "DrillLok™/Tracker control key" on page 24.



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Operation with Ditch Witch® Tracking Equipment: See tracker manual.

Operation without Ditch Witch® Tracking Equipment: Only available on units with DrillLok™ system. See DrillLok™ operation sheet.

Downhole Tools

Nozzles

Nozzles control fluid flow from the pipe to the bore. Select nozzles that will supply **at least** the amount of fluid per minute needed for the flow and pressure you will be using. A nozzle that will supply more fluid per minute is recommended. See your Ditch Witch® dealer for nozzle recommendations.

Bits

Selection

These charts are meant as a guideline only. No one bit works well in all conditions. See your Ditch Witch dealer for soil conditions and bit recommendations for your area.

- 1 = best
- 2 = good
- 3 = fair
- 4 = not recommended

Bit	Sandy Soil	Soft Soil	Medium Soil	Hard Soil	Rocky Soil	Soft Rock	Hard Rock
Sand bit	1	2	4	4	4	4	4
Durabit	2	2	1	1	4	4	4
Tuff bit	2	1	1	1	2	3	4
Steep Taper Tuff bit	4	3	2	1	1	2	4
Barracuda bit	2	1	1	2	3	4	4
Steep Taper bit	4	3	2	1	1	2	4
Hard Surface bit	2	1	2	3	4	4	4
Glacier bit	4	4	4	3	1	2	4
Rhino bit	4	4	3	3	1	1	3
Jetting assembly	4	4	3	2	1	2	3
Rockmaster™	4	4	3	2	1	1	1
Talon bit	4	3	2	1	1	1	4

Soil	Description
sandy soil	sugar sand, blow sand, or other soils where sand is the predominant component
soft soil	sandy loam
medium soil	loams, loamy clays
hard soil	packed clays, gumbo, all compacted soils
rocky soil	chunk rock, glacial till, cobble, rip rap, gravel
soft rock	soft limestone, sandstone, shale, coral, caliche
hard rock	granite, schist, marble, hard limestone

Installation

Remove all paint from mating surfaces before attaching any bit to housing. Install screws (p/n 107-277) and tighten to 120 ft•lb (163 N•m).

Beacon Housings

Lid Installation

1. Clean all threads, bolt holes, and mating surfaces.
2. Use removable thread locker (Loctite® 242 or equivalent), if desired.
3. Tighten bolts to 60-70 ft•lb (81-95 N•m).
4. Repeat tightening sequence.

Backreamers

A backreamer enlarges the hole as pipe is pulled back through the bore. No one backreamer works well in all conditions. These charts are meant as a guideline only. See your local Ditch Witch® dealer for soil conditions and backreamer recommendations for your area.

- 1 = best
- 2 = good
- 3 = fair
- 4 = not recommended

Backreamer	Sandy Soil	Soft Soil	Medium Soil	Hard Soil	Rocky Soil	Soft Rock	Hard Rock
Beavertail	3	1	1	1	3	4	4
Three Wing	4	3	3	2	1	1	4
Water Wing	4	3	2	1	2	2	4
Compact Fluted	1	1	2	2	2	3	4
Kodiak	4	3	3	2	1	2	4
Rhino Rock	4	4	4	4	3	2	1
Rockmaster™	4	4	4	4	3	1	1
Compaction Cone	1	2	3	4	4	4	4
HC Hard Condition	4	3	2	1	1	4	4
ST Saw Tooth	2	2	1	2	2	3	4
MX Mixer	2	2	3	4	4	4	4
CT Cutter	3	2	1	2	3	4	4
EX Expander	1	2	3	4	4	4	4
Fluted Cone	1	1	2	2	2	3	4

IMPORTANT: For soil definitions, see the chart on the previous page.

Backream Fluid Requirements

Backreaming is only successful when enough fluid reaches the bore. The amount of fluid needed depends on size of bore and soil condition.

Follow these steps to find the **minimum** amount of fluid needed in perfect conditions.

IMPORTANT: Use more fluid than recommended or the backream might be dry and unsuccessful.

Instructions	Example
1. Find amount of fluid needed for your size of backreamer. See the table on the next page.	**U.S.** A 6" backreamer requires at least 1.47 gal/ft.
	Metric A 152-mm backreamer requires at least 18.24 L/m.
2. Multiply this number by distance per minute you plan to backream. The answer is an estimate of amount of fluid you will need for each minute of backreaming.	**U.S.** 1.5 gal x 2 ft/min = 3 gal for each minute of backreaming.
	Metric 18 L x .5 m/min = 9 L for each minute of backreaming

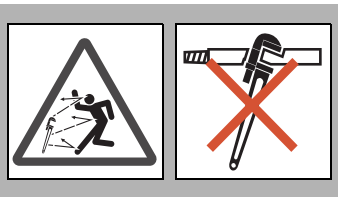
IMPORTANT: After you have determined how much fluid you will need, see your Ditch Witch® dealer for nozzle recommendations.

Backream Fluid Requirements

Backreamer/product diameter		Gal/ft	L/m	Backreamer/product diameter		Gal/ft	L/m
.5 in	13 mm	0.01	0.13	13.5 in	343 mm	7.44	92.35
1 in	25 mm	0.04	0.51	14 in	356 mm	8.00	99.31
1.5 in	38 mm	0.09	1.14	14.5 in	368 mm	8.58	106.54
2 in	51 mm	0.16	2.03	15 in	381 mm	9.18	114.01
2.5 in	64 mm	0.25	3.17	15.5 in	394 mm	9.80	121.74
3 in	76 mm	0.37	4.56	16 in	406 mm	10.44	129.72
3.5 in	89 mm	0.5	6.21	16.5 in	419 mm	11.11	137.95
4 in	102 mm	0.65	8.11	17 in	432 mm	11.79	146.44
4.5 in	114 mm	0.83	10.26	17.5 in	445 mm	12.49	155.18
5 in	127 mm	1.02	12.67	18 in	457 mm	13.22	164.17
5.5 in	139 mm	1.23	15.33	18.5 in	470 mm	13.96	173.42
6 in	152 mm	1.47	18.24	19 in	483 mm	14.73	182.92
6.5 in	165 mm	1.72	21.41	19.5 in	495 mm	15.51	192.68
7 in	178 mm	2.00	24.83	20 in	508 mm	16.32	202.68
7.5 in	190 mm	2.29	28.50	20.5 in	521 mm	17.15	212.94
8 in	203 mm	2.61	32.43	21 in	533 mm	17.99	223.46
8.5 in	216 mm	2.95	36.61	21.5 in	546 mm	18.86	234.23
9 in	229 mm	3.30	41.04	22 in	559 mm	19.75	245.25
9.5 in	241 mm	3.68	45.73	22.5 in	572 mm	20.65	256.52
10 in	254 mm	4.08	50.67	23 in	584 mm	21.58	268.05
10.5 in	267 mm	4.50	55.86	23.5 in	597 mm	22.53	279.83
11 in	289 mm	4.94	61.31	24 in	610 mm	23.50	291.86
11.5 in	292 mm	5.40	67.01	24.5 in	622 mm	24.49	304.15
12 in	305 mm	5.88	72.97	25 in	635 mm	25.50	316.69
12.5 in	318 mm	6.37	79.17	25.5 in	648 mm	26.53	329.49
13 in	330 mm	6.90	85.63	26 in	660 mm	27.58	342.53

Quick Wrench

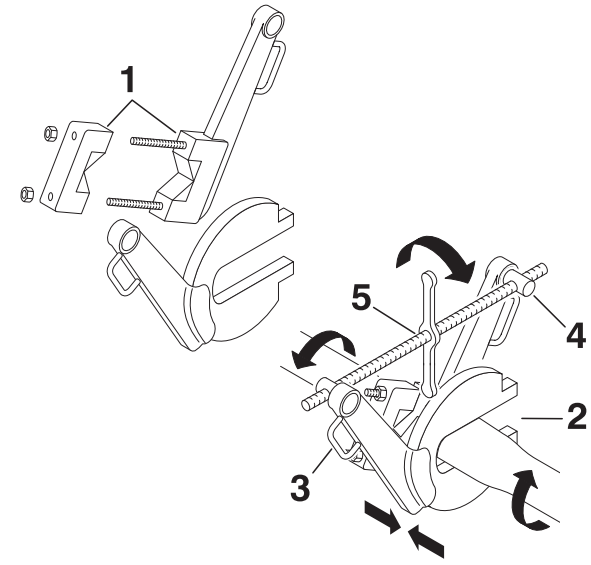
To attach or remove downhole tools, use quick wrench to join or break the joint.



DANGER Moving tools will kill or injure. Never use pipe wrenches on drill string. 273-278

IMPORTANT: Apply TJC to threads and hand-tighten joint before attaching quick wrench components to tighten joint.

Attach quick wrench in either the join or break position.



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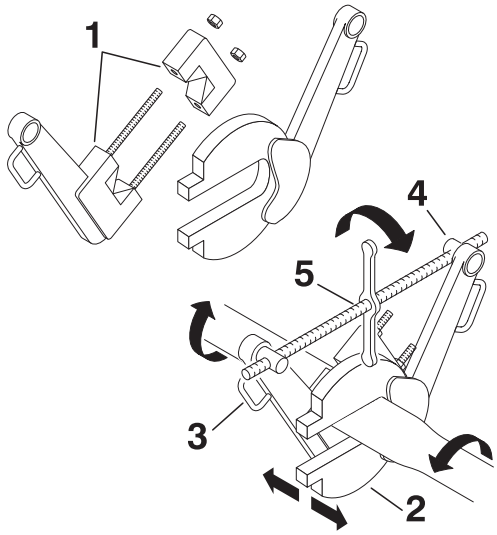
Join

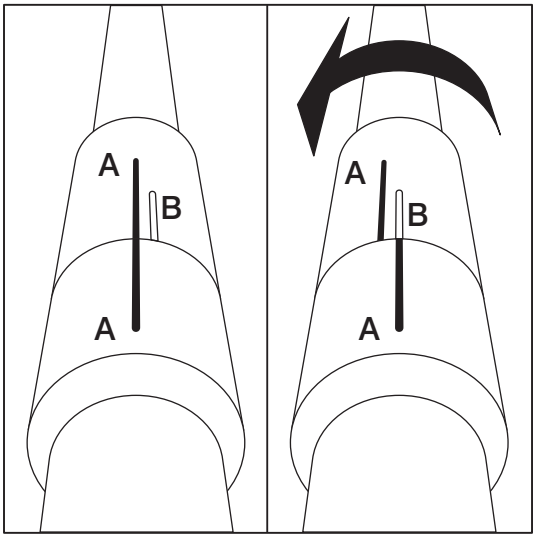


Break

- Unbolt vise (1) and place jaws around pipe.
- Bolt jaws of vise together.
- Place jaw (2) around pipe.
- Pin handles (3) to wrench jaws. Be sure handles are both up.
- Attach pivot nuts (4) to wrench handles so that screw drive handle (5) is over joint.

To Join

1. Scribe straight line across joint on both sides of separating line (A).
2. Scribe second line (B) on moveable side of joint in the opposite direction of tightening action .25" (6 mm) away from first line.
3. Turn handle until second line (B) meets first (A).
4. Turn handle opposite direction two turns to relieve pressure.
5. Remove quick wrench components.



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To Break

To help avoid injury: Ensure that engine is not on or DrillLok™/tracker control has disabled the unit before breaking joints.

1. Turn handle until joint is broken.
2. Turn handle opposite direction two turns to relieve pressure.
3. Remove quick wrench components.

Drill Pipe

Perform Regular Drill Pipe Care

Precondition New Pipe

Repeat this procedure **three times** for each piece of pipe before it is used the first time:

1. **Hand-lubricate** entire surface of threads and shoulders of both ends of pipe with copper base tool joint compound. See page 163 for correct lubricant.
2. Join pipe and tighten joint.
3. Break joint.
4. Move pipe back to box.

NOTICE: Failure to follow this procedure could result in fused joints. Pipe will be damaged or destroyed.

Lubricate Joints Before Each Use

Lubricate threads and shoulders of male joints with copper base tool joint compound. This prevents rust and reduces wear on shoulders and threads. See page 163 for correct lubricant.

Clean the Threads

Clean the threads as needed with high-pressure water and detergent.

NOTICE: Do not use gasoline or other petroleum-based solvents. This prevents tool joint compound from sticking to the joints and will reduce thread life.

Replace Worn Saver Sub

Because each pipe comes in contact with the saver sub, check saver sub regularly for wear. Compare condition of saver sub threads to condition of your drill pipe threads. Replace saver sub any time when its thread condition is not better than thread condition of your drill pipe. Failing to replace saver sub will result in damaged drill pipe. See page 185 for replacement procedure.

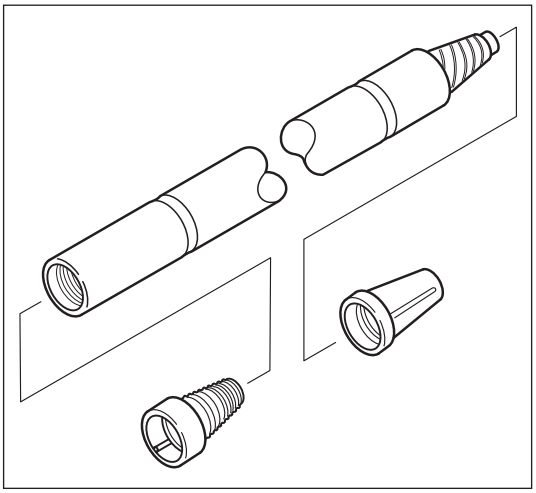
Precondition a new saver sub the same way you do new pipe. See “Precondition New Pipe” on page 135.

Rotate Pipe Order

Because the lead drill pipe is in the ground longer, it is subjected to higher shock loads and experiences more wear. To help spread this wear evenly over all pipe, move the lead pipe from the previous job out of the first position. See “Rotate Drill Pipe Order” on page 140.

Use Caps and Plugs

Before transporting in dusty conditions or prolonged storage, install caps and plugs to male and female ends of pipe and to saver sub.



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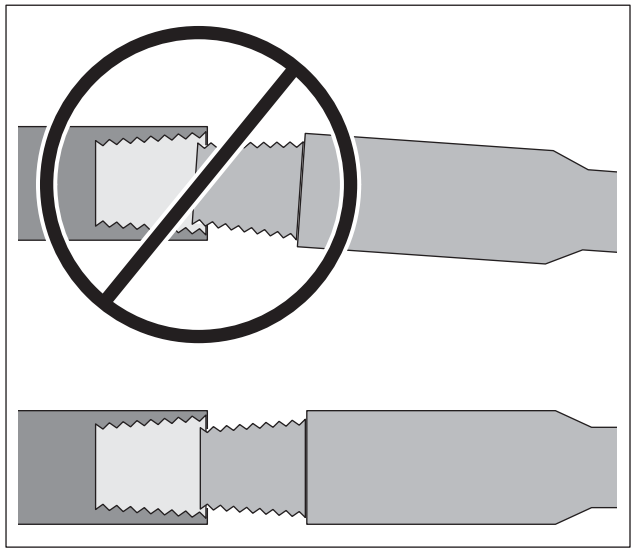
Use Drill Pipe Correctly

Align the Joints

Always carefully align the male and female ends of pipe before connecting them together. Poor alignment can damage the threads and destroy the usefulness of the joint.

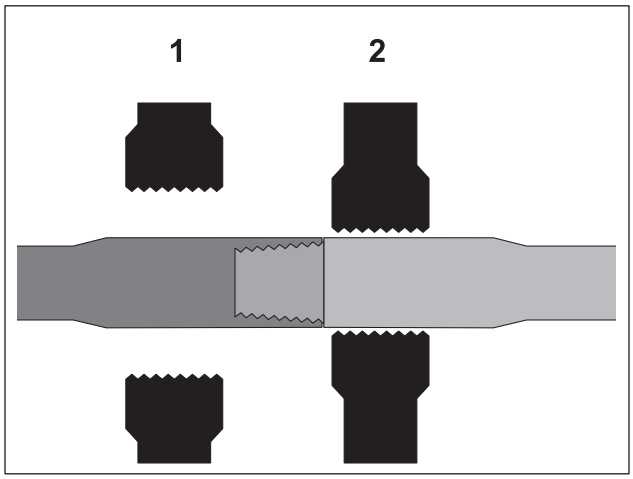


DrillPipe_Align.eps

Clamp Pipe Correctly

Clamp on pipe when joint is centered between wrenches. Clamp only on the tool joint of the drill pipe as shown. This portion of the drill pipe is designed for clamping and is considerably thicker and stronger than the rest of the pipe.

