JT60/JT60 All Terrain

Operator's Manual



CE

Issue 3.2
Original Instruction

053-2547

Overview



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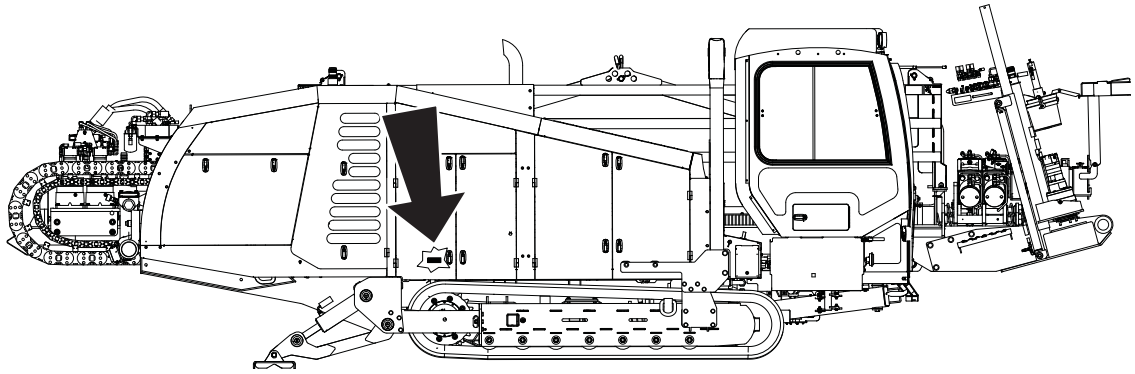
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Serial Number Location

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	
Engine serial number	
Trailer serial number	

Intended Use

The JT60/JT60 All Terrain is a self-contained horizontal directional drilling unit capable of drilling through solid rock, cobblestone, broken rock, gravel, and other soil/rock mixes, as well as less extreme soil conditions. It is designed to install buried cable and pipe at distances to 1,000' (300 m) depending on soil conditions.

The unit is designed for operation in temperatures typically experienced in earth moving and construction work environments. Provisions may be required to operate in extreme temperatures. Contact your Ditch Witch® dealer. Use in any other way is considered contrary to the intended use.

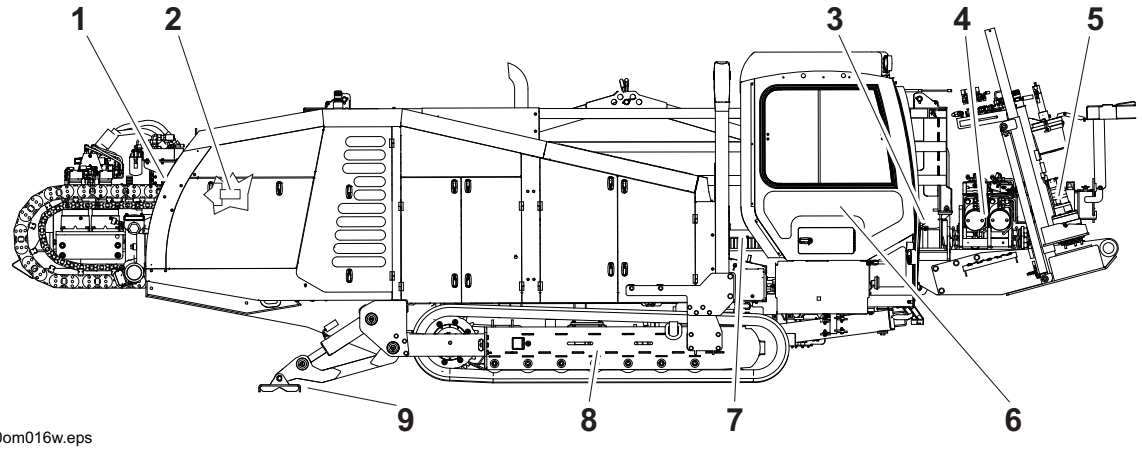
The unit can be used with Ditch Witch drilling fluid units and Ditch Witch locating equipment. It should be operated, serviced, and repaired only by persons familiar with its particular characteristics and acquainted with the relevant safety procedures.

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.

The protection offered by the Rollover Protective System (ROPS) will be impaired if it has been subjected to any modification, structural damage, or has been involved in an overturn accident. The ROPS must be replaced after a roll-over.

Unit Components

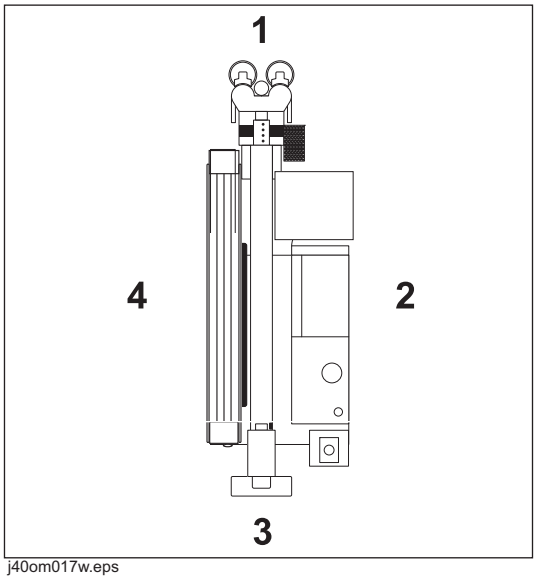


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1. Carriage
2. Spindle
3. Pipeloader
4. Vise wrenches
5. Anchoring system
6. Operator's station
7. Drill frame
8. Tracks
9. Stabilizer

Operator Orientation

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.

JT60/JT60 All Terrain (Tier 4i) Operator's Manual

Issue number 3.2/OM-11/16
Part number 053-2547

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This product is covered by one or more of the following patents:
U.S. B1 5,684,466; 5,794,719; 5,880,680; 6,085,852; 6,109,371; 6,179,065; 6,250,403; 6,250,404; 6,311,790; 6,411,094; 6,543,551; 6,550,547; 6,672,409; 6,808,210; 6,827,158; 6,848,506; 6,871,712; 7,018,164; 7,240,742; 7,392,858; 7,600,584; 7,628,226; 7,987,924; 8,201,644; 8,534,388; RE38,418; **AU** 689,533; 706,544; 718,034; 755,862; **CA** 2,156,398; 2,217,899; **DE** 694 17 019; 695 29 634; **EP** 0674093; 0817901; 0846841; 0927892; **FR** 674,093; **GB** 2,312,006; EP674,093; EP846,841; **JP** 3,458,247; other U.S. and foreign patents pending.

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machine serial number, information about the type of work this machine is designed to perform, basic machine components, and how to use this manual



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part number, revision level, and publication date of this manual, and factory contact information



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machine safety alerts and emergency procedures



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machine controls, gauges, and indicators and how to use them



Operation Overview 55
an overview for completing a job with this machine: planning, setting up, installing product, and restoring the jobsite; with cross references to detailed procedures



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procedures for inspecting and classifying the jobsite, planning the installation path, and preparing the jobsite for work



Drive 81
procedures for startup, cold start, driving, and shutdown



Transport 85
procedures for lifting, hauling, and towing



Conduct a Bore 91
procedures for drilling and backreaming



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downhole tools and drill pipe, anchor, electric strike, tracker control, and fluid systems



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procedures for backfilling and restoring the jobsite and rinsing and storing equipment



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service intervals and instructions for this machine including lubrication, replacement of wear items, and basic maintenance



Specifications **201**
machine specifications including weights, measurements, power ratings, and fluid capacities



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the warranty policy for this machine, and procedures for obtaining warranty consideration and training



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a record of major service performed on the machine

Safety

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Guidelines



When you see this safety alert sign, carefully read and follow all instructions.
YOUR SAFETY IS AT STAKE. Read this entire section before using your equipment.

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

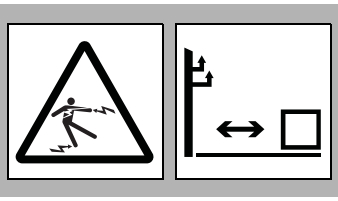


WARNING Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.

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

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.

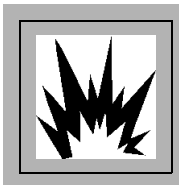
If you suspect an electric line has been damaged and you are **off drilling unit or bonded equipment**, DO NOT TOUCH ANY EQUIPMENT connected to drilling unit. Take the following actions. The order and degree of action will depend on the situation.

- 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 possible.
- 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.