NOTICE: Clamping anywhere else on the pipe will weaken the pipe. Pipe can later break, even when operating under normal loads.



DrillPipe_Clamp.eps

Make Up and Break Out Joints Correctly

This consists of two steps:

- **Make up and break out joints slowly.** Do not ram pipes together during makeup or force them apart during breakout. Carefully time rotation with carriage travel speed, and always connect and disconnect joints slowly and deliberately. This will help prevent thread crossing, galling, and shoulder swelling.
- **Tighten joints fully.** Once the joint is connected and the shoulder faces are touching, tighten to full machine torque. Improperly tightened joints will damage the shoulder faces and threads, and will cause joints to leak or break while drilling or backreaming.

Do not Overwork the Pipe

Never exceed the bend radius for your pipe. See "Recommended Bend Limits" on page 68. Do not oversteer.

NOTICE: Bending pipe more sharply than recommended will damage pipe and cause failure.

Pipeloader

Shift Pipe Box

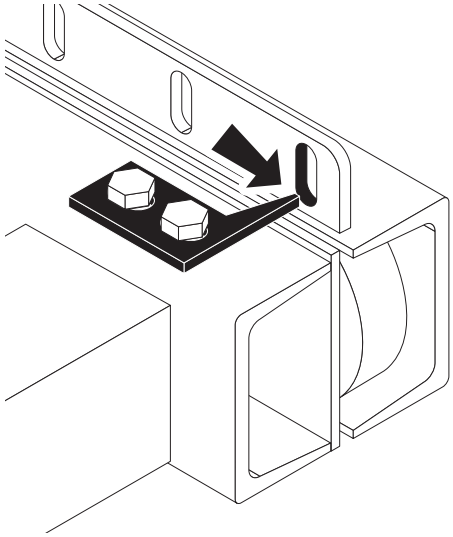
IMPORTANT: Lift arms must be fully raised for pipe box to move.

Drilling

1. Shift pipe box when both pipe box status lights are off.
2. Release pipe box switch when box hits mechanical stops, then move back to align mechanical pointer in center of cutout (shown) for new column.

Backreaming

1. Shift pipe box when active column is full (8 pipes).
2. Release pipe box switch when mechanical pointer is in center of cutout (shown) for new column.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Correct Dropped Pipe

When grippers are not closed before drill pipe automation is enabled, the pipeloader can drop a drill pipe when automation is turned off. To prevent this, always grip pipe before enabling pipeloader automation. See "Enable Automated Pipeloader System" on page 99.

To return a dropped pipe to the drill string, turn off engine and manually retrieve pipe. Return it to the pipe box by one of the following methods:

- To return the pipe to its original position in the drill string, load it as a single piece of pipe.
- To return the pipe to a later position in the drill string, remove two pins over top of pipe box, manually place the pipe into top of the active column, and install two pins.

Correct Misaligned or Jammed Pipe

One pipe box status light on and one light off indicates a misaligned or jammed pipe. Turn off engine and inspect pipe in active column.

- If one end of a drill pipe is jammed and will not drop correctly from pipe box, inspect pipe box position. If pipe box appears to be improperly aligned with discharge chute, return to operator's station and move pipe box slightly until mechanical pointer is in center of cutout (see page 139) for active column.
- If drill pipe is bent, remove it from pipe box and discard.

NOTICE: If neither of the causes and solutions outlined above correct the misaligned or jammed pipe, contact your Ditch Witch® dealer for assistance.

Rotate Drill Pipe Order

Rotating the lead pipe to the back of the string is a manual process. Rotate drill pipes in the drill string weekly.

Guidelines

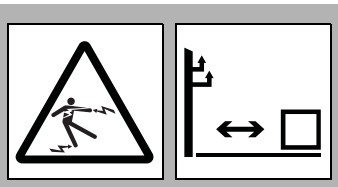
- Rotate only as many columns as used on the longest bore of the week. For example, if the longest bore was 320' (98 m), then only rotate the four columns used.
- Plan to rotate the pipes during the longest bore of the week.
- The lead pipe can only be rotated to the very back of the drill string when a bore requires at least one pipe from last (inner) column.

Procedure

1. During pullback, move to next column when only seven pipes are in last column from which pipe was removed during drilling.
2. Follow regular pullback procedure to load pipe into all remaining columns.
3. When lead pipe is in grippers, disconnect from both ends of lead pipe and retract shuttles fully.
4. Follow procedure for removing a single pipe. See page 141.
5. Turn off engine.
6. Remove pins across top of pipe box.
7. Remove lead pipe from auxiliary shuttles and place into vacant slot in pipe box.
8. Install pins over drill pipe.
9. Close both auxiliary pipe loaders.

Add/Remove Single Pipe

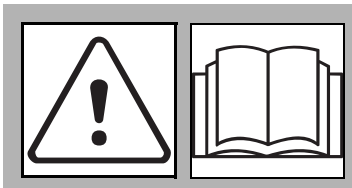
Load a single drill pipe or up to a whole column of drill pipe into an empty column of pipe box to finish bore.



DANGER Electric shock will cause death or serious injury. Stay away. 274-049

To help avoid injury:

- Do not attempt to load and unload pipe while drilling or backreaming. Unprotected worker can be injured by electric strike.
- On electrical jobsite, load and unload pipe only if loader is wearing electrically insulating boots and gloves.



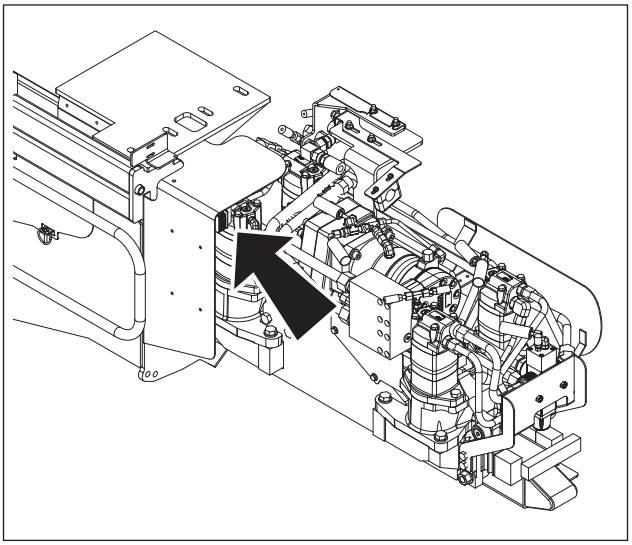
WARNING Read operator's manual. Know how to use all controls. Your safety is at stake. 273-475

To help avoid injury:

- Open or close **both** auxiliary pipe loaders. Moving shuttles with one auxiliary pipe loader open and one closed will damage equipment and cause possible injury.
- Carriage must be in full back position to load and unload pipe.

Add Single Pipe

1. Press top of shuttle lockout switch (shown) to prevent shuttle operation.
2. Ensure shuttle guard is lowered.



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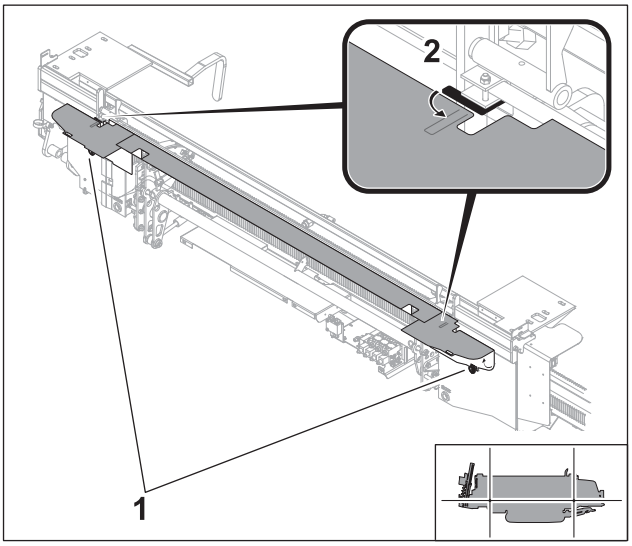
3. Remove two pins (1) and raise shuttle cover.
4. Slide tabs out (2) to support shuttle cover.
5. Press bottom of shuttle lockout switch to allow shuttle operation.
6. Raise pipe lifters.
7. Move shuttles out.
8. Press top of shuttle lockout switch to prevent shuttle operation.



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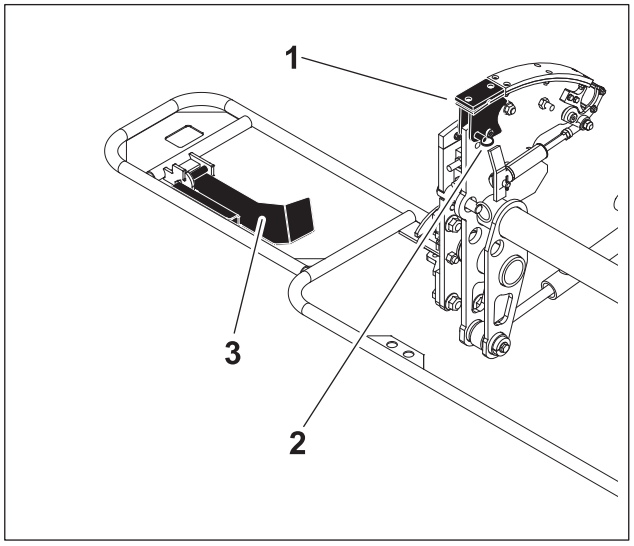
9. Pull pin (2) on shuttle, rotate auxiliary pipe loader down, and install pin.
10. Repeat for other shuttle.
11. Lift pipe stop indicator (3), rotate, and lock into slot.



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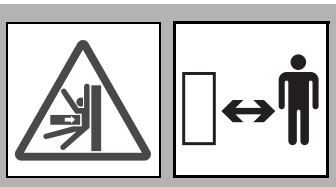
12. Load pipe into auxiliary pipe loaders with lower end resting against pipe stop indicator.



WARNING Crushing weight could cause death or serious injury. Use proper procedures and equipment or stay away.

To help avoid injury:

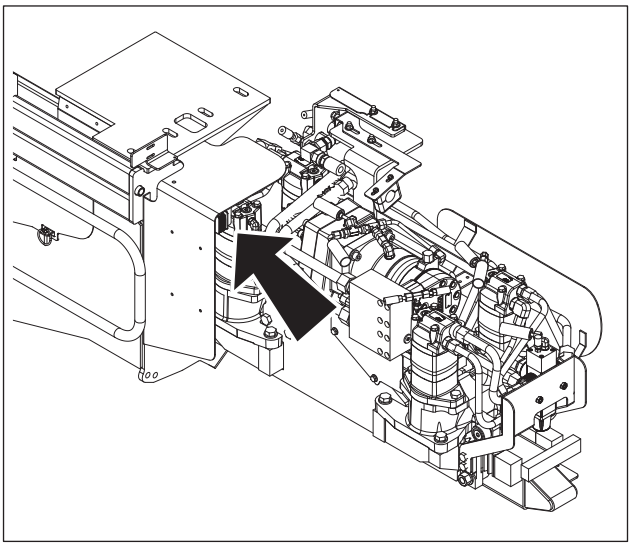
- Drill pipe is heavy. Have enough people on hand to manually add or remove single pipe to pipe box.
- Do not attempt to move shuttles until everyone is at least 10 ft (3m) away from machine.

13. Press bottom of shuttle lockout switch to allow shuttle operation.
14. Lower pipe lifters.
15. Move shuttles in fully.
16. Raise pipe into column.
17. Move shuttles out.
18. Repeat steps 8-16 to load more pieces of pipe.
19. Move pipe into pipeloader grippers.
    - Raise last pipe.
    - Move shuttles out.
    - Lower pipe into front grippers.
20. Before operating pipe loader:
    - Press top of shuttle lockout switch to prevent shuttle operation.
    - Close both auxiliary pipe loaders.
    - Remove pipe stop and store it on shuttle guard.
    - Slide tabs in on shuttle guard and let shuttle guard cover drop. Replace pins.
    - Move at least 10 ft (3 m) away from drill.

Remove Single Pipe

Unload all drill pipe loaded with auxiliary pipe loaders. Pipe in fifth row of pipe box can be unloaded only when all other rows are empty.

1. Press top of shuttle lockout switch (shown) to prevent shuttle operation.
2. Ensure shuttle guard is lowered.



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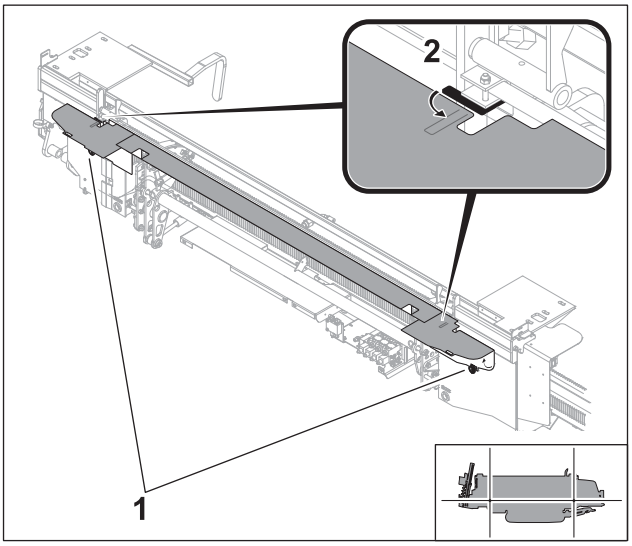
3. Remove two pins (1) and raise shuttle cover.
4. Slide tabs out (2) to support shuttle cover.



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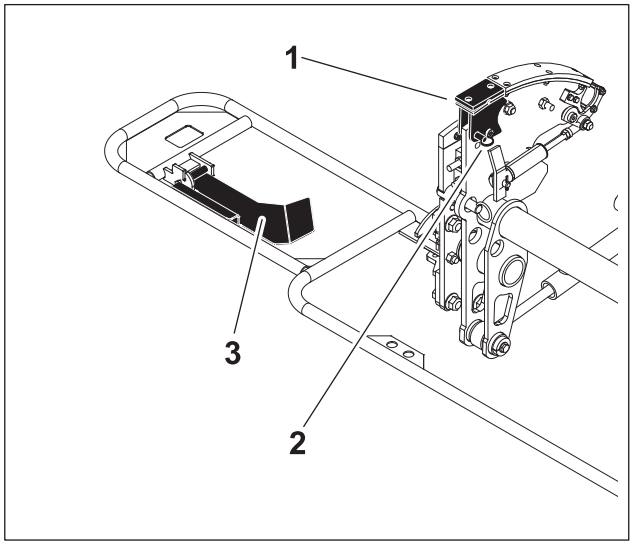
5. Pull pin (2) on shuttle, rotate auxiliary pipe loader down, and install pin.
6. Repeat for other shuttle.
7. Lift pipe stop indicator (3), rotate, and lock into slot.
8. Press bottom of shuttle lockout switch to allow shuttle operation.
9. Lower pipe into auxiliary pipe loaders.
10. Move shuttles out.
11. Press top of shuttle lockout switch to prevent shuttle operation.
12. Remove pipe.



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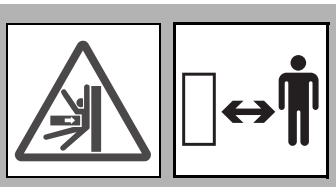


WARNING Crushing weight could cause death or serious injury. Use proper procedures and equipment or stay away.

To help avoid injury:

- Drill pipe is heavy. Have enough people on hand to manually add or remove single pipe to pipe box.
- Do not attempt to move shuttles until everyone is at least 10 ft (3 m) away from machine.

13. Press bottom of shuttle lockout switch to allow shuttle operation.
14. Move shuttles in.
15. Repeat steps 9-12 to unload remaining added drill pipe.
16. After all added drill pipe is unloaded with auxiliary pipe loaders:
    - Press top of shuttle lockout switch to prevent shuttle operation.
    - Close both auxiliary pipe loaders.
    - Remove pipe stop and store it on shuttle guard.
    - Slide tabs in on shuttle guard and let shuttle guard cover drop. Replace pins.
17. Press bottom of shuttle lockout switch to allow shuttle operation and move at least 10 ft (3 m) away from drill.
18. Finish loading remaining drill pipe into row 5 using standard procedure. See "Remove Pipe" on page 109.