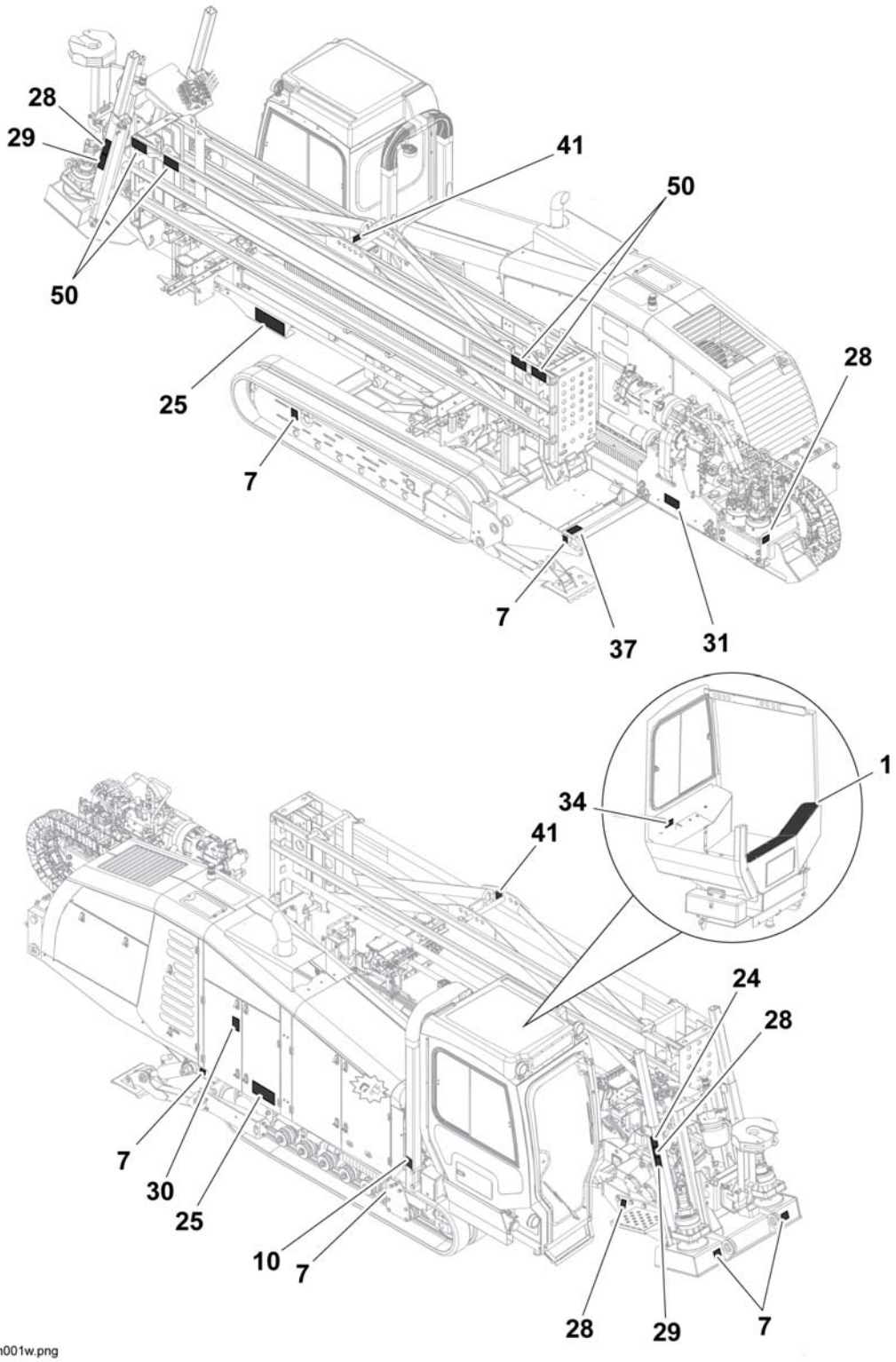
CAUTION indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

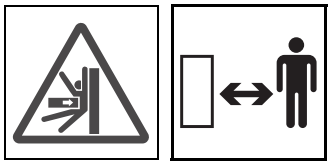
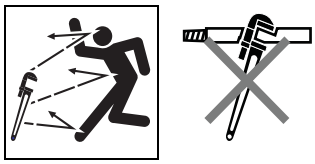
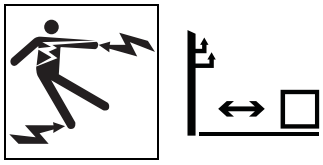
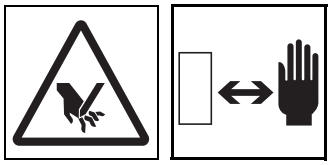
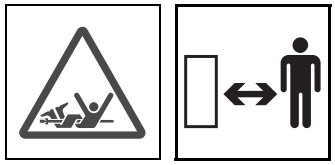
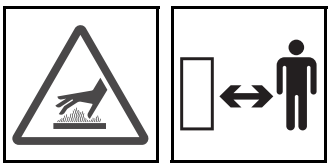
Watch for two other words: ***NOTICE*** and **IMPORTANT**.

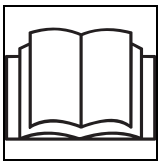
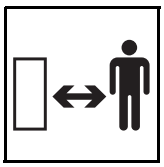
NOTICE indicates information considered important, but not hazard-related (e.g., messages relating to property damage).

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

Machine Safety Alerts



1		**WARNING** Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.
7		Tiedown location. See Transport chapter for more information.
10		**WARNING** Crushing weight could cause death or serious injury. Use proper procedures and equipment or stay away.
24		**DANGER** Moving tools will kill or injure. Shut off drill string power when anyone can be struck by moving or thrown tools. Never use pipe wrenches on drill string.
25		**DANGER** Electric shock. Contacting electric lines will cause death or serious injury. Know location of lines and stay away.
28		**WARNING** Moving parts could cut off hand or foot. Stay away.
29		**DANGER** Turning shaft will kill you or crush arm or leg. Stay away.
30		**CAUTION** Hot parts may cause burns. Do not touch until cool or wear gloves.

31		**WARNING** Moving parts could cut off hand or foot. Stay away.
34	 	**WARNING** Read operator's manual. Know how to use all controls before operating machine. When you see this sign ⚠ on the machine or in the manual, read it and use caution. Your safety is at stake.
37	 	**WARNING** Moving parts can crush. Secure extended cylinder with locking device before servicing.
41		Lift point. See Transport chapter for more information.
50	 	**WARNING** Crushing weight could cause death or serious injury. Use proper procedures and equipment or stay away.

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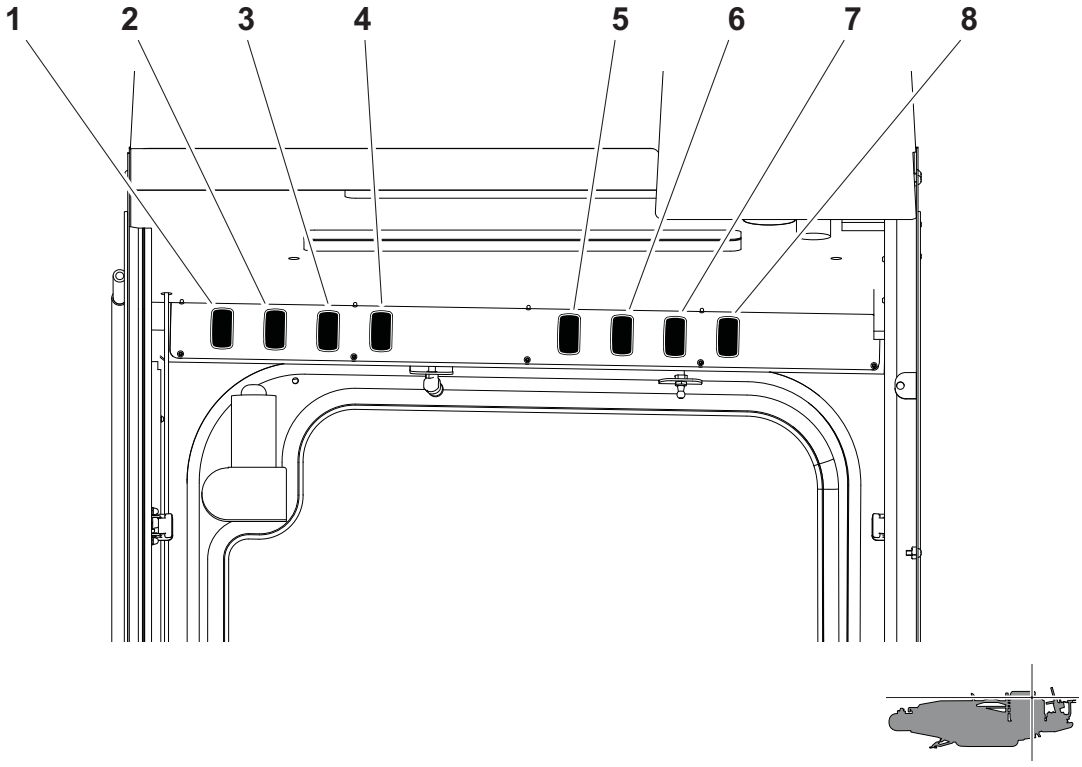
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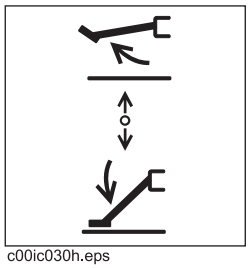
Rear Console. 54

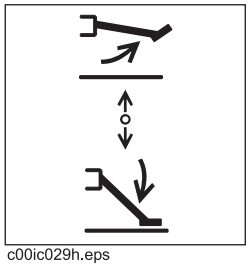
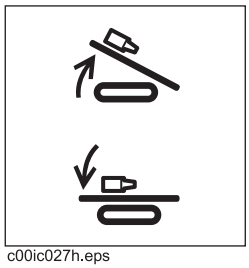
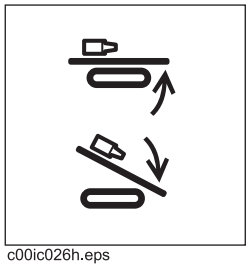
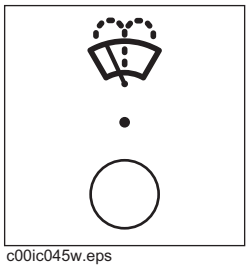
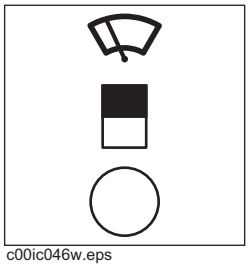
Setup Controls

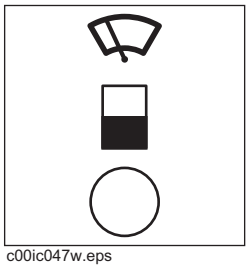
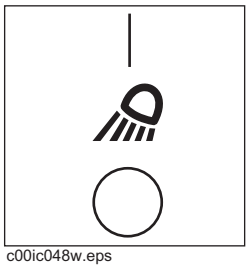


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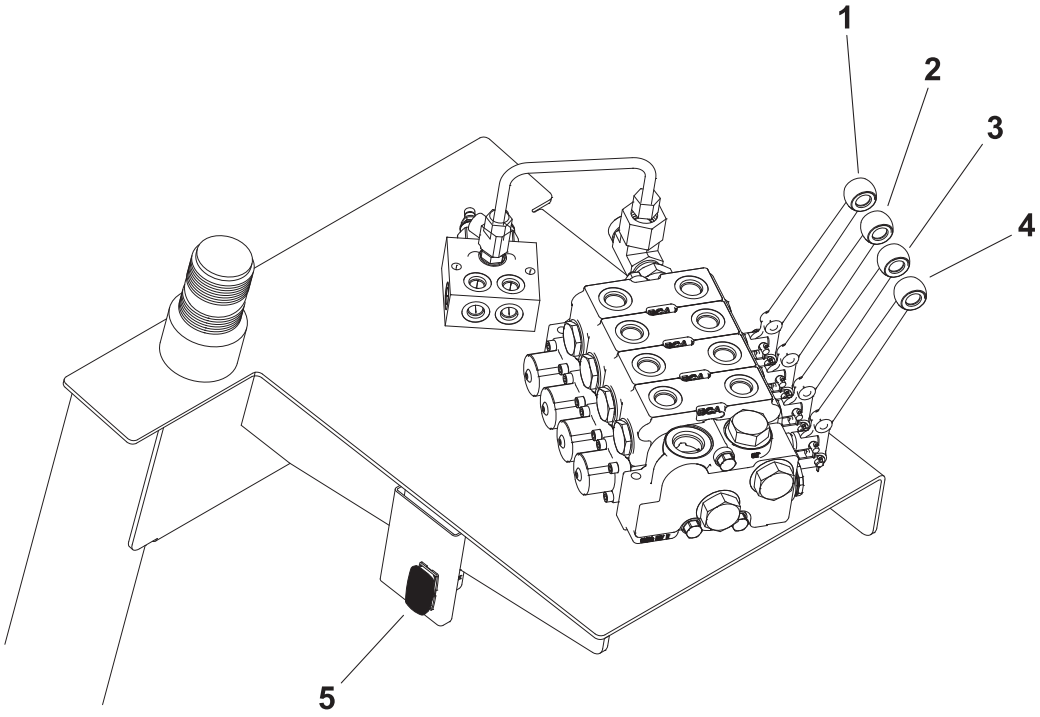
1. Left stabilizer control
2. Right stabilizer control
3. Back frame tilt control
4. Front frame tilt control
5. Washer fluid on/off switch
6. Upper wiper switch
7. Lower wiper switch
8. Worklight switch

Item	Description	Notes
1. Left stabilizer control  c00ic030h.eps	To raise, push up. To lower, pull down.	**IMPORTANT:** Lower right and left stabilizers to the ground together, then adjust individually.

Item	Description	Notes
2. Right stabilizer control  c00ic029h.eps	To raise, push up. To lower, pull down.	**IMPORTANT:** Lower left and right stabilizers to the ground together, then adjust individually.
3. Back frame tilt control  c00ic027h.eps	To raise, push up. To lower, pull down.	**IMPORTANT:** To ensure a stable platform for drilling, use front and back tilt controls together to set frame at desired pitch without raising tracks off the ground.
4. Front frame tilt control  c00ic026h.eps	To raise, push up. To lower, pull down.	**IMPORTANT:** To ensure a stable platform for drilling, use front and back tilt controls together to set frame at desired pitch without raising tracks off the ground.
5. Washer on/off switch  c00ic045w.eps	To start windshield washer fluid, press and hold top. To stop washer fluid flow, release.	
6. Upper wiper switch  c00ic046w.eps	To start wiper blade, press top. To stop wiper blade, press bottom.	

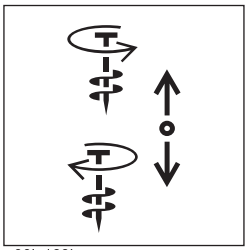
Item	Description	Notes
7. Lower wiper switch  c00ic047w.eps	To start wiper blade, press top. To stop wiper blade, press bottom.	
8. Worklight switch  c00ic048w.eps	To turn on, press top. To turn off, press bottom.	

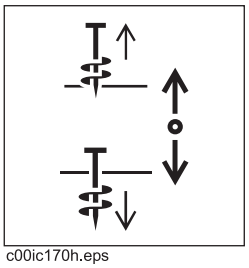
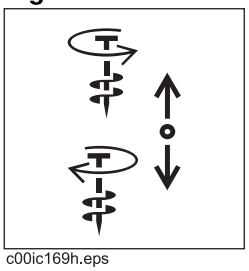
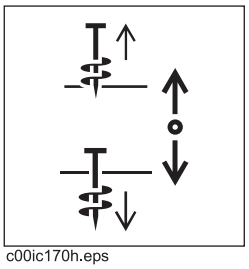
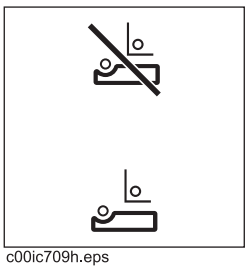
Anchor System Console



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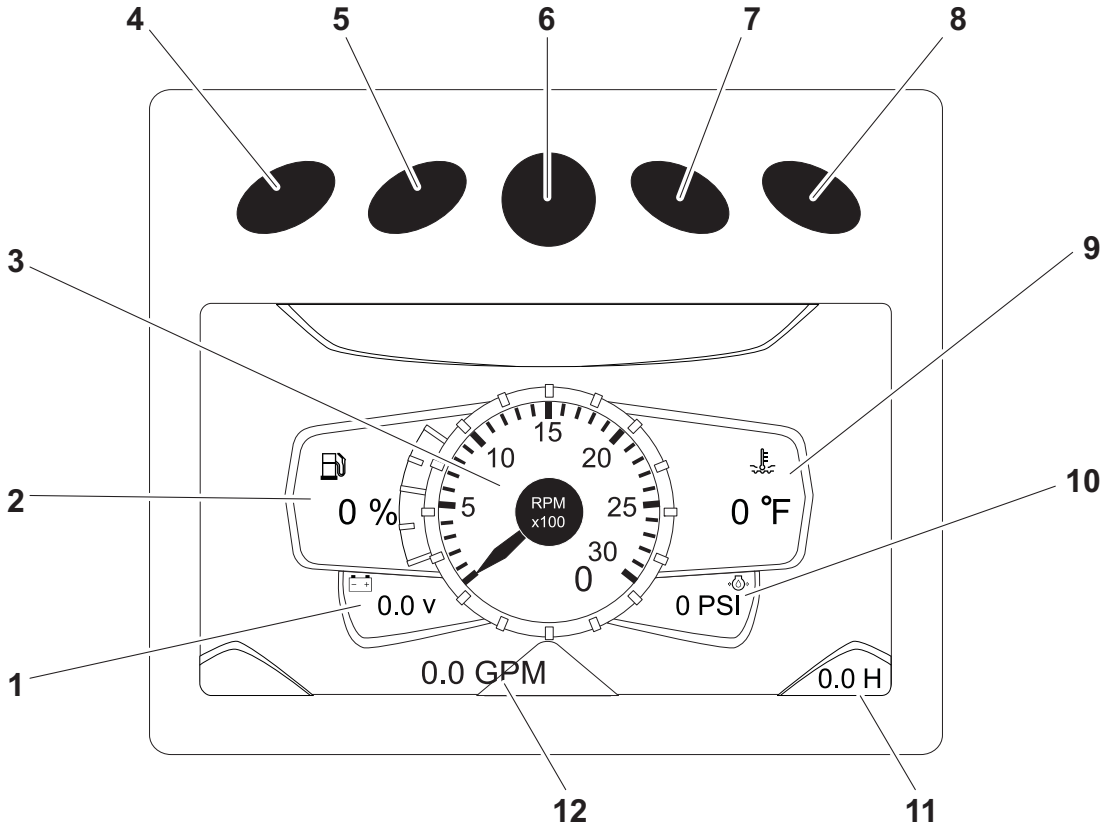
1. Left rotation control
2. Left thrust control
3. Right rotation control
4. Right thrust control
5. Shuttle lockout switch

Item	Description	Notes
1. Left rotation control  c00ic169h.eps	To remove anchor, pull. To drive anchor, push.	See "Anchor System" on page 117.

Item	Description	Notes
2. Left thrust control  c00ic170h.eps	To move anchor up, pull. To move anchor down, push.	See "Anchor System" on page 117.
3. Right rotation control  c00ic169h.eps	To remove anchor, pull. To drive anchor, push.	See "Anchor System" on page 117.
4. Right thrust control  c00ic170h.eps	To move anchor up, pull. To move anchor down, push.	See "Anchor System" on page 117.
5. 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.

Left Control Console

Engine Display



j40om011w.eps

1. Voltmeter display
2. Fuel level display
3. Tachometer
4. Soft key
5. Soft key
6. Main menu key
7. Soft key
8. Soft key
9. Engine coolant temperature display
10. Engine oil pressure display
11. Hour meter
12. Drilling fluid flow display

Item	Description	Notes
1. Voltmeter display	Shows system voltage.	Normal voltage is 13-14V with engine running.
2. Fuel level display	Displays amount of fuel remaining in tank.	See "Approved Fuel" on page 166.
3. Tachometer	Displays engine speed.	

Item	Description	Notes
4. Soft key	Press to select a soft key command.	Soft key commands change with each menu screen and are displayed next to the key.
5. Soft key		
6. Main menu key	Press from main screen (gauges) to select main menu.	
7. Soft key	Press to select a soft key command.	Soft key commands change with each menu screen and are displayed next to the key.
8. Soft key		
9. Engine coolant temperature display	Displays engine coolant temperature.	Normal coolant temperature is 160°-212° F (71°-100° C).
10. Engine oil pressure display	Displays engine oil pressure.	Full load reading should be 45-70 psi (3.1-4.8 bar).
11. Hour meter	Displays number of hours engine has been running.	
12. Drilling fluid flow display	Displays the estimated GPM or LPM of drilling fluid being pumped.	