Cruise Control

During the bore, you can set the desired thrust, pullback, and rotation speeds to match ground conditions. Cruise control enables the unit to maintain these settings hands-free. You can engage, disengage, override, and resume these settings at any time.

IMPORTANT: In order for cruise control to function, front wrench must be open and shuttles must be under pipe box.

Engage

Thrust/Pullback and Rotation Control	Thrust/Pullback Control Only
1. Position joystick so that thrust or pullback and rotation are at desired speeds. 2. Press set. Green control cycle light will come on. 3. Release joystick.	1. Position joystick to desired thrust or pullback setting. 2. Press set. Green control cycle light will come on. 3. Release joystick. 4. Operator controls rotation with joystick. ***NOTICE:*** Counterclockwise rotation can "break out" pipe joints downhole and unthread the joint. Operator should not rotate counterclockwise long enough to unthread a joint.

Adjust Settings

Setting	Instructions
Thrust or Pullback	• To increase thrust or pullback speed while joystick is in neutral position, press resume. • To decrease thrust or pullback speed while joystick is in neutral position, press set.
Rotation	• To increase rotation speed, move joystick to left and press resume. • To decrease rotation speed, move joystick to left and press set.

Override

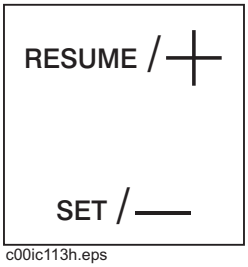
- To override thrust settings, move joystick out of neutral and beyond current setting. Unit will increase to new setting.
- To return to previous setting, release joystick.

Disengage

To disengage cruise control, move joystick out of neutral and in opposite direction of carriage travel. Green control cycle light will go off.

Resume

1. Position joystick out of neutral in previous direction of travel.
2. Press resume. Green control cycle light will come on.



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Diagnostic Codes

The JT20 is equipped with two diagnostic systems: engine and machine. The engine diagnostic system detects critical and non-critical errors within the engine operating system and communicates fault codes on the engine display. The machine diagnostic system detects essential and non-essential errors within the automated machine control system.

Electronic Controlled Engine Overview

This unit is equipped with a self-diagnostic computer-controlled fuel management system. A variety of sensors send input data to an ECU (Electronic Control Unit) that compares inputs with pre-programed parameters and sends output voltage to a variety of actuators to adjust and operate the engine within the specified parameters.

Warning indicators on the engine display tell the operator when critical and non-critical faults develop. Non-critical faults occur when engine sensors detect moderate trouble with coolant temperature, oil pressure, charge air temperature, or fuel temperature. Non-critical faults cause the operator alert indicator to light. Critical faults cause the engine shutdown indicator to light. In both cases, a fault code is stored in the ECU. If the fault corrects itself, the engine will gradually return to normal power. The alert indicator will continue to flash until the trouble goes away, but a fault code will remain stored.

Engine shutdown will occur due to critical faults in engine coolant temperature or oil pressure. Before shutdown, the operator alert indicator will light continuously and the engine will begin a rapid power derate. If the fault does not improve in 30 seconds the engine will shut down.

Reading Engine Diagnostic Codes

Problems with the engine are indicated by a popup message box on the engine display. The popup message is presented as either yellow for non-critical faults, or red for critical engine faults.

To hide/show active codes:

Press the soft key on the right next to the Hide icon. The message box will disappear, however the Warning or Stop message will remain on the screen until the fault is cleared.

Reading Machine Diagnostic Codes

Use the red diagnostic light to learn the condition of the diagnostic system. Under normal operating conditions, the diagnostic light will light steadily for two seconds after ignition is turned on to indicate light is working. It will then go out and remain out unless a diagnostic code is recorded.

If diagnostic codes are detected, the diagnostic light will either flash on and off for 10 seconds to indicate a non-essential code or remain on for 3 seconds and off for half a second to indicate an essential code.

Code Severity Levels

Diagnostic codes are given one of two levels of severity.

- A **non-essential** code affects non-essential functions of the unit. If the system detects a non-essential problem, a diagnostic code will be recorded and the diagnostic light will flash for 10 seconds and then go out. Each time ignition is turned on, full operation will be available until the diagnostic system detects a problem.
- An **essential** code affects rotation, thrust, drilling fluid, or ground drive. If the system detects an essential problem, a diagnostic code will be recorded and the diagnostic light will cycle on for three seconds and off for 1/2 second. Some machine functions may not work until the problem is corrected. Each time ignition is turned on, full operation will be available until the diagnostic system detects a problem.

Review Modes

IMPORTANT: Do not turn off ignition. Diagnostic codes are cleared each time ignition is turned off.

View All Codes	View Codes Individually
1. Ensure that engine is running and no one is sitting in operator's seat. 2. Press and hold the **resume** button for two seconds. 3. Diagnostic light will flash code 12 three times to indicate review mode is operational. 4. After flashing code 12, all diagnostic codes detected since the last time the ignition was turned on are flashed three times each. 5. To save diagnostic codes, continue normal operation. Do not turn ignition off. 6. Once the problem has been corrected, clear all codes by turning ignition off.	1. Ensure that engine is running and no one is sitting in operator's seat. 2. Press and hold the **set** button for two seconds. 3. Diagnostic light will flash code 12 (flash, pause, flash, flash, longer pause) to indicate review mode is operational. 4. After code 12 is flashed, press **set** button to see first code. • Press **resume** to see same code again or press **set** to see next code. • Continue pressing **set** until all diagnostic codes detected since the last time the ignition was turned on are flashed. 5. To save diagnostic codes, continue normal operation. Do not turn ignition off. 6. Once the problem has been corrected, clear all codes by turning ignition off.

Diagnostic Code Interpretation

Diagnostic codes are displayed through a series of light flashes and pauses. Count number of flashes and pauses to interpret code.

Example: "Flash, flash, flash, pause, flash, flash, longer pause" represents code 32.

Tips for interpreting codes:

- In View All Codes mode, the green control cycle light will come on the first time the red diagnostic light flashes a code. The green control cycle light will then go off and the red diagnostic light will flash the code two more times.
- Codes are displayed from lower to higher numbers.
- Code 11 is not used.
- Code 12 signals successful entry into and exit from review mode.

Machine Diagnostic Codes

The following table lists the attributes of each diagnostic code. Information presented includes: code number, condition causing code to be sent, result, and level of severity.

Code	Condition	Result	Severity
12	normal review mode entry	code is not stored	n/a
13	no 12V power to controller	drill and drive are blocked	essential
14	no 5V power from controller	drill and drive are blocked	essential
15	unknown output driver continuity problem	code is stored	non-essential
32	no continuity to shuttle extend solenoid	add pipe or remove pipe is aborted and code is stored	non-essential
33	no continuity to shuttle retract solenoid	add pipe or remove pipe is aborted and code is stored	non-essential
34	no continuity to pipe lift solenoid	add pipe or remove pipe is aborted and code is stored	non-essential
35	no continuity to pipe lower solenoid	add pipe or remove pipe is aborted and code is aborted	non-essential
42	no continuity to pipe release solenoid	add pipe or remove pipe is aborted and code is stored	non-essential
44	no continuity to lube front solenoid	add pipe or remove pipe is aborted and code is stored	non-essential
45	no continuity to carriage two speed solenoid	code is stored	non-essential
51	no continuity to rotation cw solenoid	cruise control is blocked	essential
52	no continuity to rotation ccw solenoid	cruise control is blocked	essential
53	no continuity to thrust forward solenoid	cruise control is blocked	essential
54	no continuity to thrust backward solenoid	cruise control is blocked	essential
55	no continuity to left track forward solenoid	drive is blocked	essential
61	no continuity to pipe box in solenoid	code is stored	non-essential
62	no continuity to pipe box out solenoid	code is stored	non-essential
63	no continuity to auxiliary dump valve	add pipe or remove pipe aborted and code is stored	non-essential

Code	Condition	Result	Severity
65	no continuity to thrust/right track neutral valve	cruise control is blocked	essential
71	no continuity to drive selector valve	drive is blocked	essential
111	no continuity to left track reverse solenoid	drive is blocked	essential
112	no continuity to right track forward solenoid	drive is blocked	essential
113	no continuity to right track reverse solenoid	drive is blocked	essential
114	no continuity to drilling fluid pump solenoid	code is stored	essential
131	no continuity to thrust rear home switch	add pipe and remove pipe are blocked	non-essential
132	no continuity to thrust front home switch	add pipe and remove pipe are blocked	non-essential
133	no continuity to shuttle home switch	add pipe and remove pipe are blocked	non-essential
134	no continuity to front wrench switch	add pipe and remove pipe are blocked	non-essential
144	drive joystick left/right out of range	drive is blocked	essential
145	drive joystick forward/backward out of range	drive is blocked	essential
151	drill joystick left/right out of range	rotation and cruise control are blocked	essential
152	drill joystick forward/backward out of range	rotation and cruise control are blocked	essential
154	drilling fluid potentiometer out of range	code is stored	essential
161	no continuity to front pipe box switch	code is stored	non-essential
162	no continuity to rear pipe box switch	code is stored	non-essential
163	no continuity to pipe up switch	pipe box movement is blocked and code is stored	non-essential
164	no continuity to DrillLok™/tracker control input	code is stored	non-essential
166	no continuity to thrust rear stop switch	code is stored	non-essential

Code	Condition	Result	Severity
221	system voltage is below 12.5V	code is stored	non-essential
233	drill and drive inputs both on	drill and drive are blocked	essential
235	front home and rear home inputs both on	add pipe and remove pipe are blocked	non-essential
241	shuttles not responding correctly	add pipe or remove pipe is aborted and code is stored	non-essential
254	error reading setup table information	add pipe and remove pipe are blocked	essential
255	undefinable diagnostic code reported	code is stored	non-essential

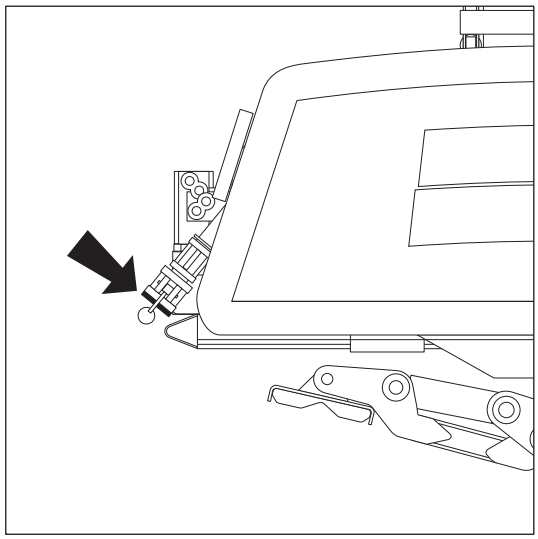
Complete the Job

Chapter Contents

Antifreeze Drilling Unit

Your drilling unit can be left overnight in freezing conditions by circulating a polypropylene-based antifreeze (p/n 265-644) through optional antifreeze system before shutdown.

Add Antifreeze



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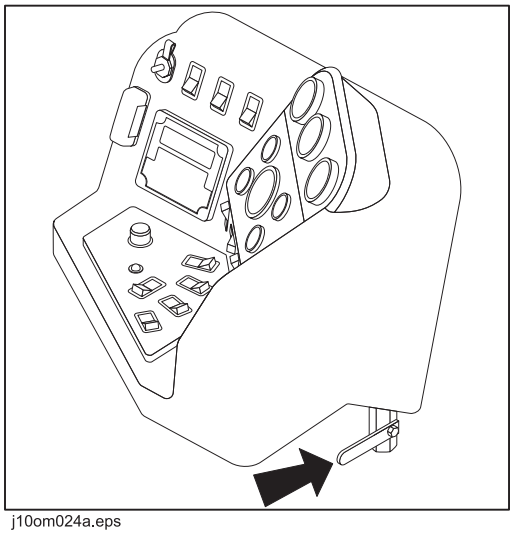
1. Fill antifreeze tank with 3 gal (11 L) of approved antifreeze.
2. Move carriage to front of drill frame.
3. Position 3-gal (11-L) bucket under spindle.
4. Install plug at quick coupler for drilling fluid pump (shown).
5. Open valve between antifreeze tank and head of drilling fluid pump.
6. Turn drilling fluid potentiometer counterclockwise to zero position.
7. Start unit and set throttle to slow position.
8. Slowly turn drilling fluid potentiometer clockwise until indicator light comes on. If light does not come on, press drilling fluid pump switch.
9. Run drilling fluid pump until antifreeze comes out of spindle.
10. Turn drilling fluid potentiometer counterclockwise to zero position.
11. Open valve below operator's console (shown).
12. Slowly turn drilling fluid potentiometer clockwise until indicator light comes on.
13. Close valve below console when antifreeze runs out of valve below console.
14. Turn drilling fluid potentiometer counterclockwise to zero position.



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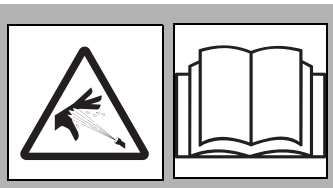
Reclaim Antifreeze

1. Connect remote fluid system. See page 93.
2. Turn on remote fluid system engine.
3. Start drilling unit and run at low throttle.
4. Move carriage to front of drill frame.
5. Position 3-gal (11-L) bucket under spindle.
6. Turn drilling fluid pump on low speed.
7. Turn drilling fluid pump off when drilling fluid comes out of spindle.
8. Open hood and pour antifreeze into tank.

IMPORTANT: Antifreeze can be removed from antifreeze tank and disposed of properly or it can be reused until it is too diluted with drilling fluid to protect against freezing.

Rinse Equipment

Using Washwand



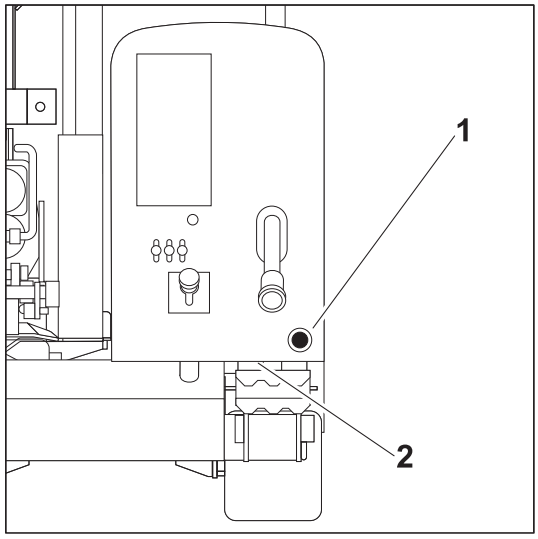
WARNING Pressurized fluid or air could pierce skin and cause severe injury. Refer to operator's manual for proper use. 270-6035

To help avoid injury:

- Never use high flow when using washwand.
- Prime the drilling fluid pump before operating washwand. Failure to prime the drilling fluid pump will cause flow fluctuations, which will make it difficult to control the washwand. For instructions, see "Prime Drilling Fluid Pump" on page 94.

NOTICE: Do not spray water onto operator's console. Electrical components could be damaged. Wipe down instead.

1. Connect the washwand at quick connect (1) at rear of unit. Open valve (2) to start water flow. Close valve to stop water flow.
2. Spray water onto equipment to remove dirt and mud. Some pressure might be needed to remove dried mud from wrench area.



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Disconnect

Disconnect and store the following hoses and cables (if used):

- electric strike system voltage stake
- fluid hose

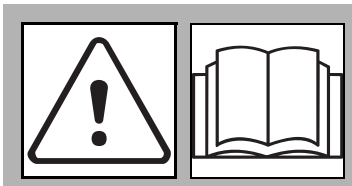
Stow Tools

Make sure all quick wrenches, bits, pullback devices, and other tools are loaded and properly secured on trailer or truck.

Service

Chapter Contents

Service Precautions

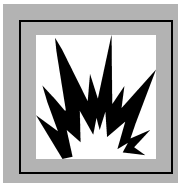


WARNING Read operator's manual. Know how to use all controls. Your safety is at stake. 273-475

To help avoid injury:

- Unless otherwise instructed, all service should be performed with engine off.
- Refer to engine manufacturer's manual for engine maintenance instructions.

Welding Precaution



WARNING Explosion possible. Serious injury or equipment damage could occur. Follow directions carefully.

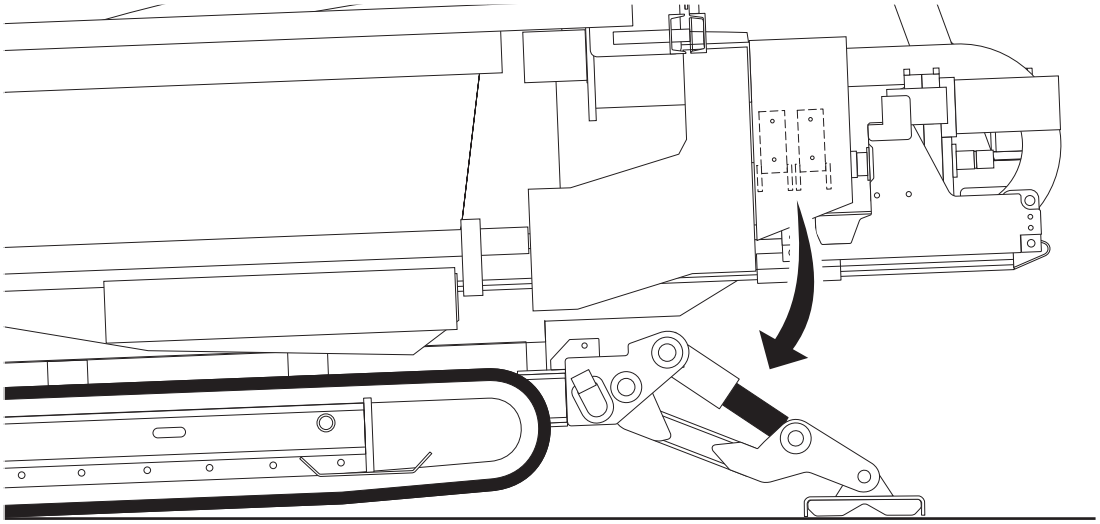
To help avoid injury:

- Disconnect battery to prevent damage to battery. Do not turn off battery disconnect switch with engine running, or alternator and other electronic devices may be damaged.
- Connect welder ground clamp close to welding point and make sure no electronic components are in the ground path.
- Always disconnect the electronic control module (ECM) ground connection from the frame, harness connections to the ECM, and other electronic components prior to welding on machine or attachments.

Washing Precaution

NOTICE: Water can damage electronics. When cleaning equipment, do not spray electrical components with water.

Working Under Drilling Unit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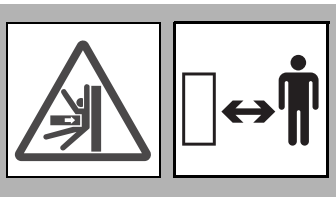


WARNING Crushing weight could cause death or serious injury. Use proper procedures and equipment or stay away.

Before working under area of drilling unit **supported by a stabilizer**, make sure drilling unit is parked on hard surface.

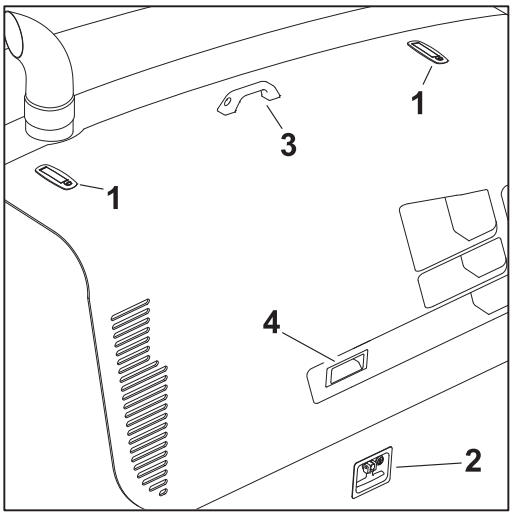
1. Remove cylinder locks from storage at rear of pipe box and place over extended cylinder rods (shown) with curved ends toward stabilizer shoes.
2. Raise stabilizers to lower unit until load is supported by cylinder locks.

If working under **raised drill frame**, support front and back of drill frame with jack stands or equivalent brace capable of supporting the weight of the unit.

Opening/Closing Front Hood

To open:

1. Unlock hood at handles (1, 2) if hood is locked.
2. Unlatch handles (1) and rotate handle (2) counterclockwise.
3. Grasp upper and lower (2, 4) handles.
4. Lift hood upward and outward.
5. Continue lifting hood and push inward until up-latch (5, below) engages.



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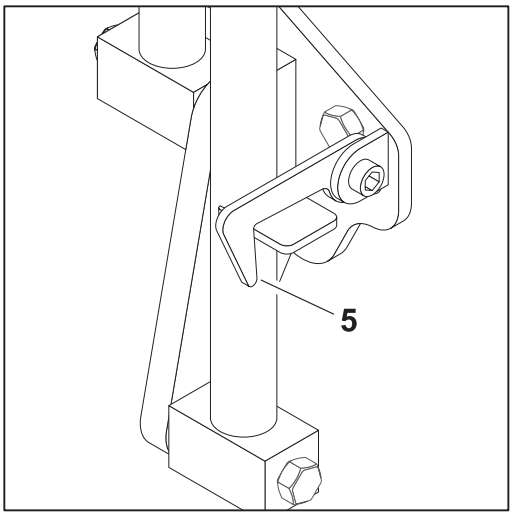
To close:

1. Disengage the up-latch (5) by holding it up as the hood is pulled outward using the lower handle (4).
2. Pull outward on the hood until it begins to move downward.
3. Place other hand on top outer surface of hood (1) and firmly push downward until hood is in place.
4. Latch handles (1) and rotate handle (2) to secure hood.
5. Lock hood at handle (1,2), if desired.



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Recommended Lubricants/Service Key

Item	Description
DEO (Tier 4 Units)	Diesel engine oil meeting or exceeding Deutz specification DQC III- LA. ***NOTICE:*** This unit is shipped from the factory with API CJ-4 DEO meeting Deutz specification DQC II-LA. Change oil initially at 250 hours. • Engine must use low sulfated ash, phosphorous, and sulfur (low (SAPS) oil. • See viscosity chart. • If oils meeting only API CJ-4 or ACEA E6/E9 are used, service interval is reduced to 250 hours.
DEO (Tier 4i Units)	Diesel engine oil meeting or exceeding Deutz® specification DQC III. ***NOTICE:*** Shipped from factory with API CJ-4 DEO meeting Deutz specification DQC II-LA. Change oil initially at 100 hours if fuel sulfur level content exceeds 500 ppm (500 mb/kg). Otherwise initial oil change should be at 250 hours. • See viscosity chart. • If oils meeting only API CJ-4 or ACEA E7 are used, service interval is reduced to 250 hours.
NDO	SAE 30 Non-detergent oil
MPG	Multipurpose grease. Use polyurea based NLGI GC-LB Grade 1.5 or lithium based NLGI GC-LB Grade 2.
EPG	Open gear extreme pressure lubricant (p/n 256-666)
EPS	Open gear extreme pressure lubricant, spray (p/n 256-034)
MPL	Multipurpose gear oil meeting API service classification GL-5 (SAE 80W90)
THF	Tractor hydraulic fluid, similar to Phillips 66® HG, Mobilfluid® 424, Chevron® Tractor Hydraulic Fluid, Texaco® TDH Oil, or equivalent
TJC	Tool joint compound: Ditch Witch® standard (p/n 259-858), environmentally friendly (257-1005), or summer grade (p/n 256-031)
DEAC	Low silicate, nitrite free, fully formulated diesel engine antifreeze/coolant meeting Deutz specification DQC CB-14. See "Approved Coolant" on page 164.

	Check level of fluid or lubricant		Check condition
	Filter		Change, replace, adjust, service or test

Proper lubrication and maintenance protects Ditch Witch® equipment from damage and failure. Service intervals listed are for minimum requirements. In extreme conditions, service machine more frequently. Use only genuine Ditch Witch parts, filters, approved lubricants, TJC, and approved coolants to maintain warranty. Fill to capacities listed in "Specifications" on page 191.

For more information on engine lubrication and maintenance, see your engine manual.

IMPORTANT: Use the "Service Record" on page 199 to record all required service to your machine.

Approved Fuel

This engine is designed to run on diesel fuel. Use only high quality fuel meeting ASTM D975 No. 2D, EN590, or equivalent. At temperatures below 32° F (0° C) winter fuel blends are acceptable. See the engine operation manual for more information.

IMPORTANT: Fuel sulfur content should be less than 5000 ppm (0.5%). Worldwide, fuel sulfur regulations vary widely. Fuel used should always comply with local regulations. If using lube oil meeting API CJ-4, (or other low SAPS equivalent) and fuel with sulfur content above 15 ppm (0.0015%), ULSD in the U.S.), reduce oil change interval to 125 hours.

Biodiesel blends up to 5% (B5) are approved for use in this unit. The fuel used must meet the specifications for diesel fuel shown above. In certain markets, higher blends may be used if certain steps are taken. Extra attention is needed when using biodiesel, especially when operating in cold weather or storing fuel. Contact your Ditch Witch dealer or the engine manufacturer for more information.

Approved Coolant

Beginning April 4, 2016, this unit was filled with **red** coolant meeting Deutz® DQC CB-14 before shipment from factory. Add or replace only with coolant meeting this specification. This coolant is available, pre-diluted, from your Ditch Witch dealer as part number 255-1053. Contact your Deutz service partner for a full list of approved coolants meeting DQC CB-14. In an emergency, non-Deutz approved, heavy duty diesel engine coolant meeting ASTM D6210 may be used. Change to DQC CB-14 coolant as soon as practical.

Prior to April 4, 2016, this unit was filled with **yellow** John Deere® Cool-Gard® coolant before shipment from factory. Add only John Deere Cool-Gard (p/n 255-006) or any fully-formulated, ethylene glycol based, low-silicate, heavy-duty diesel engine coolant meeting ASTM specification D6210. Switch to the new approved **red** coolant described above at the next change interval.

NOTICE:

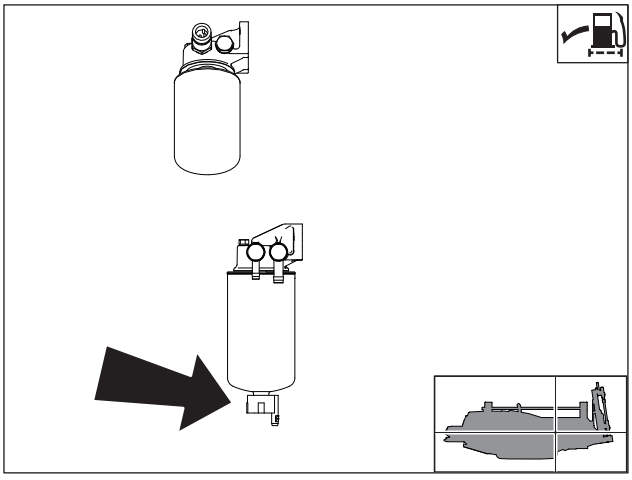
- Use only pre-diluted or concentrated coolant mixed with distilled water. Do not use tap water.
- Do not use water or high-silicate automotive-type coolant. This will lead to engine damage or premature engine failure.
- Do not mix heavy-duty diesel engine coolant and automotive-type coolant. This will lead to coolant breakdown and engine damage.

Startup/10 Hour

Task	Notes
Check fuel filter water separator	
Check air filter indicator and clean dust trap	
Check engine oil level	DEO
Check engine coolant level	DEAC
Check hydraulic hoses	
Check hydraulic fluid level	THF
Check fluid pump oil level	NDO
Test control switches	
Check pipe lube applicator	
Check pipe auto lubricator spray nozzle	
Check pipe auto lubricator TJC level	TJC
Check drilling fluid y-strainer	

Check Fuel Filter Water Separator

Check fuel filter water separators before startup and every 10 hours of operation. Drain water at plug (shown) as needed.



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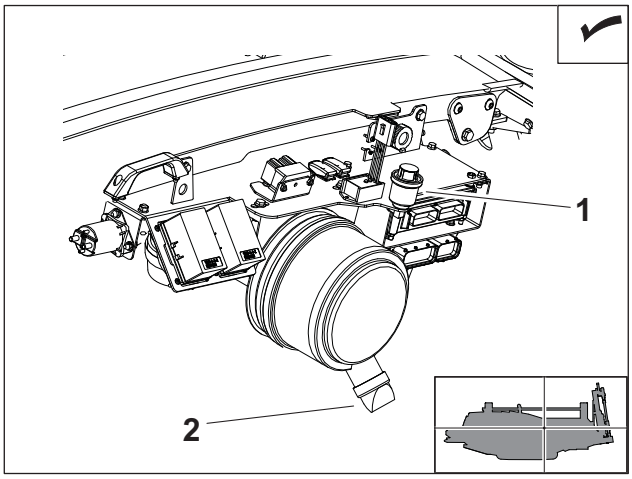
Check Air Filter Indicator and Clean Dust Trap

Check air filter indicator (1) and inspect dust trap (2) for cracks every 10 hours. Change filter elements when indicator reaches the red zone. See "Change Air Filter" on page 184.

NOTICE: Only open the air filter canister when air restriction is indicated. Change the elements, do not attempt to clean them.

- Compressed air or water may damage filter elements.
- Tapping filter elements to loosen dirt may damage filter seals.



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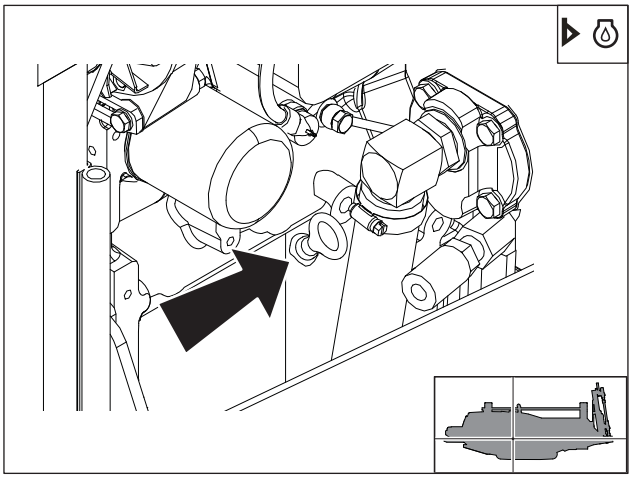
Check Engine Oil Level

Check engine oil at dipstick before startup and every 10 hours of operation. Check with unit on level surface and at least 15 minutes after stopping engine. Add DEO at fill as necessary to keep oil level at highest line on dipstick.



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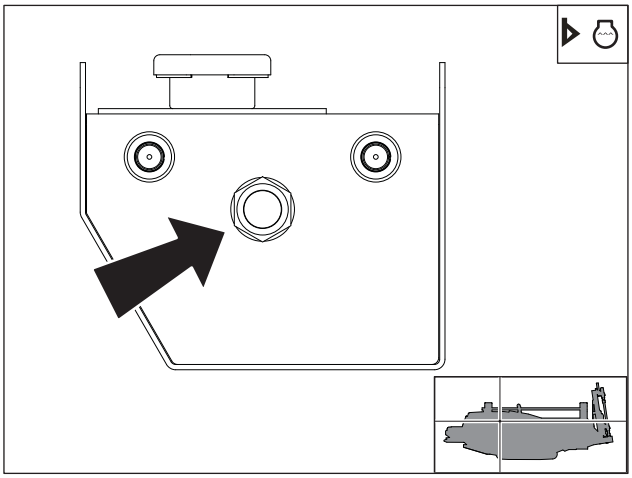
Check Engine Coolant Level

Check coolant level, with engine cool, at expansion tank before startup and every 10 hours of operation. Maintain coolant level at halfway point on sight glass. If low, add pre-diluted coolant to maintain proper freeze protection.

IMPORTANT: See "Approved Coolant" on page 164 for information on approved coolants.