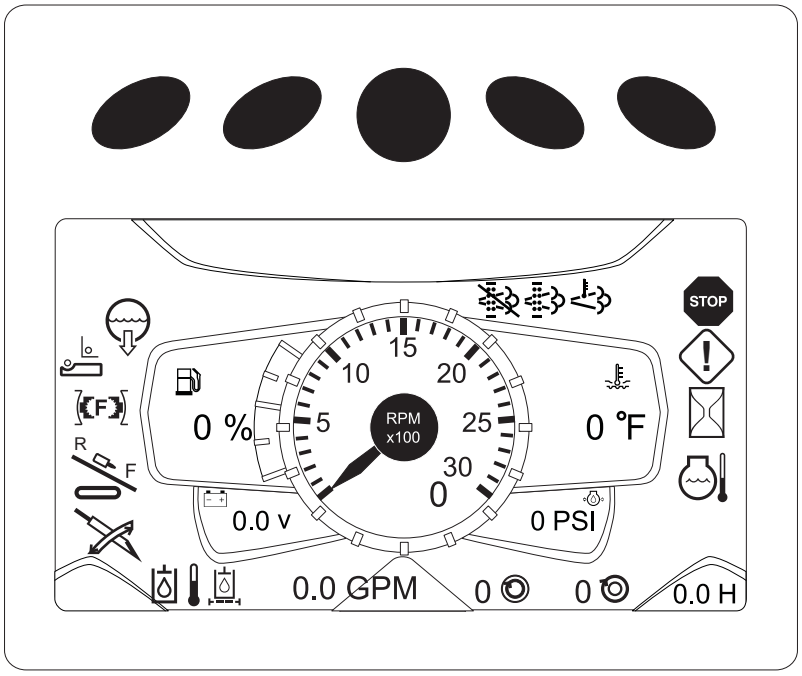
Most engine display functions are self-explanatory. For more information about functions, see the manufacturer's instructions at www.fwmurphy.com.

Main Menu

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

Item	Description	Notes
11. 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.
10. 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.
9. Main screen key	Press to return to main screen (gauges).	
8. Engine diagnostics key	Press to select engine diagnostics menu.	For dealer technician use only.

Status Indicators

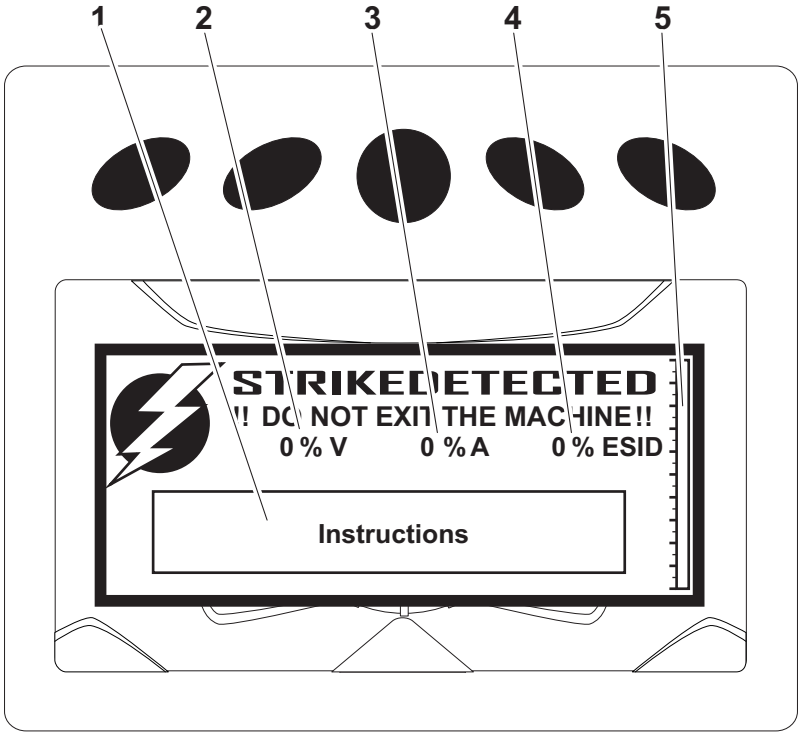


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Indicators

JT drill mode active	Front wrench closed	Engine caution
AT dirt mode active	Shuttle home (shuttles retracted)	Wait to start
AT rock drill mode active	Drill fluid on	Engine warm-up protection
Drive mode active	DPF Regen inhibited See engine manual	Outer rotation speed
JT carve mode active	DPF Regen indicator See engine manual.	Inner rotation speed
AT dirt carve mode active	High exhaust temperature	Hydraulic filter restriction
Front/Rear carriage home	Engine stop	High hydraulic temperature

ESID Strike Display



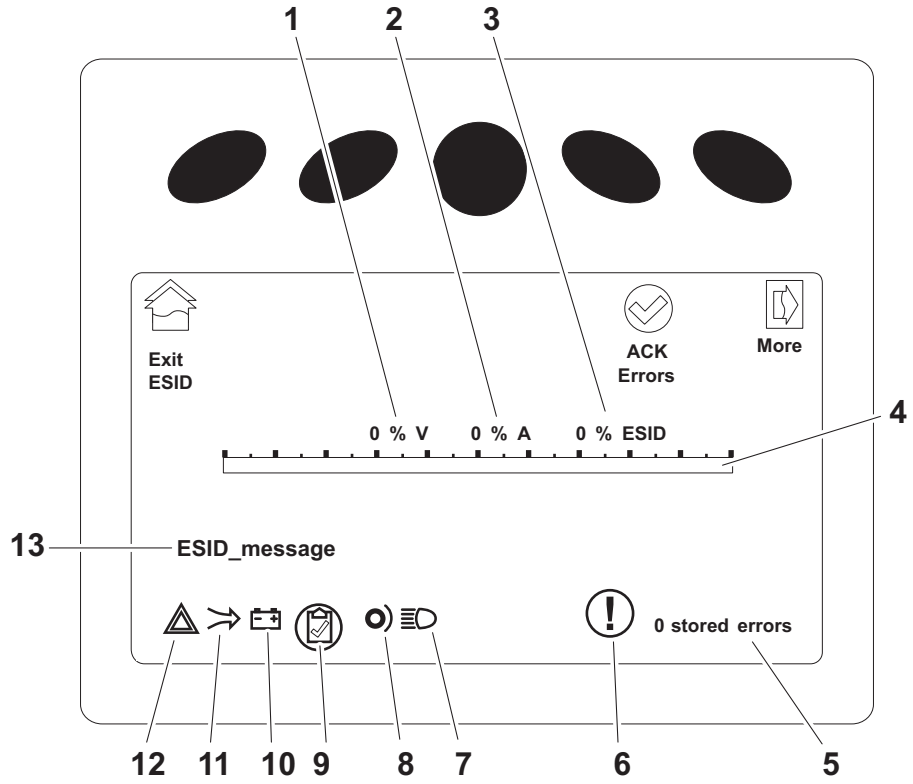
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1. Instruction display
2. Voltage indicator
3. Current indicator
4. Strike condition
5. Percentage of strike indicator

The above screen is displayed when an electrical strike is detected. Follow the instructions on the screen. For more information, See "Electric Strike System" on page 121.

IMPORTANT: 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.

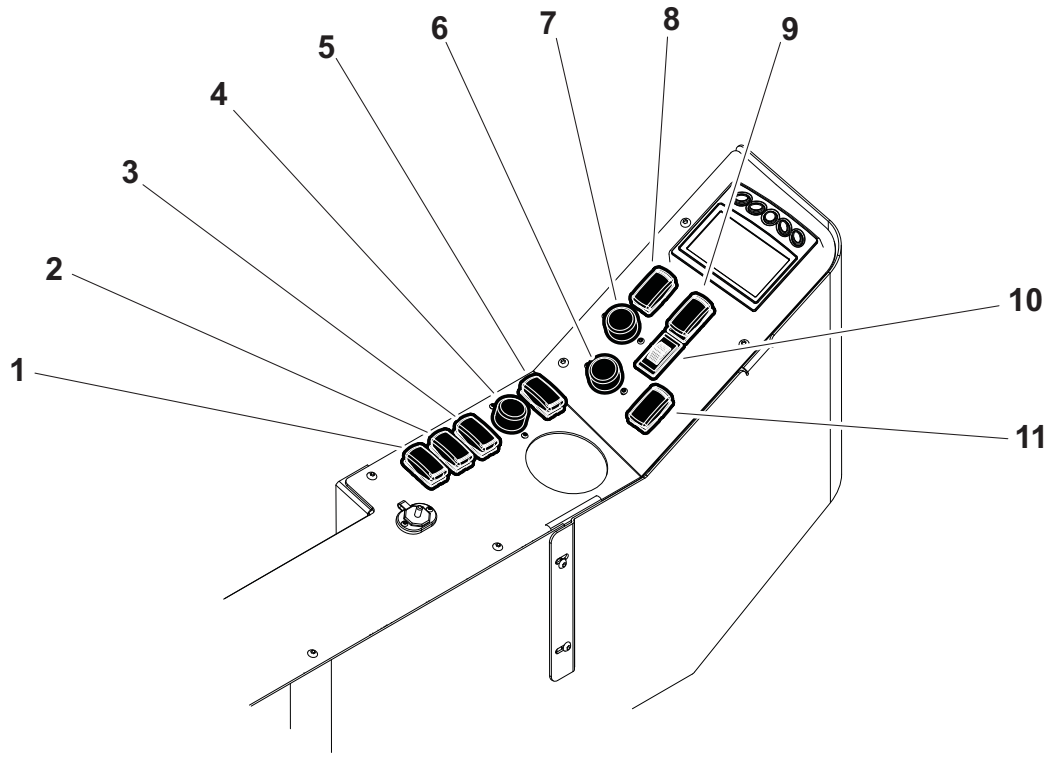
ESID Application Display



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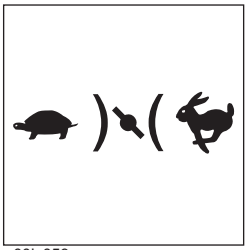
Item Description	Notes
1. Voltage % of strike threshold	
2. Amperage % of strike threshold	
3. Combined % of strike threshold	
4. Graphical display of electrical strike percentage	
5. ESID stored error count	
6. ESID error code indicator	
7. ESID strobe active indicator	
8. ESID horn active indicator	
9. ESID test indicator	
10. ESID voltage indicator	
11. ESID amperage indicator	
12. ESID okay (check) indicator	
13. ESID message display	