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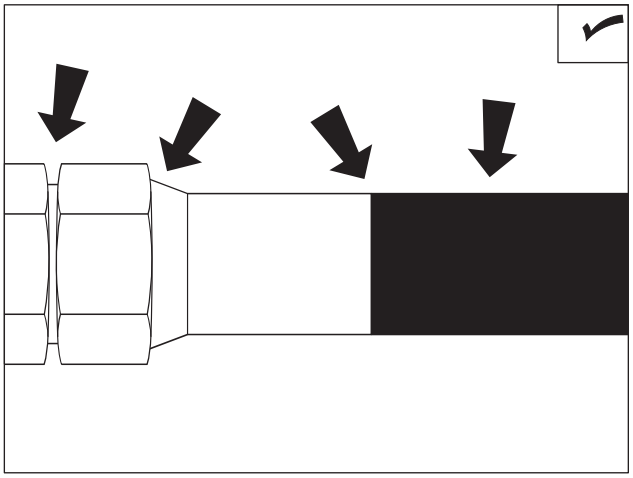
Check Hydraulic Hoses

WARNING Pressurized fluid or air could pierce skin and cause severe injury. Refer to operator's manual for proper use. 270-6035

To help avoid injury:

- Before disconnecting a hydraulic line, turn engine off and operate all controls to relieve pressure. Lower, block, or support any raised component with a hoist. Cover connection with heavy cloth and loosen connector nut slightly to relieve residual pressure. Catch all fluid in a container.
- Before using system, check that all connections are tight and all lines are undamaged.
- Use a piece of cardboard or wood, rather than hands, to search for leaks.
- Wear protective clothing, including gloves and eye protection.
- If you are injured, seek immediate medical attention from a doctor familiar with this type of injury.

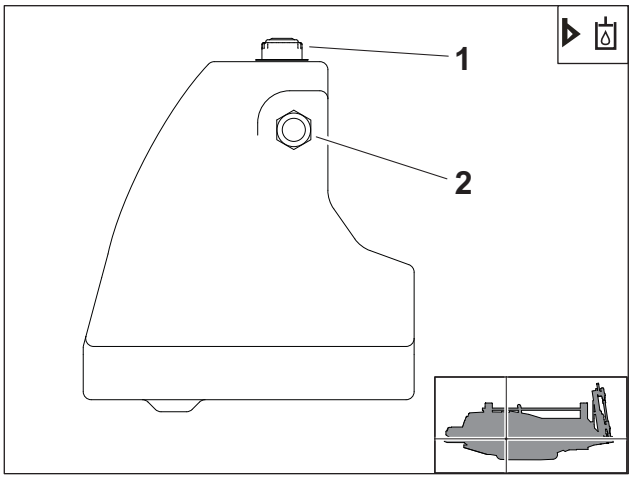
Check hydraulic hoses for leaks before startup and every 10 hours of operation.



CheckHoses.eps

Check Hydraulic Fluid Level

Check hydraulic fluid level before startup and every 10 hours of operation. Maintain fluid level at halfway point on sight glass (2), when engine is off and fluid is cool. Refill with THF at hydraulic fluid fill (1).



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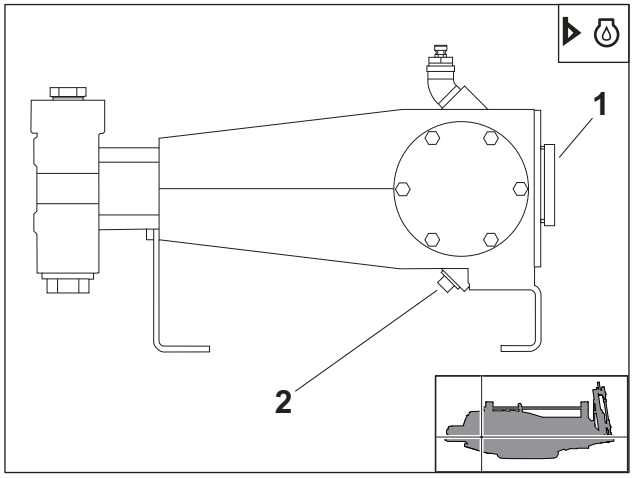
Check Fluid Pump Oil Level

Check fluid pump oil level at fill plug (1) before startup and every 10 hours of operation. Maintain fluid level at fill plug. Add NDO at fill plug (1) as needed.



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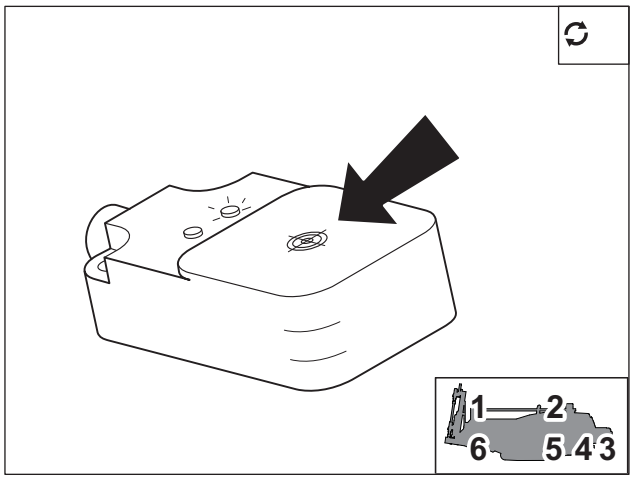
Test Control Switches

Check control proximity switches before startup and every 10 hours of operation and clean or replace as needed.

1. front pipe box switch
2. rear pipe box switch
3. rear stop switch
4. rear home switch
5. shuttle position switch
6. front home switch



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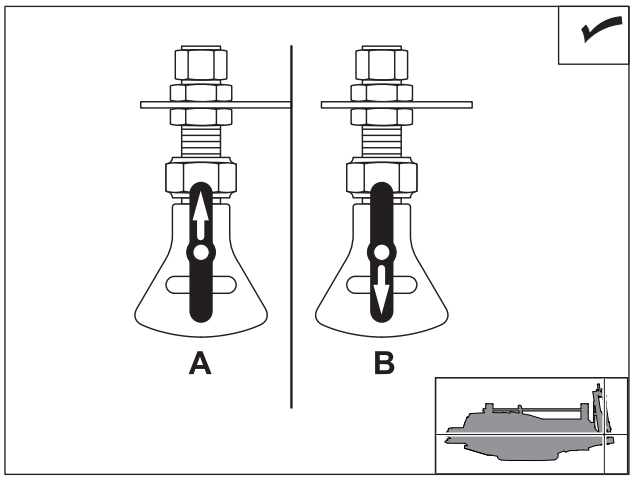
To test:

1. Turn ignition switch to the on position. Do not start engine.
2. Place metal object above target on each switch.
3. If yellow LED on switch lights, switch sensor is working.

Check Pipe Auto Lubricator Spray Nozzle

Check pipe auto lubricator spray nozzle before startup and every 10 hours of operation. Ensure that nozzle is free of obstructions and operates properly. Clean as needed.

NOTICE: Ditch Witch® tool joint compound is specially formulated to work with Ditch Witch pipe lubrication system. Use of other tool joint compounds will clog system. See "Recommended Lubricants/Service Key" on page 163 for more information.



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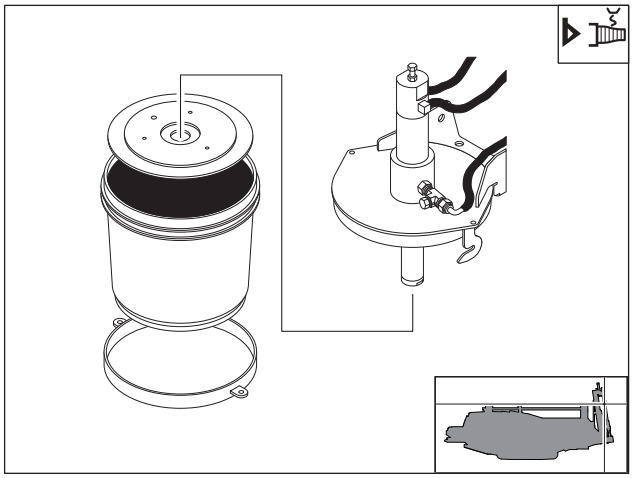
To clean:

1. Rotate handle to the upward, or cleanout, position (A).
2. Operate pump until obstruction is flushed.
3. Rotate handle to the downward, or spray, position (B).
4. Clean nozzle guard. If necessary, pull handle/nozzle insert out of housing to clean with fine wire or solvent.

Check Pipe Auto Lubricator TJC Level

Check pipe auto lubricator TJC level before startup and every 10 hours of operation. Change pail as needed. See "Change Auto Lubricator TJC Pail" on page 181 for procedure.

NOTICE: Ditch Witch tool joint compound is specially formulated to work with Ditch Witch pipe lubrication system. Use of other tool joint compounds will clog system. See "Recommended Lubricants/Service Key" on page 163 for more information.



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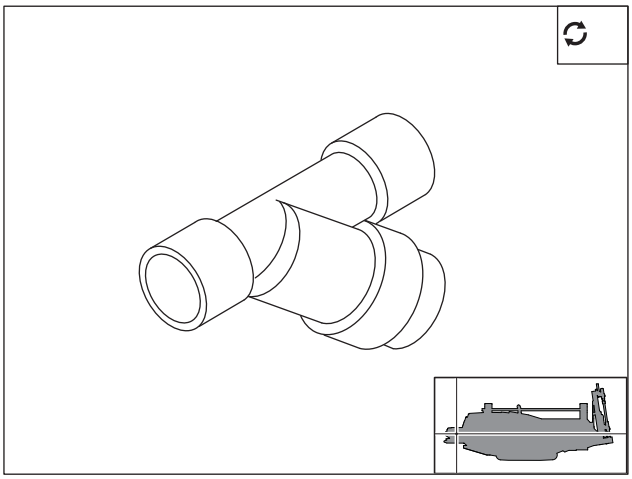
Clean Drilling Fluid Y-Strainer

Clean drilling fluid y-strainer before startup and every 10 hours of operation. Ensure that strainer is free of debris.



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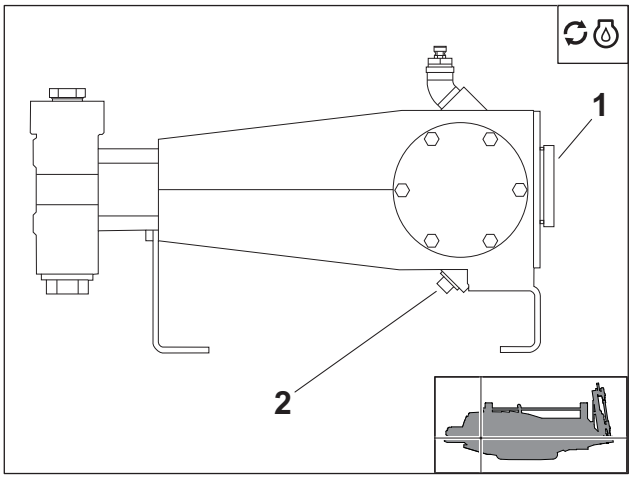
50 Hour

Task	Notes
Change fluid pump oil	Initial service, NDO
Check radiator	
Change hydraulic filter	Initial service
Check ground drive gearbox oil level	2 gearboxes, MPL
Check rotation gearbox oil level	MPL
Lube rotation gearbox sliding output shaft	EPS
Inspect thrust rollers	

Change Fluid Pump Oil (Initial Service)

Change fluid pump oil after first 50 hours and every 1000 hours thereafter. Drain at plug (2) and add NDO engine oil at plug (1). Maintain fluid level at fill plug.



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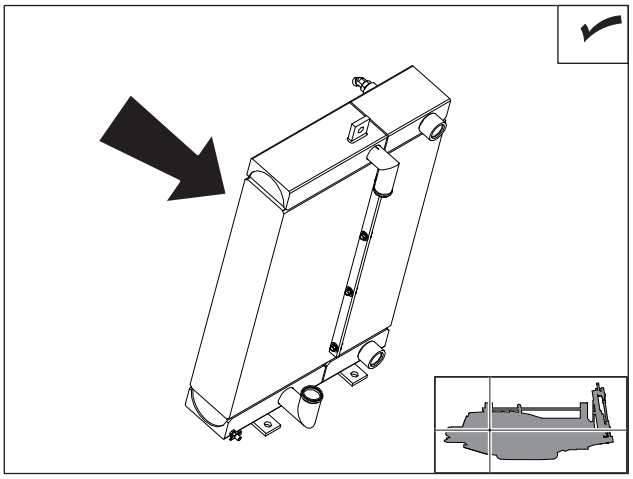
Check Radiator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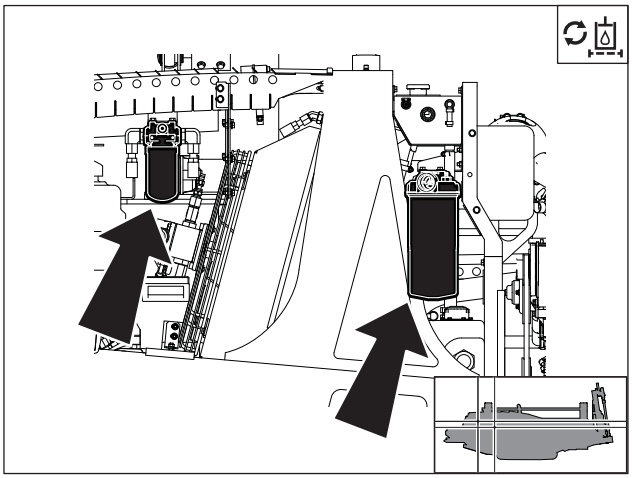
Check radiator for dirt, grass, and other debris every 50 hours. Check more often if operating in dusty or grassy conditions. Clean as needed.

To clean:

- Clean fins with compressed air or spray wash.
- Open rear hood and spray through radiator toward engine.
- If grease and oil are present on radiator, spray with solvent and allow to soak overnight.

IMPORTANT: Be careful not to damage fins with high pressure air or water.

Change Hydraulic Filters (Initial Service)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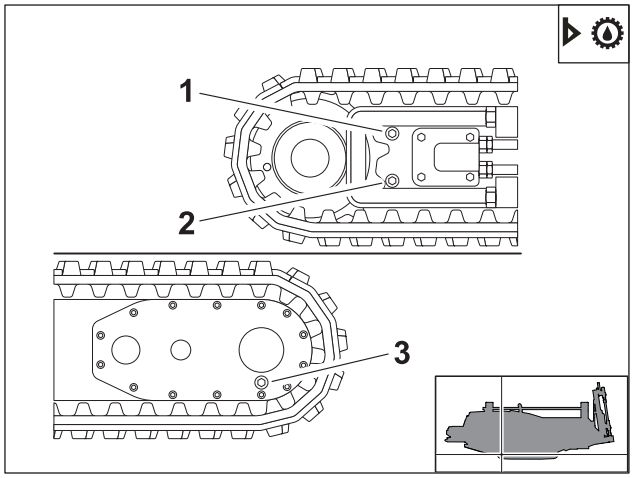
Change hydraulic main and charge filters after first 50 hours. Replace filter every 500 hours thereafter. Change filter more often if indicated by filter indicator. See "Specifications" on page 191.

Check Ground Drive Gearbox Oil Level



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Check oil level in both ground drive gearboxes every 50 hours.

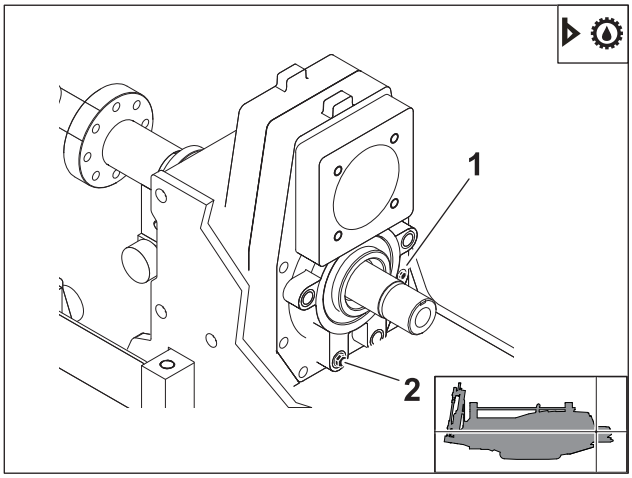
To check:

Open check plug (2). If oil does not come out, open fill plug (1) and add MPL until level with check plug (2).

IMPORTANT:

- Drilling unit must be on level ground for accurate reading.
- Use helper to assist in positioning gearbox plugs for checking and adding oil.
- Do not overfill.

Check Rotation Gearbox Oil Level



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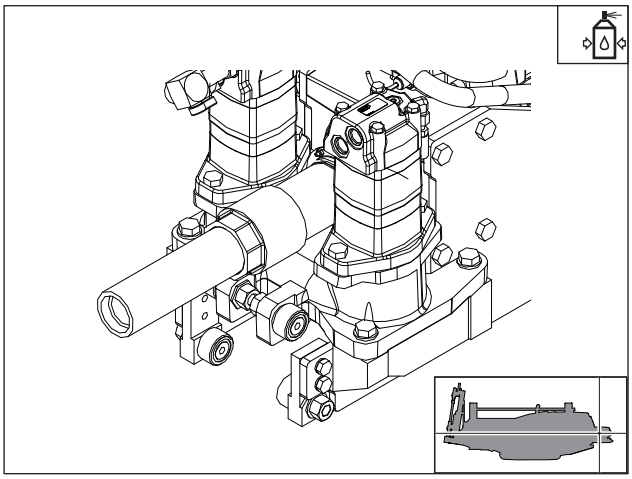
Check rotation gearbox oil level every 50 hours. Add MPL through plug (1) as needed.

IMPORTANT: Drill frame must be level for accurate reading.

Lube Rotation Gearbox Sliding Output Shaft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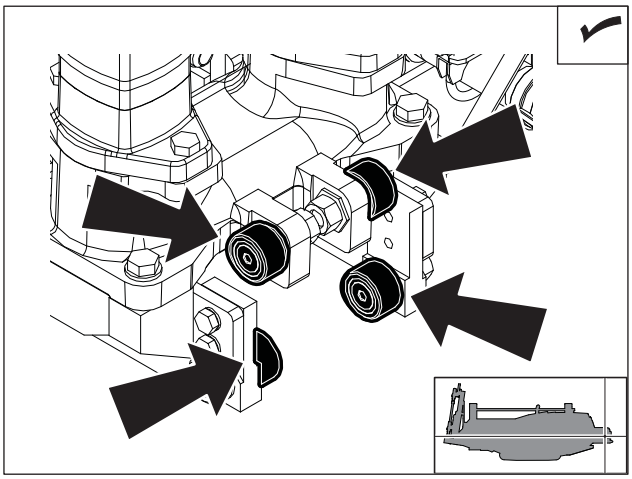
Lube rotation gearbox sliding output shaft with EPS every 50 hours.

To lube:

- Stop engine and turn battery disconnect switch to the OFF position.
- Clean exposed portion of sliding output shaft with pressure washer to remove grime.
- Blow dry with compressed air.
- Apply EPS spray lube to all exposed shaft surfaces while manually moving the shaft in and out.
- Turn battery disconnect switch to the ON position.

Inspect Thrust Rollers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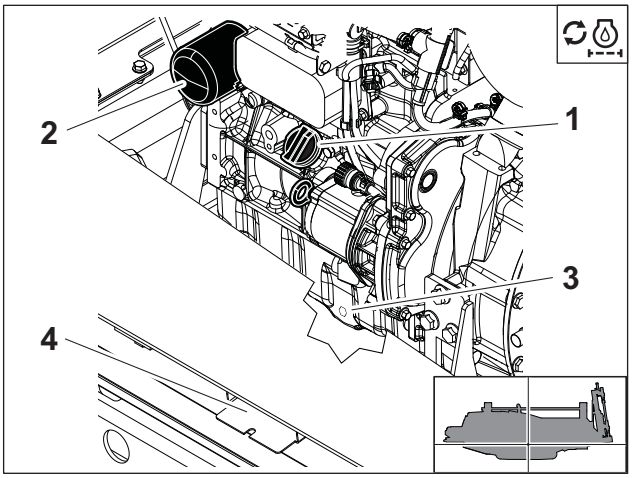
Inspect thrust rollers (at each end of carriage) every 50 hours. Clean or replace if they do not turn freely.

100 Hour

Initial Engine Oil and Filter Change (Tier 4i units)

Initial engine oil and filter change is 100 hours if fuel sulfur content is above 500 PPM. Otherwise initial oil change should be at 250 hours. See "Recommended Lubricants" for more information about DEO specifications.



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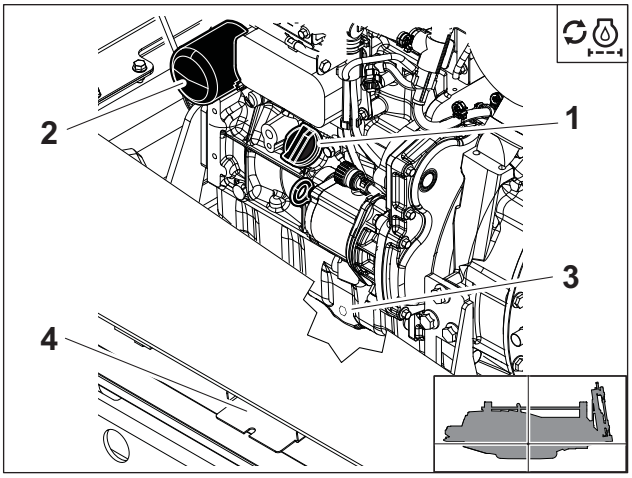
To change:

1. Extend drain tray (4).
2. While oil is warm, remove drain plug (3). Drain oil, replace plug, and slide drain tray (4) into original location.
3. Remove filter (1) and replace with new filter each time oil is changed. Add DEO at fill neck (2).

250 Hour

Task	Notes
Change engine oil and filter (Tier 4 final units)	
Inspect air intake system	

Engine Oil and Filter Change (Tier 4 final units)



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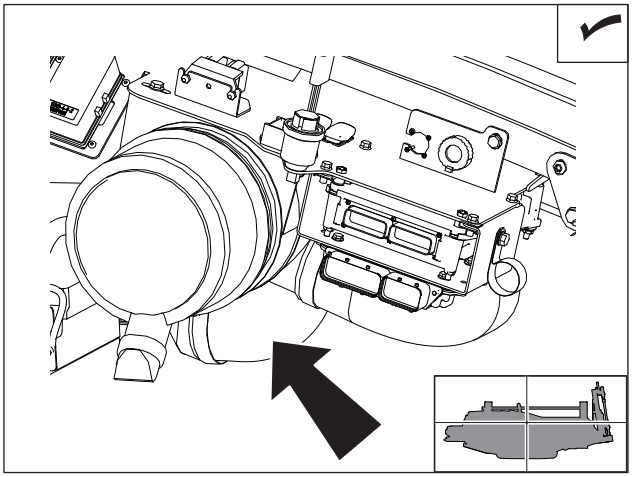
Regular engine oil and filter change is 250 hours See "Recommended Lubricants" for more information about DEO specifications.

To change:

1. Extend drain tray (4).
2. While oil is warm, remove drain plug (3). Drain oil, replace plug, and slide drain tray (4) into original location.
3. Remove filter (1) and replace with new filter each time oil is changed. Add DEO at fill neck (2).

Inspect Air Intake System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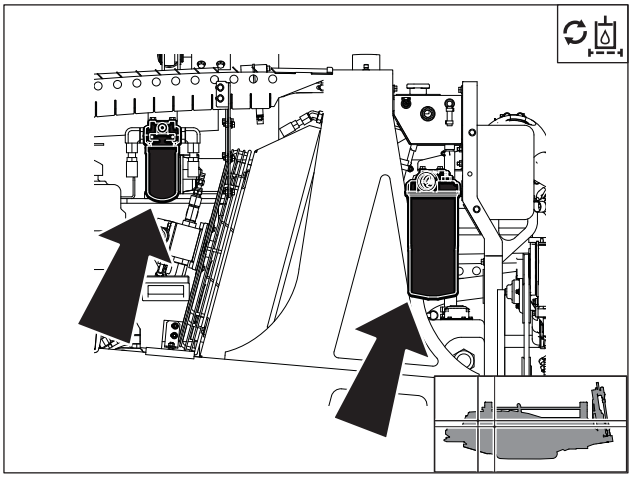
Inspect intake piping for cracked hoses, loose clamps, or punctures. Tighten or replace parts as necessary.

500 Hour

Task	Notes
Change hydraulic fluid and filter	Normal conditions
Change fuel filter	

Change Hydraulic Fluid and Filter (Normal Conditions)

Change hydraulic main and charge filters every 500 hours. Change filter more often if indicated by filter indicator.



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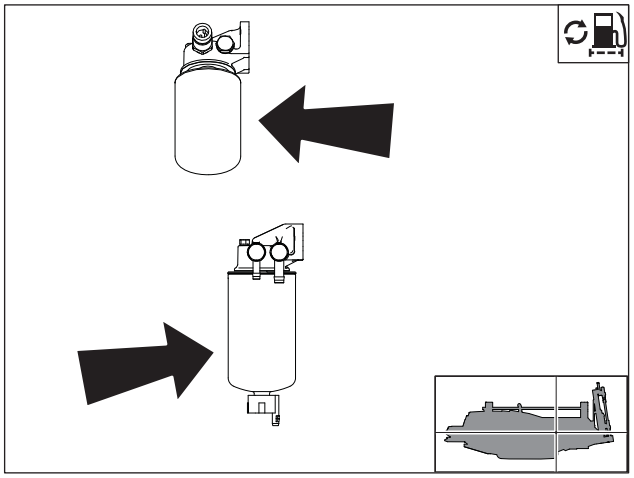
Change Fuel Filters

Replace fuel filters every 500 hours. See parts manual or contact your Ditch Witch® dealer for correct replacement filter.



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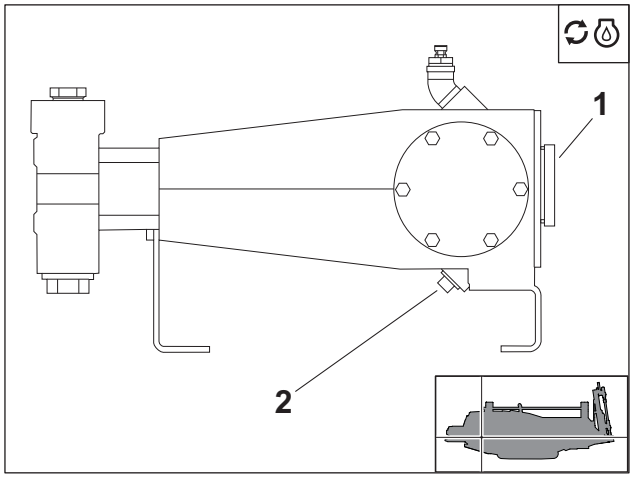
750 Hour

Change Fluid Pump Oil

Change fluid pump oil after first 50 hours and every 750 hours thereafter. Drain at plug (2) and add NDO engine oil at plug (1). Maintain fluid level at fill plug. Capacity for pump is 1 qt (0.9 L).



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1000 Hour

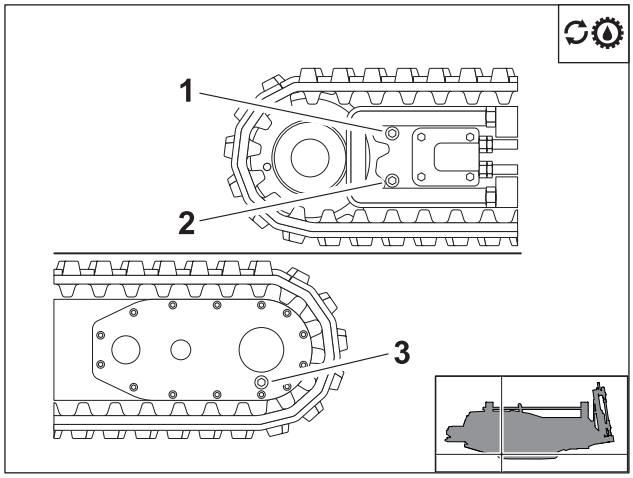
Task	Notes
Change ground drive gearbox oil	2 gearboxes, MPL
Change rotation gearbox oil	MPL
Lube rotation gearbox inner splines	EPG

Change Ground Drive Gearbox Oil

Change oil in both ground drive gearboxes every 1000 hours.

To change:

Drain MPL at plug (3). Add MPL at plug (1) until level with check plug (2).



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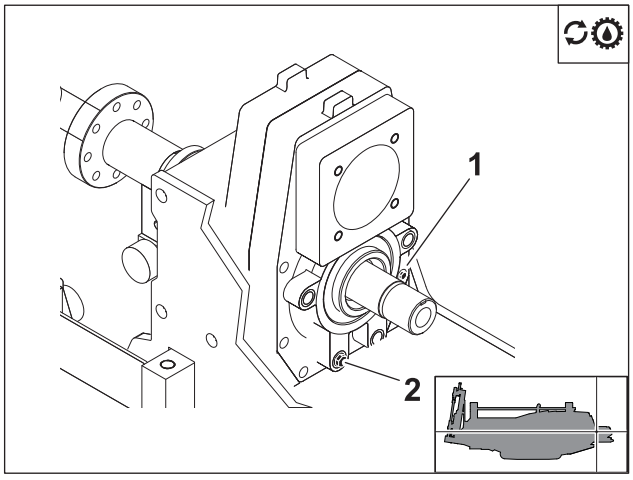
Change Rotation Gearbox Oil

IMPORTANT:

- Drill unit must be parked on level surface for accurate reading.
- Use helper to assist in positioning gearbox plugs for checking and adding oil.
- Do not overfill.

Drain oil at gearbox oil drain (2) every 1000 hours. Replace drain plug. Add MPL at fill plug (1). Replace fill plug.

IMPORTANT: Drill frame must be level for accurate reading.



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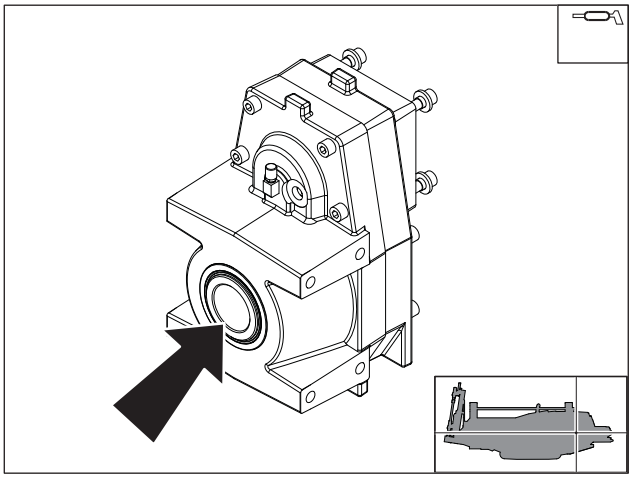
Lube Rotation Gearbox Internal Splines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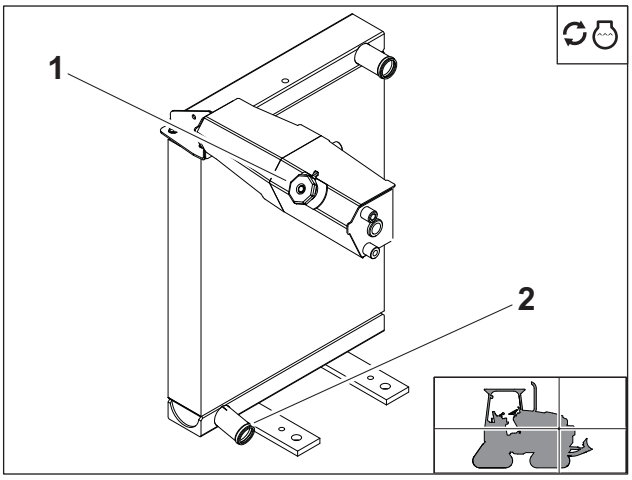
Lube rotation gearbox internal splines with EPG every 1000 hours.

To lube:

- Turn battery disconnect switch to the OFF position.
- Clean rotation gearbox area to remove grime.
- Disconnect hose and remove water swivel.
- Using special socket, remove thrust locknut, tang lock washer, and nut.
- Remove sliding shaft from front side of gearbox. Clean and dry all components.
- Coat internal splines in gearbox with EPG.
- Reinstall shaft and components in reverse order of removal.
- Apply EPS spray lube to sliding shaft surfaces. See page 174.
- Turn battery disconnect switch to the ON position.

2000 Hour

Drain Cooling System



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Drain cooling system at drain (2) every two years or 2000 hours. Add approved coolant at fill (1).