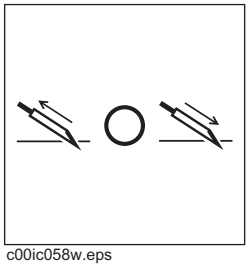
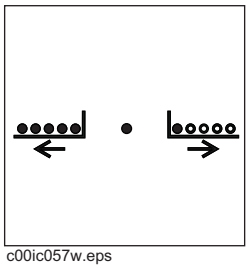
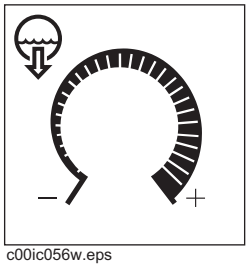
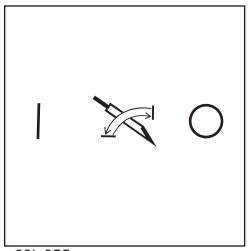
Drilling Controls

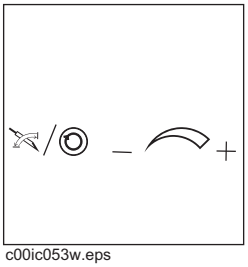
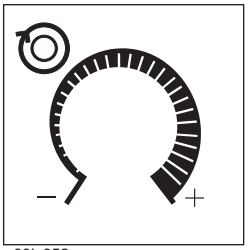
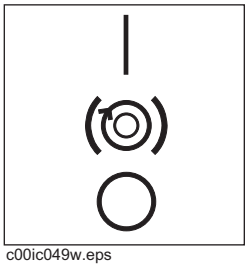
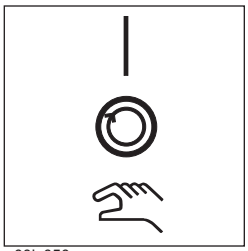


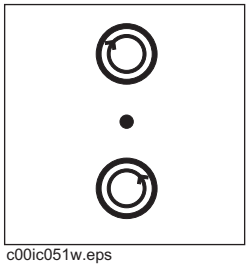
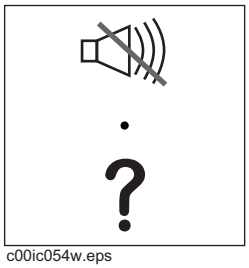
j40om004w.eps

1. Engine throttle switch
2. Add pipe/manual/remove pipe switch
3. Pipe shuttle stop switch
4. Drilling fluid flow control
5. AutoCarve Switch
6. Carve window / inner rotation control
7. Outer rotation speed control
8. Spindle brake switch
9. Inner spindle switch
10. Manual inner rotation switch
11. ESID alarm interrupt / ESID self-test switch

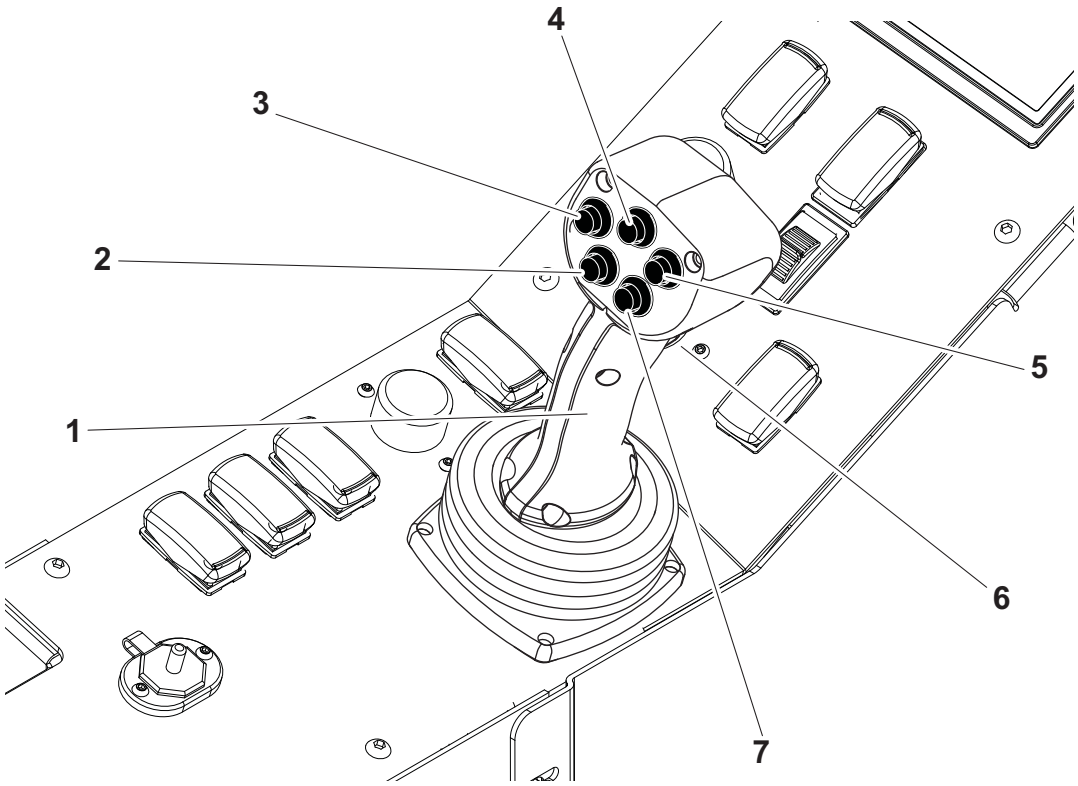
Item	Description	Notes
1. Engine throttle switch  c00ic059w.eps	To increase speed, press right. To decrease speed, press left. To further increase or decrease speed, press additional times.	Autothrottle mode slows the engine to low throttle after 15 seconds of inactivity involving thrust, rotation, drilling fluid flow, or pipeloader functions. To return to high speed, activate thrust, rotation, drilling fluid, or an add/remove pipe cycle.

Item	Description	Notes
2. Add pipe/manual/ remove pipe switch  c00ic058w.eps	To select "add pipe" automated pipeloader function, press right. To use manual pipeloader controls, move to center. To select "remove pipe" automated pipeloader function, press left.	See "Add Pipe" on page 102. See "Remove Pipe" on page 112.
3. Pipe shuttle stop switch  c00ic057w.eps	To lower shuttle stop, press right. To raise shuttle stop, press left.	**IMPORTANT:** Look at pipe row indicator on drill frame to see which row shuttles will stop under.
4. Drilling fluid flow control  c00ic056w.eps	To increase flow, turn clockwise. To decrease flow, turn counterclockwise.	
5. AutoCarve switch  c00ic055w.eps	To enable autocarve, press left. To deactivate autocarve, press right.	Two-speed thrust is not allowed in autocarve mode.

Item	Description	Notes
6. Carve window / inner rotation speed control  c00ic053w.eps	To increase, turn clockwise. To decrease, turn counterclockwise.	See "Use AutoCarve" on page 106.
7. Outer rotation speed control  c00ic052w.eps	To increase outer rotation maximum speed above 75 rpm, turn clockwise. To decrease outer rotation maximum speed toward 75 rpm, turn counterclockwise.	**IMPORTANT:** Unless outer rotation speeds greater than 75 rpm are needed, keep knob turned fully counterclockwise to maintain full torque.
8. Spindle brake switch  c00ic049w.eps	To engage, press top. To disengage, press bottom.	**IMPORTANT:** Use when steering in rock.
9. Inner spindle switch  c00ic050w.eps	To turn on, press top. To turn off, move to center. To manually dither, press bottom and control dither with the manual inner rotation switch.	**IMPORTANT:** To restart inner rotation after operator has left seat, turn inner rotation off and then on.

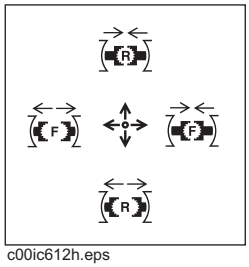
Item	Description	Notes
10. Manual inner rotation control  c00ic051w.eps	To rotate clockwise, move to top. To rotate counterclockwise, move to bottom. To stop inner rotation, release.	**IMPORTANT:** • Inner spindle control must be in manual position for this control to work. • Range of speed is reduced to allow easier manual control. • Up/down paddle is spring centered. Moving it above center rotates inner rod clockwise. Moving it further rotates the rod faster. Moving it below center does the same for counter clockwise rotation.
11. ESID Alarm interrupt / self test button  c00ic054w.eps	To turn off strike alarm at drilling unit, press top. To start manual self test, press bottom. To reset system after a strike has been detected, press bottom.	Self test checks all systems and circuits except voltage limiter. **IMPORTANT:** See "If an Electric Line is Damaged" on page 14.

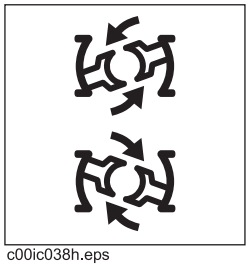
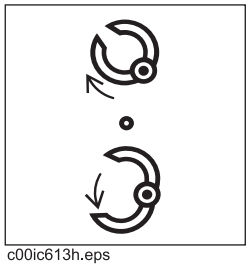
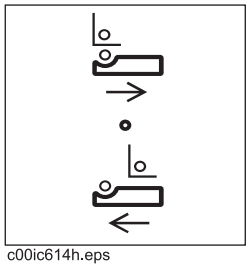
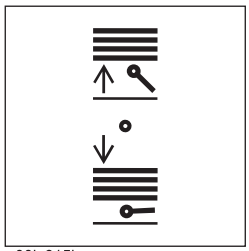
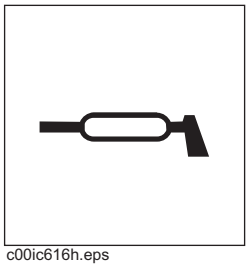
Wrench Control

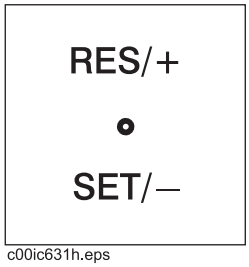


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1. Wrench control
2. Wrench rotate
3. Pipe gripper switch
4. Pipe shuttle switch
5. Pipe lift switch
6. Pipe lubricator switch
7. Set/Resume switch