As Needed

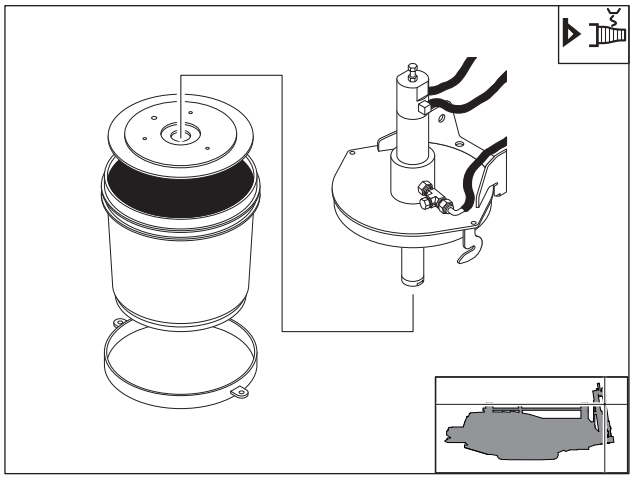
Task	Notes
Change pipe auto lubricator pail	TJC
Change hydraulic filter	Any time system is opened
Check pipeloader pads	
Check front pipe guide inserts	
Check fluid pump ball valve	
Check track tension and condition	
Change/Adjust engine drive belt	
Change air filter	
Check saver sub	
Replace SaverLok® body	
Check battery	
Charge battery	

Change Auto Lubricator TJC Pail

Check pipe auto lubricator TJC level and change pail as needed.

To change pail:

1. Remove wingnuts and bolts attaching base ring (4) to pail cover (1).
2. Rotate base ring slightly to clear hooks on cover and remove pail from cover.
3. Remove follower plate (3) from empty pail and install into new pail. Press firmly on follower plate until TJC comes up in center opening.



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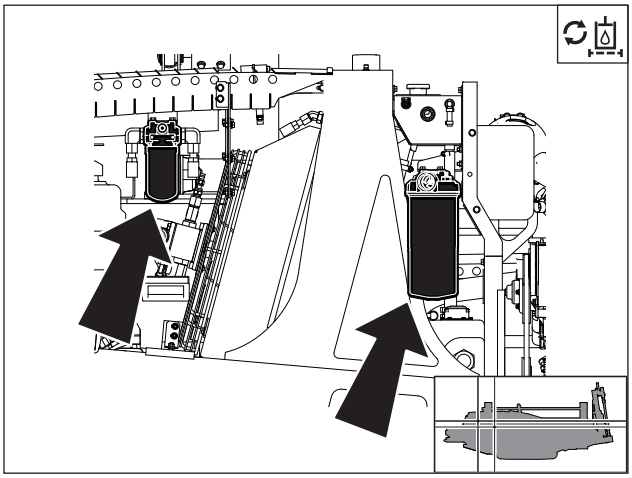
4. Remove base ring from empty pail and install onto new pail.
5. Install pail into place over pump dip tube. Use hooks on cover to support base ring.
6. Install bolts and wingnuts.
7. Remove cap (2) from discharge tee on pump. Operate pump until discharged TJC is free of air pockets. Replace cap.

NOTICE: Use only genuine Ditch Witch® tool joint compound to maintain warranty. See "Recommended Lubricants/Service Key" on page 163 for more information.

Change Hydraulic Filters (Anytime System Opened)

Change hydraulic filters anytime system is opened for repair. Change filter and add THF at hydraulic oil fill.



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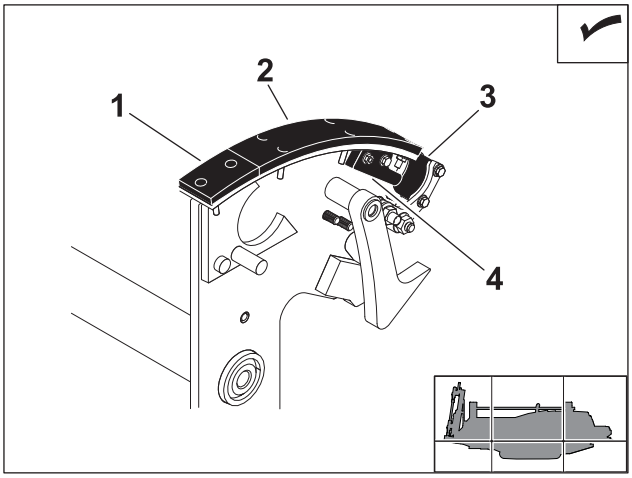
Check Pipeloader Inserts

Check pipeloader inserts at indicated areas for wear. Flip gripper inserts for longer wear, or replace as needed. See your Ditch Witch® dealer for replacement parts.

1. wear pad
2. shuttle wear pad
3. shuttle gripper pad
4. gripper pad

IMPORTANT: Ensure bolts are tightened evenly to enable inserts to slide freely and wear evenly.



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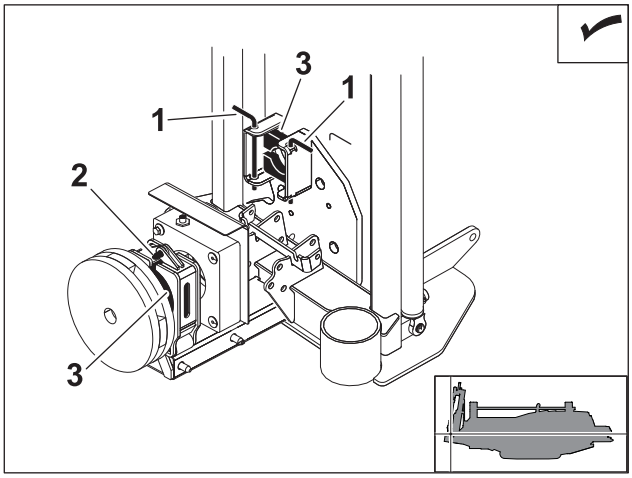
Check Front Pipe Guide Inserts



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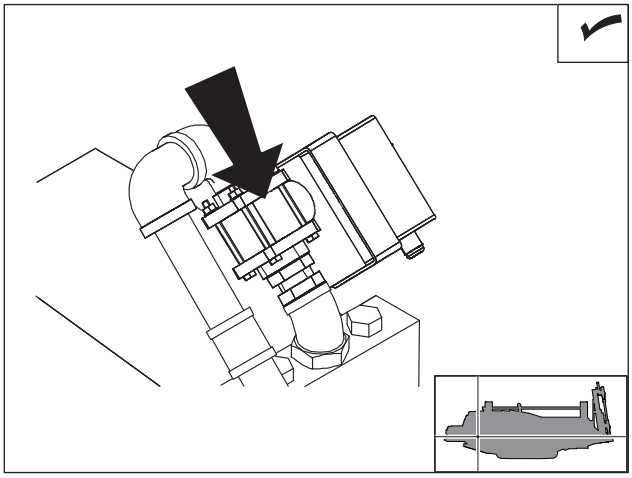
Check front pipe guide inserts (3) for wear. Rotate inserts for longer wear, or replace as needed. See your Ditch Witch® dealer for replacement parts.

To replace:

1. Remove lynch pins (1, one on each side).
2. Remove guide inserts (3).
3. Remove pin (2) and open pipe guide.
4. Remove guide inserts (3).
5. Replace in reverse order.

Check Fluid Pump Ball Valve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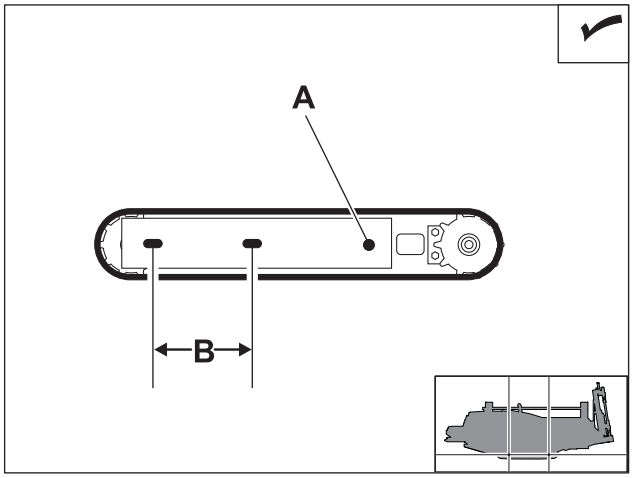
Check ball valve for leaks. Tighten stem packing as needed. See your Ditch Witch dealer for replacement packing.

Check Track Tension and Condition



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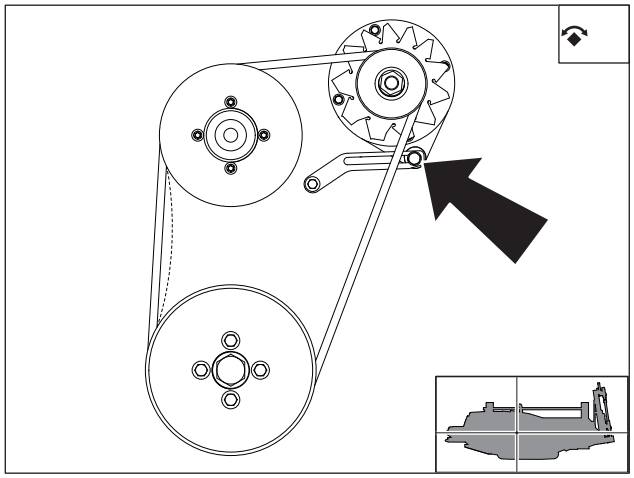
Check track tension and condition, and adjust or replace as needed. See your Ditch Witch dealer for replacement parts.

To adjust:

1. Pump MPG into fitting (A) until dimension (B) is 21 7/8" (555 mm).
2. Drive straight forward one machine length and check tension again.

Change/Adjust Drive Belt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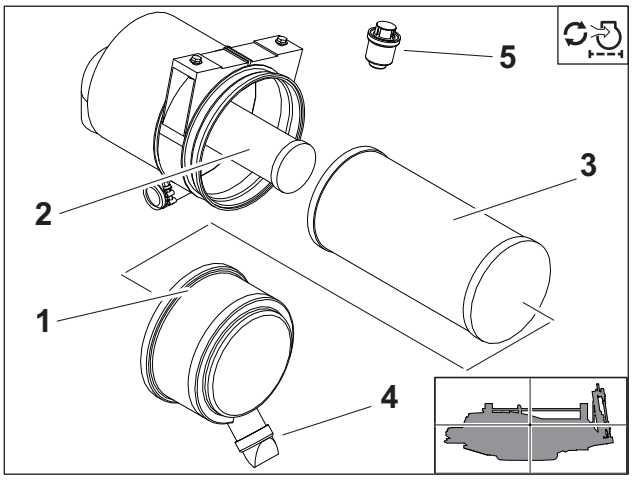
Change or adjust engine drive belt as needed.

To adjust:

1. Turn off engine and remove key.
2. Apply moderate thumb pressure to belt between pulleys, as shown.
3. Belt is properly tensioned when deflection is about 3/8" (10 mm).
4. If needed, loosen alternator bolts and pull alternator out until correct tension is reached.
5. Tighten alternator bolts.

Change Air Filter



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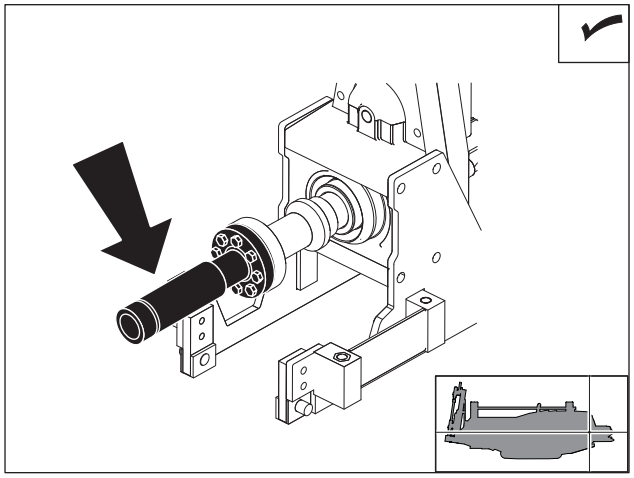
Change air filter when red band on air filter service indicator pops up.

To change:

1. Disengage clasps (1) and remove end cup.
2. Remove primary element (3).
3. Remove secondary element (2), if dirty.
4. Wipe inside of housing and wash end cup (4).
5. Install new element(s).
6. Install end cup and engage clasps.
7. Reset air filter service indicator (5).

Check Saver Sub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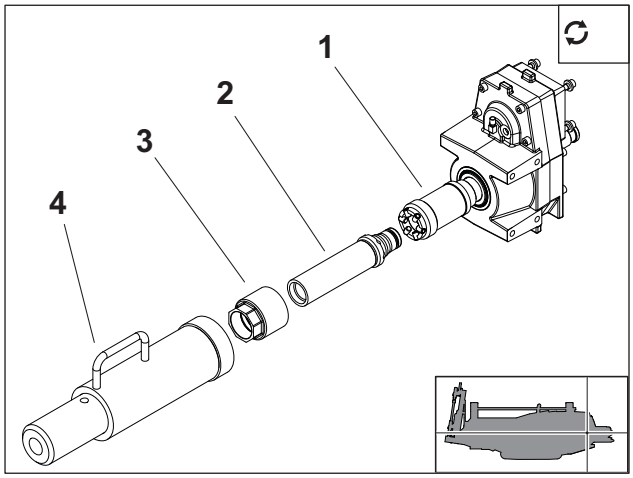
Check saver sub and replace as needed. See your Ditch Witch® dealer for replacement parts.

To replace:

1. Remove eight bolts that attach saver sub to spindle. Do not remove indexing dowels from spindle.
2. Remove and replace o-ring, if necessary.
3. Install in reverse order and tighten eight bolts in a cross pattern to 47 ft•lb (64 N•m). Apply Loctite® 242 to bolts before installation.

Replace SaverLok® Body



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Replace SaverLok body (2) as needed. See your Ditch Witch® dealer for replacement parts.

To remove:

1. Slide tool (4) over collar (3).
2. Start unit and position carriage so the SaverLok tool can be clamped in rear wrench.
3. Close front wrench or clamp front wrench on drill pipe tool joint if pipe is present.

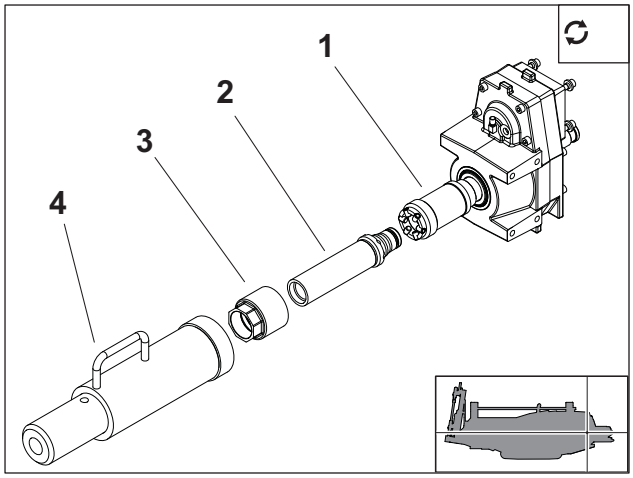
NOTICE: Clamping front wrench on SaverLok nose will damage the threads and impede disassembly.

4. Clamp rear wrench on SaverLok tool.

IMPORTANT: Unit may not build enough torque to break out the SaverLok body unless both wrenches are closed.

5. Rotate spindle counterclockwise to unthread collar.
6. Turn off engine.
7. Remove collar from system and set aside for later use.
8. Remove SaverLok body from SaverLok connection (1).

To install:



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1. Coat SaverLok connection (1) threads with clean TJC.
2. Coat SaverLok (2) shoulder and SaverLok collar (3) threads and shoulder with clean TJC.
3. Apply grease or lubricant to the SaverLok body o-ring and insert SaverLok body into SaverLok connection. The connection will not lock fully into place.
4. Thread SaverLok body into connection until o-ring is fully engaged using one of the following methods:
   - Slide SaverLok collar over SaverLok body and engage threads by hand. Once the SaverLok collar is hand tight (bottomed out), remove collar.
   - Tap the SaverLok body nose with a rubber mallet until the o-ring is fully engaged.
5. Slide SaverLok collar over SaverLok body and hand-tighten the threads (typically 3-4 turns).
6. Slide SaverLok tool (4) over the collar until it is fully engaged.
7. Close front wrench, or if drill pipe is present, clamp front wrench on drill pipe tool joint to build pressure in wrenches.

> ***NOTICE:*** Clamping front wrench on SaverLok nose will damage threads or impede disassembly.