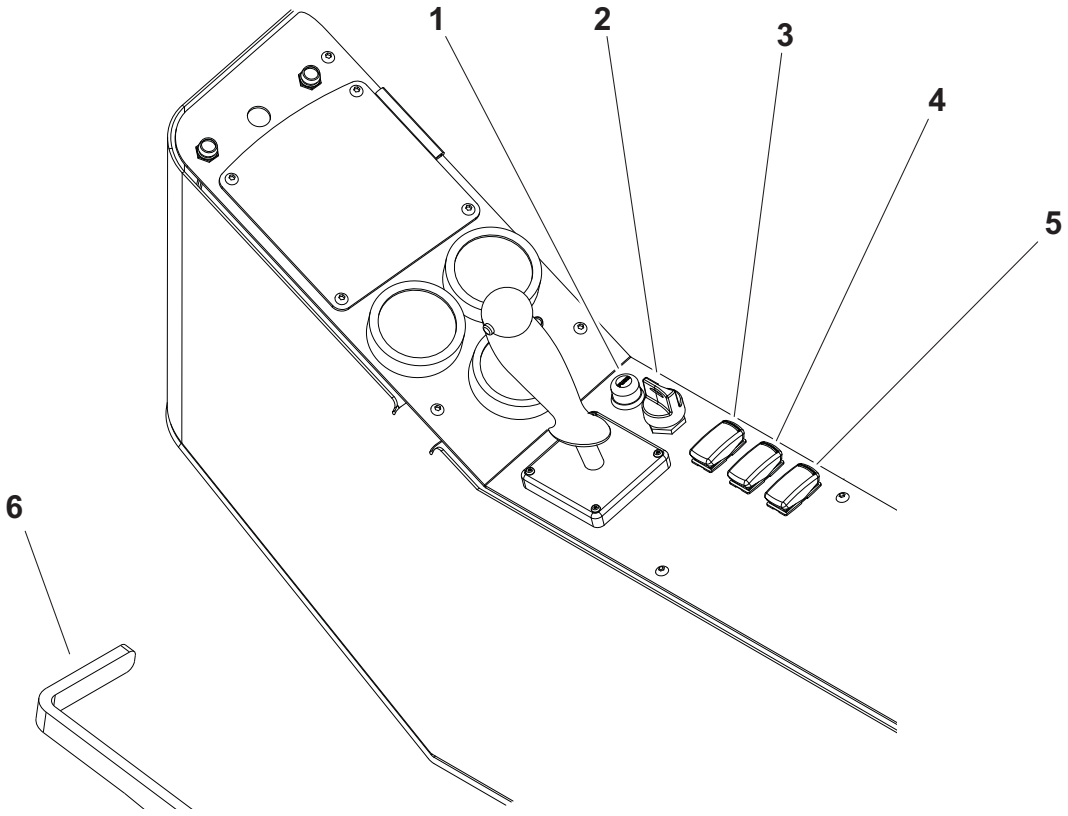
Item	Description	Notes
1. Wrench control  c00ic612h.eps	To clamp rear wrench, push forward. To unclamp rear wrench, pull back. To clamp front wrench, move to right. To unclamp front wrench, move to left.	

Item	Description	Notes
2. Rear wrench rotation switch  c00ic038h.eps	To rotate counterclockwise, press top. To rotate clockwise, press bottom. To stop rotation, release.	
3. Pipe gripper switch  c00ic613h.eps	To close, press top. To open, press bottom.	
4. Pipe shuttle switch  c00ic614h.eps	To move toward pipe box, press top. To move toward spindle, press bottom.	
5. Pipe lift switch  c00ic615h.eps	To raise, press top. To lower, press bottom.	
6. Pipe lubricator switch  c00ic616h.eps	To apply joint compound, press.	

Item	Description	Notes
7. Set/Resume switch  c00ic631h.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 150. See "Use AutoCarve" on page 106.

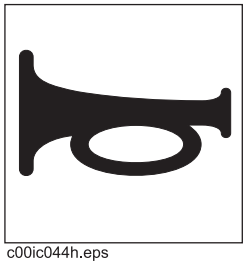
Right Control Console

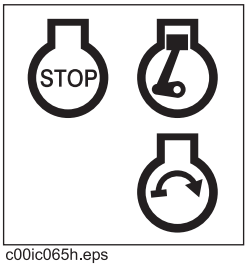
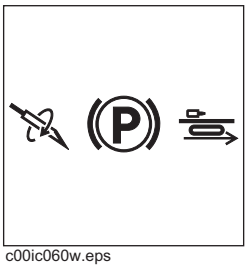
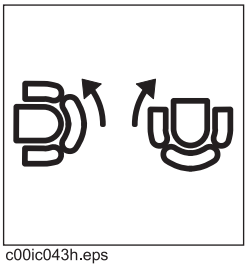
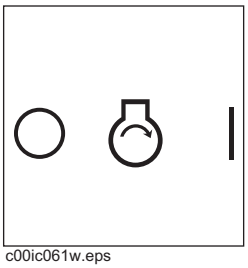
Operation Controls



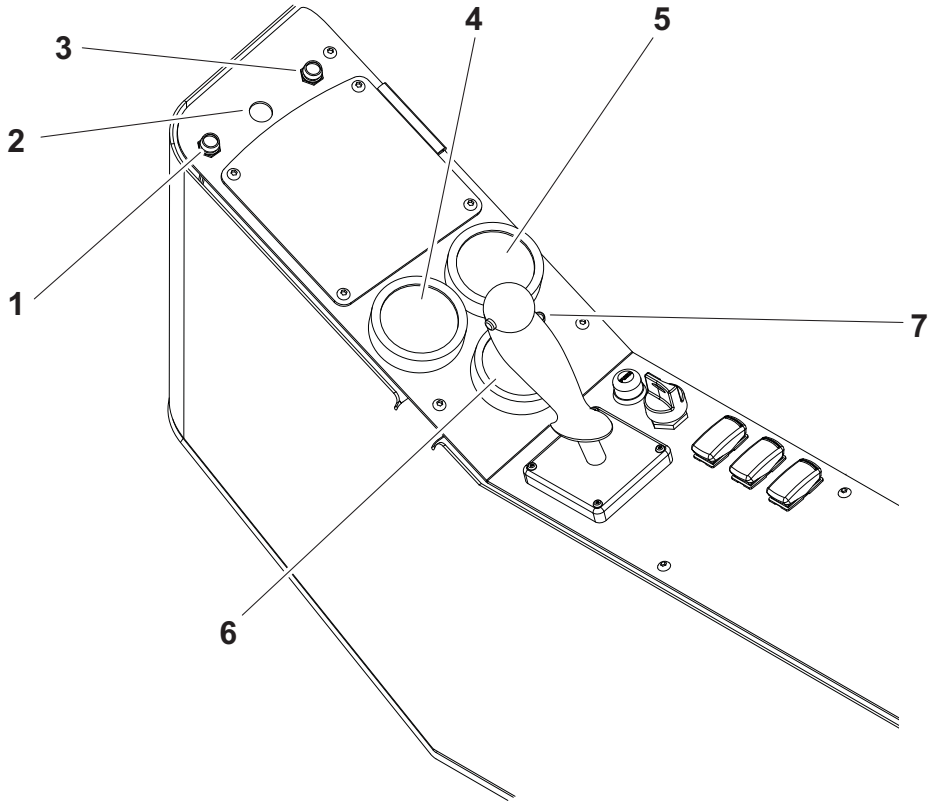
j40om006w.eps

1. Horn button
2. Ignition switch
3. Drill/Park/Drive switch
4. Cab pivot control switch
5. Engine override switch
6. Cab pivot lock

Item	Description	Notes
1. Horn  c00ic044h.eps	To sound horn, press.	

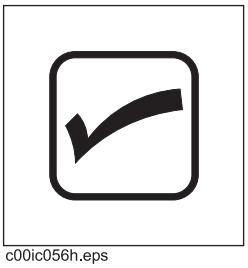
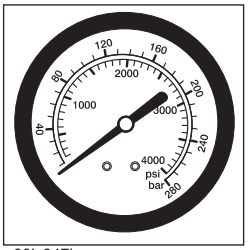
Item	Description	Notes
2. Ignition switch  c00ic065h.eps	To start engine, insert key and turn clockwise. To stop engine, turn key counterclockwise.	
3. Drill/Park/Drive switch  c00ic060w.eps	To drill, press left. To set parking brake, move to center. To drive, press right.	**IMPORTANT:** • Lighted icon on engine display indicates unit is ready to perform that function. • Cab must be in the correct position for drill or drive.
4. Cab pivot control switch  c00ic043h.eps	To pivot into drilling position, lift pivot lock and press left. To pivot into driving position, press right.	
5. Engine override switch  c00ic061w.eps	To start engine, press right. Engine will run for 30 seconds and then stop.	Use this switch to move unit if a shutdown code is present.
6. Cab pivot lock	To unlock, lift and hold while pivoting cab into drilling position. Control will lock when cab reaches driving position.	

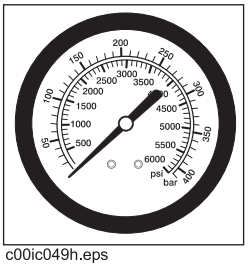
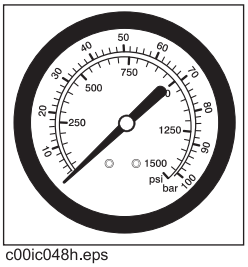
Gauges and Indicators



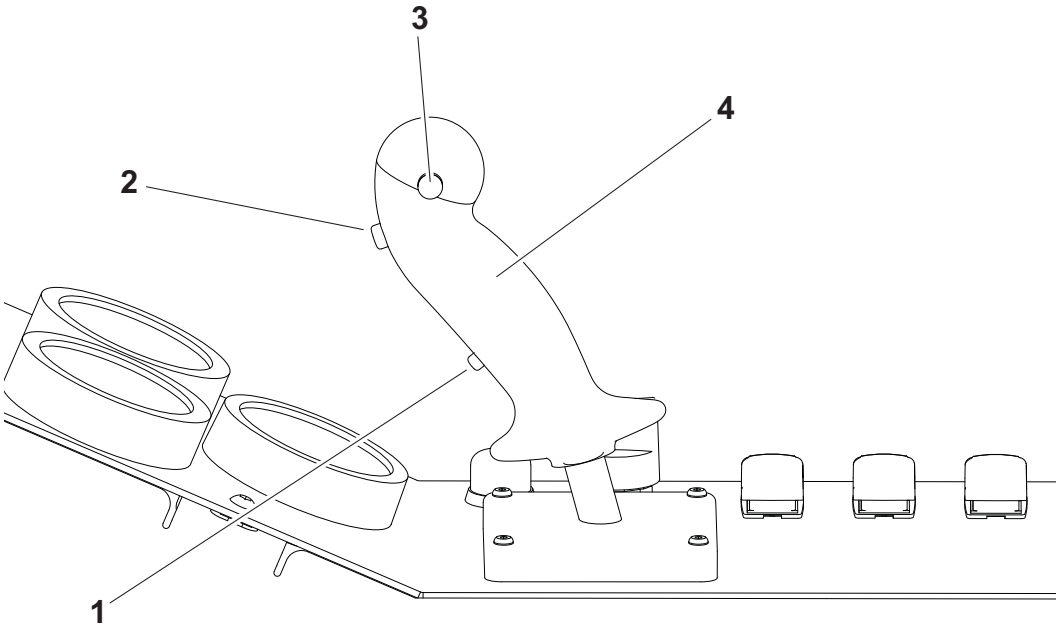
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1. Diagnostic indicator (red)
2. Control cycle indicator (green)
3. Thrust pressure gauge
4. Rotation pressure gauge
5. Drilling fluid pressure gauge
6. Drilling fluid pump indicator (red)
7. Drilling fluid pump status indicator (red)

Item	Description	Notes
1. Diagnostic indicator (red)  c00ic062w.eps	If system is OK, light should be off. If system may not be getting power, light should be on. If a non-essential diagnostic code is recorded, light should flash on and off for 10 seconds. If an essential diagnostic code is recorded, light should flash on for three seconds and off for half a second.	
2. EDT Port	Connection for Electronic Diagnostic Tool.	For use by qualified Ditch Witch® technicians.
3. Control cycle indicator (green)  c00ic056h.eps	If nothing is being controlled, light should be off. If system is waiting for an action before starting cycle, light should flash on and off. If something is being controlled, light should be on. If control cycle is interrupted, light should flash twice quickly.	
4. Thrust pressure gauge  c00ic047h.eps	Displays hydraulic fluid pressure to thrust motor during thrust and pullback.	

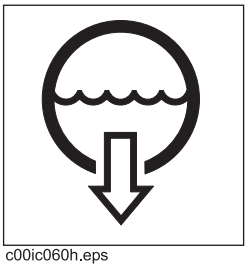
Item	Description	Notes
5. Rotation pressure gauge  c00ic049h.eps	Displays hydraulic fluid pressure to rotation motor when spindle is turned clockwise.	Inner rotation pressure is displayed when inner rotation is on and front wrench is open. Outer rotation pressure is displayed when front wrench is closed and during backreaming.
6. Drilling fluid pressure gauge  c00ic048h.eps	Displays drilling fluid pressure in the drilling fluid hard line.	**IMPORTANT:** Monitor this gauge and drilling fluid flowmeter carefully to see if values are rising or falling at the same time. If they are not, nozzle might be plugged.
7. Drilling fluid pump status indicator (red)	Lights when pump is on.	

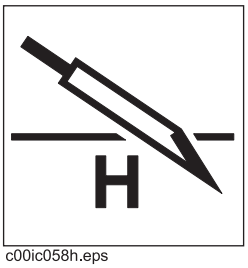
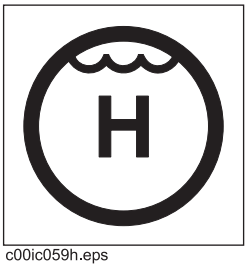
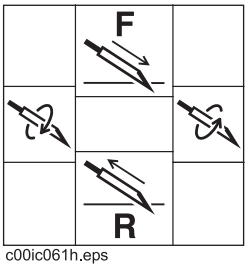
Drill/Drive Control



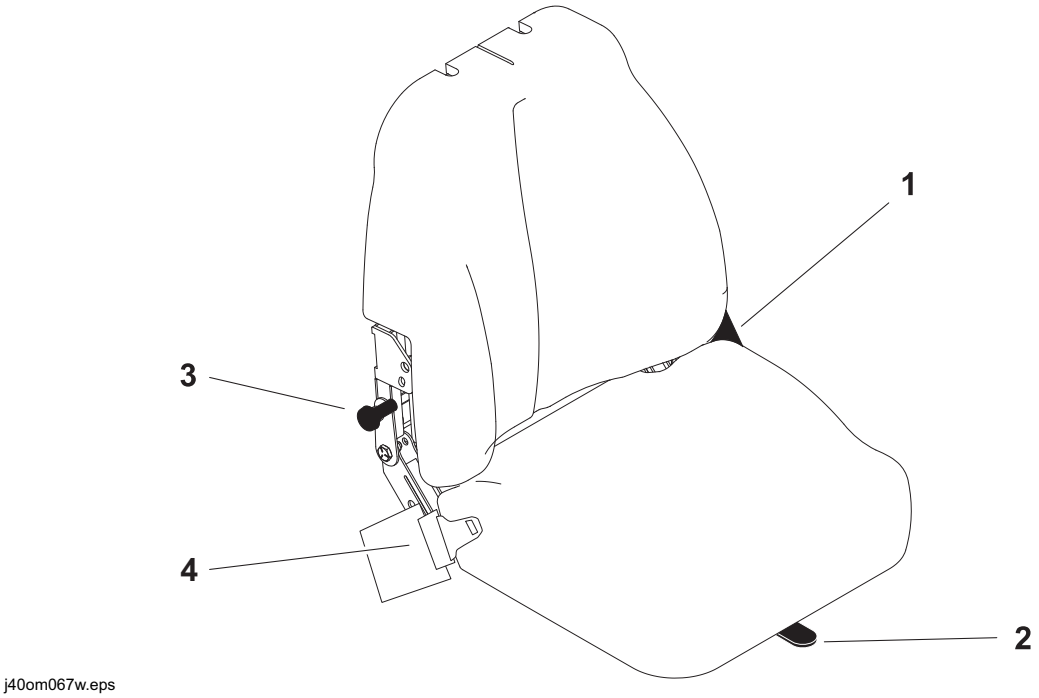
j40om008w.eps

1. Drilling fluid pump switch
2. Dual speed carriage/Two-speed ground drive control
3. Drilling fluid quick fill switch
4. Track and carriage control

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/ Two-speed ground drive control  c00ic058h.eps	Carriage travel speed: • To increase, push and hold. • To return to normal carriage speed, release. Ground drive speed: • For high ground drive speed, push once. • To return to low ground drive speed, push once.	Use during bore or pullback **when no pipe is in spindle** to save time. **IMPORTANT:** Drill/Park/Drive switch must be in **drill** position. Use **when driving straight.** **IMPORTANT:** Drill/Park/Drive switch must be in **drive** position. Unit will be in low speed each time unit is started.
3. Drilling fluid quick fill switch  c00ic059h.eps	For full pump flow to fill pipe with fluid, press and hold. To return fluid flow to flow control setting, release.	
4. Track and carriage control  c00ic061h.eps	Track control: • To move forward, push. • To move backward, pull. • To steer, move light or left while moving. Carriage control: • To move carriage forward, push. • To move carriage backward, pull. • To rotate spindle counterclockwise (breakout), move right. • To rotate spindle clockwise (makeup), move left.	**IMPORTANT:** Drill/Park/Drive switch must be in **drive** position. See "Steer Unit" on page 82 for more information. **IMPORTANT:** Drill/Park/Drive switch must be in **drill** position. See "Operate Carriage Control" on page 95 for more information.

Seat



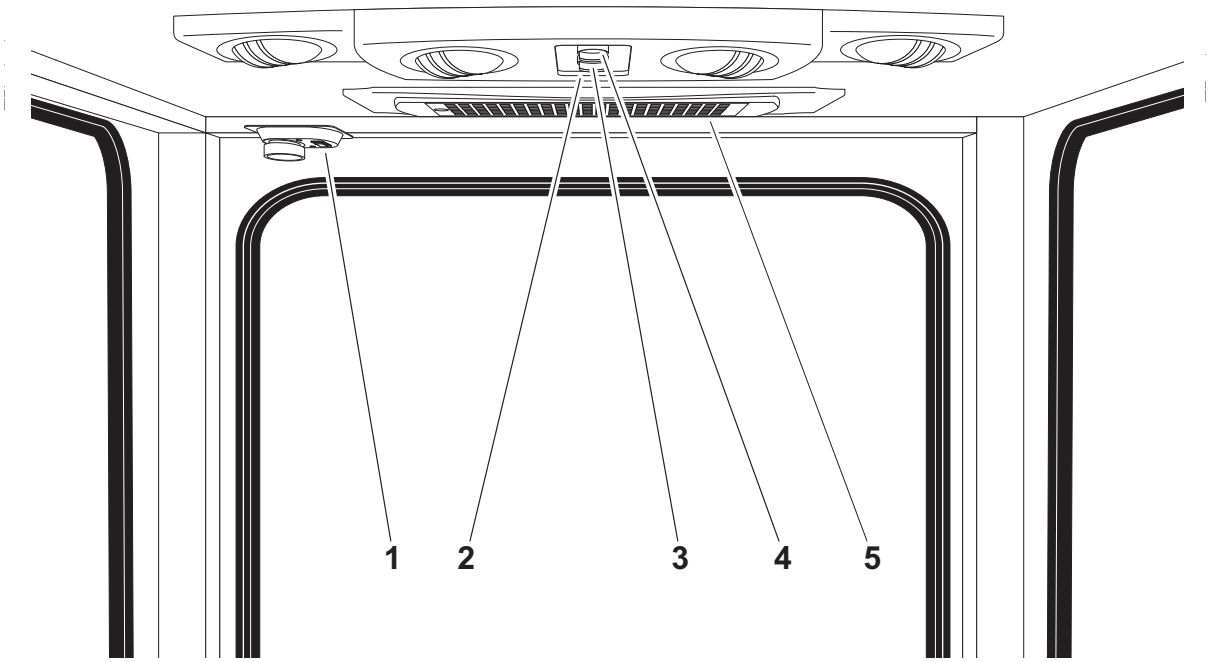
1. Seat recline control
2. Seat slide control
3. Seat lumbar control
4. Seat belt

Item	Description	Notes
1. Seat recline control	To raise seatback, turn toward anchors. To recline seatback, turn toward engine compartment.	
2. Seat slide control	To slide forward or backward, move left. To lock seat in position, release.	
3. Seat lumbar control	For least support, move up. For medium support, move down. For maximum support, move toward engine compartment.	
4. Seat belt	To fasten, insert latch into buckle. Adjust until seat belt is low and tight. To release, lift top of buckle.	