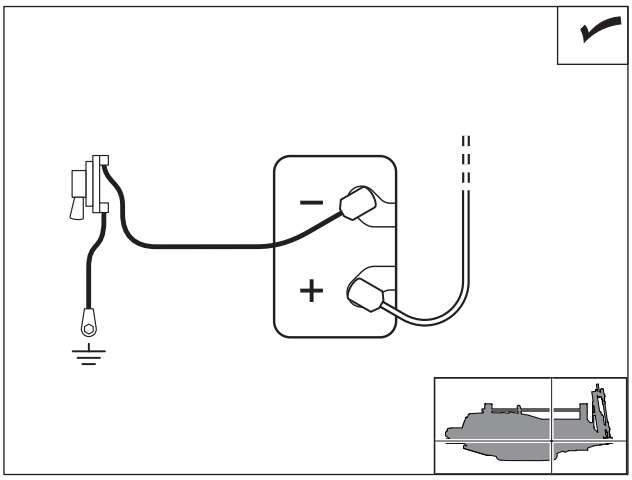
8. Start unit and position carriage so that the small end of the tool can be clamped in the rear wrenches with the tool's handle still accessible.

DANGER Moving tools will kill or injure. Never use pipe wrenches on drill string. 273-278

To help avoid injury: Do not start rotation until the tool is clamped in the wrenches.

9. Clamp SaverLok tool and tighten until rotation pressure gauge reading is between 3800-4300 psi.
10. Immediately loosen the collar and repeat the tighten/loosen process five times to break in the contact surfaces.
11. Finally, tighten collar, unclamp SaverLok tool, and move carriage to allow access to the SaverLok tool.
12. Remove tool and place it in storage location.

Check Battery



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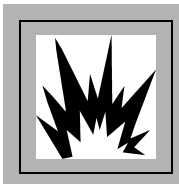
Check battery as needed. Keep batteries clean and terminals free of corrosion.

To clean:

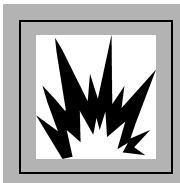
1. Turn battery disconnect switch to the off position.
2. Ensure that no ignition sources are near batteries.
3. Loosen and remove battery cable clamps carefully, **negative (-)** cable first.
4. Clean cable clamps and terminals with wire brush or battery cleaning tool to remove dull glaze.
5. Check for signs of internal corrosion in cables.
6. Connect battery cable clamps, **positive (+)** cable first.
7. Tighten any loose connections.
8. Ensure that battery tiedowns are secure.
9. Turn battery disconnect switch to the on position.



WARNING Explosion possible. Serious injury or equipment damage could occur. Follow directions carefully.

To help avoid injury, do not create sparks and do not short across battery terminals for any reason.

Charge Battery



WARNING Explosion possible. Serious injury or equipment damage could occur. Follow directions carefully.

To help avoid injury:

- Use a single 12V maximum source for charging. Do not connect to rapid chargers or dual batteries.
- Use caution and wear personal protective equipment such as safety eyewear, when charging or cleaning battery.
- Keep sparks, flames, and any ignition source away from batteries at all times. Internal contents are extremely hazardous. Leaking fluid is corrosive. Battery may be explosive at higher temperatures.
- NEVER lean over battery when making connections.
- Do not allow vehicles to touch when charging.
- Do not attempt to charge a battery that is leaking, bulging, heavily corroded, frozen, or otherwise damaged.
- NEVER short-circuit battery terminals for any reason or strike battery posts or cable terminals.
- Refer to MSDS for additional information regarding this battery.

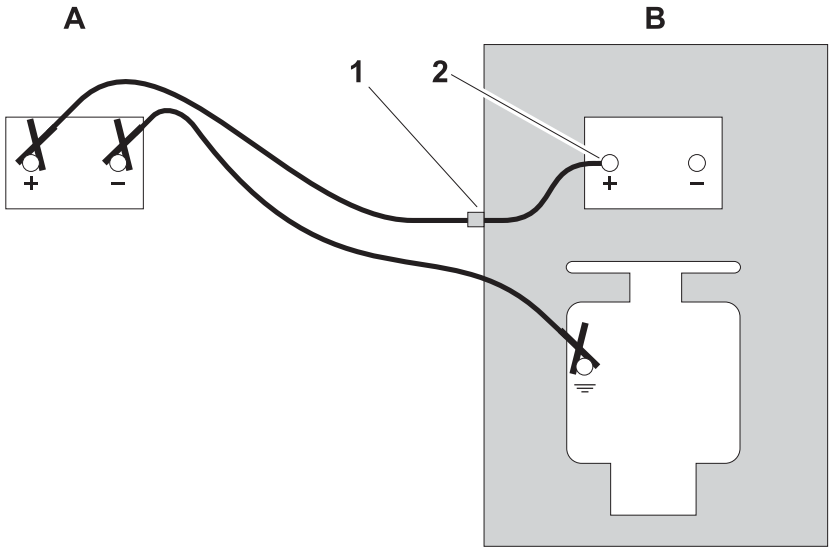
Before You Start

Electronic components can be easily damaged by electrical surges. Jump starting can damage electronics and electrical systems, and is not recommended. Try to charge the battery instead. Use quality large diameter jumper cables capable of carrying high currents (400 amps or more). Cheap cables may not allow enough current flow to charge a dead/discharged battery.

Read all steps thoroughly and review illustration before performing procedure.

Charging Procedure (Engine Off)

1. Park service vehicle close to disabled equipment but do not allow vehicles to touch. Engage parking brake in both vehicles.
2. Turn the ignition switch to the OFF position in both vehicles, and turn off all electrical loads. Disconnect the machine controller.



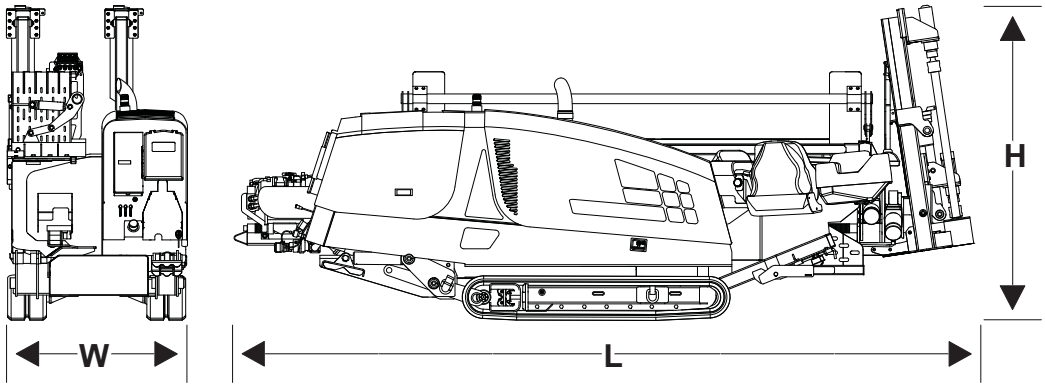
3. Inspect battery in disabled vehicle (B) for signs of cracking, bulging, leaking, or other damage. Connect red positive (+) jumper cable clamp to positive (+) post (2) of battery in disabled vehicle first.

IMPORTANT: Some equipment may have a positive jumper cable terminal (1) located externally. If so equipped, connect red positive (+) jumper cable clamp to terminal.

4. Connect the other red positive (+) jumper cable clamp to positive (+) post of battery (A) in the service vehicle.
5. Connect black negative (-) cable clamp to negative (-) post of battery (A) in service vehicle.
6. Connect the other black negative (-) cable clamp to the engine or frame ground on the disabled vehicle, at least 12" (305 mm) from the failed battery, as shown.
7. Operate service vehicle engine at 1500-2000 rpm for a few minutes to build an electrical charge in the failed battery.
8. Stop engine in service vehicle.
9. Remove jumper cables from the service vehicle, black negative (-) clamp first. Do not allow clamps to touch.
10. Remove black negative (-) cable clamp from the disabled engine or frame ground first.
11. Remove red positive (+) cable clamp from the disabled vehicle positive (+) battery post last.
12. Reconnect machine controller and try to start disabled vehicle.

If the disabled vehicle did not start, check for loose or corroded battery cable connections. Poor connections will prevent current from charging the failed battery. Clean terminals and posts if necessary and repeat steps above.

Specifications



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Dimensions	U.S.	Metric
L, overall machine length (per SAE J2022)	207 in	5.26 m
W, overall machine width (per SAE J2022)	51.5 in	1.31 m
H, overall machine height (per SAE J2022)	90 in	2.29 m
Entry angle (per SAE J2022)	10-14°	10-14°
Entry angle	18-24%	18-24%
Angle of approach	18°	18°
Angle of departure	18°	18°
Operating weight (per SAE J2022)	11,890 lb	5393 kg

Power Pipe® HD	U.S.	Metric
Length (per SAE J2022), nominal	120 in	3.05 m
Joint diameter (per SAE J2022)	2.63 in	67 mm
Tubing diameter (per SAE J2022)	2.06 in	52 mm
Minimum bend radius	107 ft	32 m
Weight (per SAE J2022), lined	67 lb	30.4 kg

Ditch Witch® Forged HD	**U.S.**	**Metric**
Length (per SAE J2022), nominal	120 in	3.05 m
Joint diameter (per SAE J2022)	2.50 in	63 mm
Tubing diameter (per SAE J2022)	2.1 in	53 mm
Minimum bend radius	109 ft	33.2 m
Weight (per SAE J2022)	64 lb	29 kg

Forged	**U.S.**	**Metric**
Length (per SAE J2022), nominal	120 in	3.05 m
Joint diameter (per SAE J2022)	2.63 in	67 mm
Tubing diameter (per SAE J2022)	2.06 in	52 mm
Minimum bend radius	108 ft	32.9 m
Weight (per SAE J2022)	73 lb	33.1 kg

Operational		**U.S.**	**Metric**
Maximum spindle speed (per SAE J2022)		210 rpm	210 rpm
Maximum spindle torque (per SAE J2022)		2200 ft•lb	2980 N•m
Thrust force (per SAE J2022)		17,000 lb	75.6 kN
Pullback force (per SAE J2022)		20,000 lb	89 kN
Thrust travel speed (per SAE J2022)		140 fpm	43 m/min
Pullback travel speed (per SAE J2022)		140 fpm	43 m/min
Minimum bore diameter		4 in	102 mm
Backream diameter (soil dependent)		variable	variable
Ground travel speed			
	forward (per SAE J2022)	0-3.2 mph	0-5.2 km/h
	reverse (per SAE J2022)	0-3.2 mph	0-5.2 km/h
Ground bearing pressure (per SAE J2022)		7.9 psi	0.56 kg/cm^2

Power		U.S.	Metric
T4 engine: Deutz® TD2.9 EPA Tier 4, EU Stage IIIB T4i engine: Deutz® TD2.9 EPA Tier 4i, EU Stage IIIA			
Fuel: diesel			
Cooling medium: liquid			
Injection: direct			
Aspiration: turbo and charge air cooled			
Cylinders: 4			
Displacement		177 in^3	2.9 L
Bore		3.62 in	92 mm
Stroke		4.33 in	110 mm
Power			
	manufacturer's gross power rating (per SAE J1995)	74 hp	55 kW
	rated speed	2600 rpm	2600 rpm

Drilling Fluid System (Onboard)	U.S.	Metric
Maximum drilling fluid flow (per SAE J2022)	25 gpm	94 L/min
Maximum drilling fluid pressure (per SAE J2022)	1000 psi	69 bar

Fluid Capacities	U.S.	Metric
Fuel tank *	30 gal	114 L
Hydraulic reservoir	19 gal	72 L
Engine oil, including filter	8.5 qt	8 L
Cooling system	4.6 gal	17 L

* Under normal operating conditions, a full tank of fuel will last 10 hours.

Battery
SAE reserve capacity 195 min, 12V, negative ground, SAE cold crank @ 0°F (-18°C), 950 amps.

Vibration Level
Vibration transmitted to the operator's hand and whole body during normal operation does not exceed 2.5 m/s^2 and 0.5 m/s^2 respectively.
Operator seat complies with ISO 7096.

Noise Levels
Operator ear sound pressure level is 82 dBA sound pressure per ISO 6396
Exterior sound power level is 99 dBA per ISO 6395

Specifications are called out according to SAE recommended practices where indicated. Specifications are general and subject to change without notice. If exact measurements are required, equipment should be weighed and measured. Due to selected options, delivered equipment may not necessarily match that shown.

Support

Procedure

Notify your dealer immediately of any malfunction or failure of Ditch Witch® equipment.

Always give model, serial number, and approximate date of your equipment purchase. This information should be recorded and placed on file by the owner at the time of purchase.

Return damaged parts to dealer for inspection and warranty consideration if in warranty time frame.

Order genuine Ditch Witch replacement or repair parts from your authorized Ditch Witch dealer. Use of another manufacturer's parts may void warranty consideration.

Resources

Publications

Contact your Ditch Witch dealer for publications and videos covering safety, operation, service, and repair of your equipment.

Ditch Witch Training

For information about on-site, individualized training, contact your Ditch Witch dealer.

Warranty

Ditch Witch® Equipment and Replacement Parts Limited Warranty Policy

Subject to the limitation and exclusions herein, free replacement parts will be provided at any authorized Ditch Witch dealership for any Ditch Witch equipment or parts manufactured by The Charles Machine Works, Inc. (CMW) that fail due to a defect in material or workmanship within one (1) year of first commercial use. Free labor will be provided at any authorized Ditch Witch dealership for installation of parts under this warranty during the first year following "initial commercial" use of the serial-numbered Ditch Witch equipment on which it is installed. The customer is responsible for transporting their equipment to an authorized Ditch Witch dealership for all warranty work.

Exclusions from Product Warranty

- All incidental or consequential damages.
- All defects, damages, or injuries caused by misuse, abuse, improper installation, alteration, neglect, or uses other than those for which products were intended.
- All defects, damages, or injuries caused by improper training, operation, or servicing of products in a manner inconsistent with manufacturer's recommendations.
- All engines and engine accessories (these are covered by original manufacturer's warranty).
- Tires, belts, and other parts which may be subject to another manufacturer's warranty (such warranty will be available to purchaser).
- ALL IMPLIED WARRANTIES NOT EXPRESSLY STATED HEREIN, INCLUDING ANY WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY.

IF THE PRODUCTS ARE PURCHASED FOR COMMERCIAL PURPOSES, AS DEFINED BY THE UNIFORM COMMERCIAL CODE, THEN THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE FACE HEREOF AND THERE ARE NO IMPLIED WARRANTIES OF ANY KIND WHICH EXTEND TO A COMMERCIAL BUYER. ALL OTHER PROVISIONS OF THIS LIMITED WARRANTY APPLY INCLUDING THE DUTIES IMPOSED.

Ditch Witch products have been tested to deliver acceptable performance in most conditions. This does not imply they will deliver acceptable performance in all conditions. Therefore, to assure suitability, products should be operated under anticipated working conditions prior to purchase.

Defects will be determined by an inspection within thirty (30) days of the date of failure of the product or part by CMW or its authorized dealer. CMW will provide the location of its inspection facilities or its nearest authorized dealer upon inquiry. CMW reserves the right to supply remanufactured replacements parts under this warranty as it deems appropriate.

Extended warranties are available upon request from your local Ditch Witch dealer or CMW.

Some states do not allow exclusion or limitation of incidental or consequential damages, so above limitation of exclusion may not apply. Further, some states do not allow exclusion of or limitation of how long an implied warranty lasts, so the above limitation may not apply. This limited warranty gives product owner specific legal rights and the product owner may also have other rights which vary from state to state.

For information regarding this limited warranty, contact CMW's Product Support department, P.O. Box 66, Perry, OK 73077-0066, or contact your local dealer.

First version: 1/91; Latest version: 11/11

A Note To Ditch Witch Equipment Owners:

If your equipment was purchased through a Ditch Witch dealer, there is no need to read further.

However, if you purchased from any other source, please fill out the form on the reverse side and return it to us.

This will enable you to receive updates on this equipment as well as information on new products of interest.

Thanks for using Ditch Witch equipment.

(Please Fold Along This Line And Seal At Bottom With Tape)

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO 23 PERRY OKLAHOMA

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The Charles Machine Works, Inc.
P.O. Box 66
Perry, Oklahoma 73077-9989

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Ditch Witch® Registration Card

Please Type or Print All Information

Purchaser's Company Name

Attention

Street Address or P.O. Box

City County

State Zip Nation

( )

Phone Number With Area Code

Model Serial Number

Attachments/Accessories Serial Numbers

Attachments/Accessories Serial Numbers

Attachments/Accessories Serial Numbers

Name of Ditch Witch Dealership

Your Signature

Ditch Witch® Registration Card

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Purchaser's Company Name

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Street Address or P.O. Box

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( )

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Name of Ditch Witch Dealership

Your Signature

Service Record

Service Performed	Date	Hours

Service Performed	Date	Hours