Cab Controls

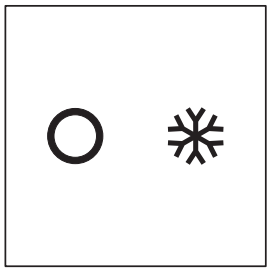
EMERGENCY EXIT: Push rear window out to exit cab when door is blocked or inoperable.

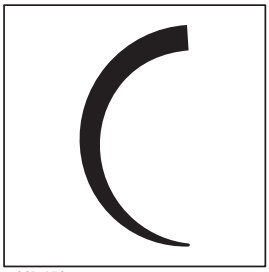
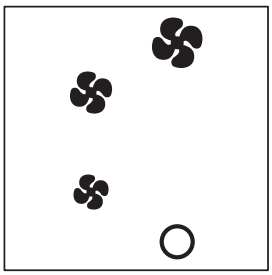
Top/Rear



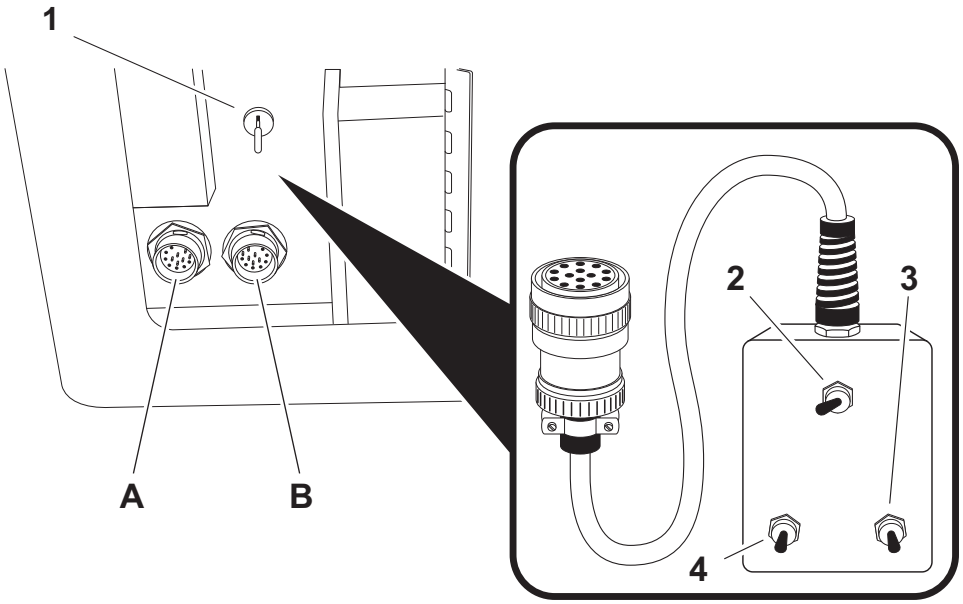
j29om002t.eps

1. Dome light switch
2. Air conditioner on/off switch
3. Air conditioner temperature dial
4. Air conditioner fan speed dial
5. Air conditioner filter

Item	Description	Notes
1. Dome light switch	To turn on or off, press.	
2. AC on/off switch  c00ic157a.eps	To turn air conditioner on, press left. To turn air conditioner off, press right.	

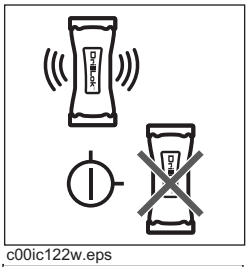
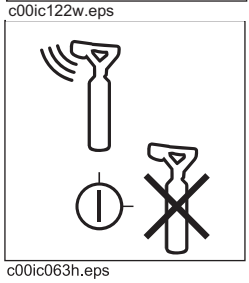
Item	Description	Notes
3. AC temperature dial  c00ic158a.eps	To adjust air temperature, turn dial.	
4. AC fan speed dial  c00ic159a.eps	To adjust fan speed, turn dial.	
5. Air conditioner filter	Filters air coming into cab.	Clean or replace air filter as needed.

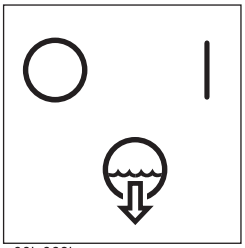
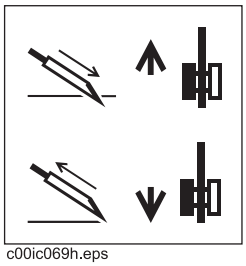
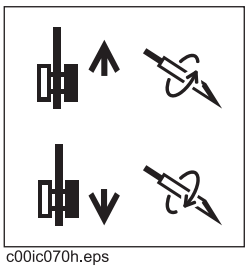
Override Box



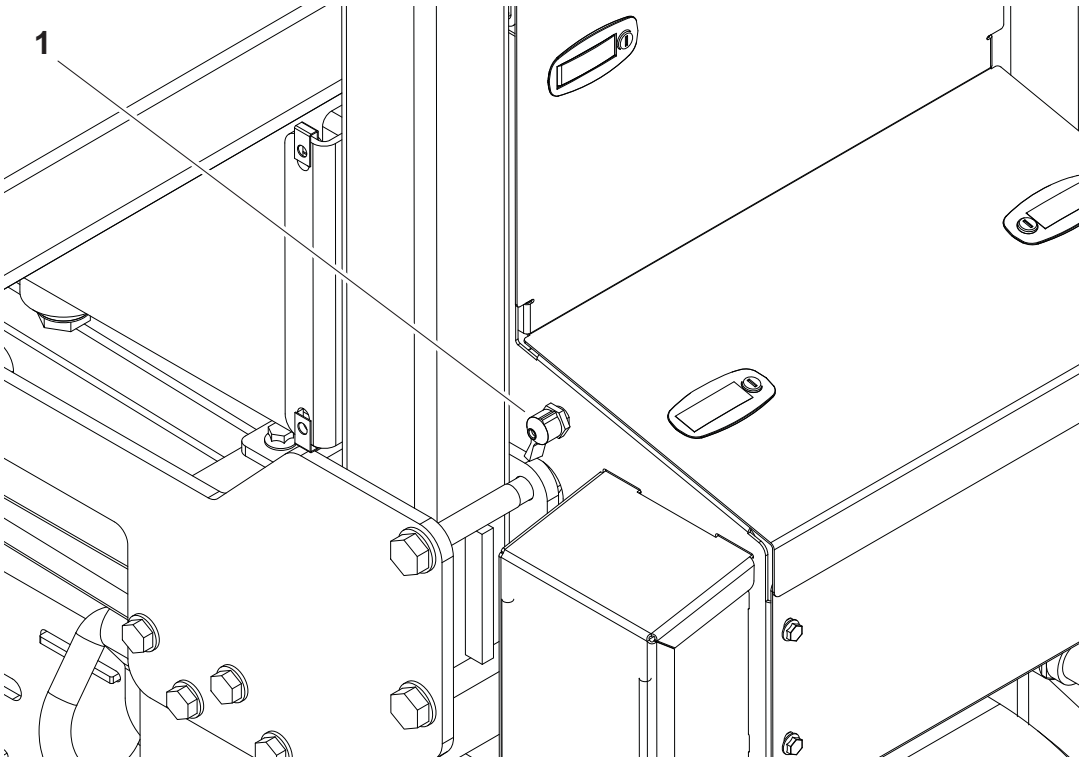
j40om073w.eps

1. DrillLok™/tracker control key
2. Drilling fluid flow override switch
3. Rotation or right track override switch
4. Thrust/pullback or left track override switch
5. Drill override port
6. Drive override port

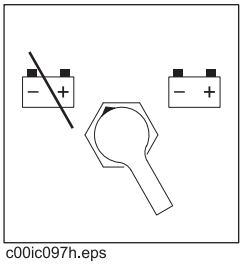
Item	Description	Notes
1. DrillLok/tracker control key  c00ic122w.eps  c00ic063h.eps	To allow tracker operator to stop thrust and rotation, move key to enable position (up). To override DrillLok or tracker control modes, move key to override position (right).	**IMPORTANT:** Remove key and keep in tracker operator's possession. See "DrillLok™ System/Tracker Control" on page 131.

Item	Description	Notes
2. Drilling fluid flow override switch  c00ic068h.eps	To turn fluid on, move right. To turn fluid off, move left.	Connect to drill connector (B) to control fluid flow.
3. Thrust/pullback or left track override switch  c00ic069h.eps	For thrust or to move track forward, move up. For pullback or to move track backward, move down.	Connect to drill connector (B) to control thrust/pullback. Connect to drive connector (A) to control left track. **IMPORTANT:** When connected to connector (A), drill fluid switch functions as an operator presence switch.
4. Rotation or right track override switch  c00ic070h.eps	For counterclockwise rotation or to move track forward, move up. For clockwise rotation or to move track backward, move down.	Connect to drill connector (B) to control rotation. Connect to drive connector (A) to control right track. **IMPORTANT:** When connected to connector (A), drill fluid switch functions as an operator presence switch.
5. Drill override port	Connect tether to this port to override drill functions.	
6. Drive override port	Connect tether to this port to override drive functions.	

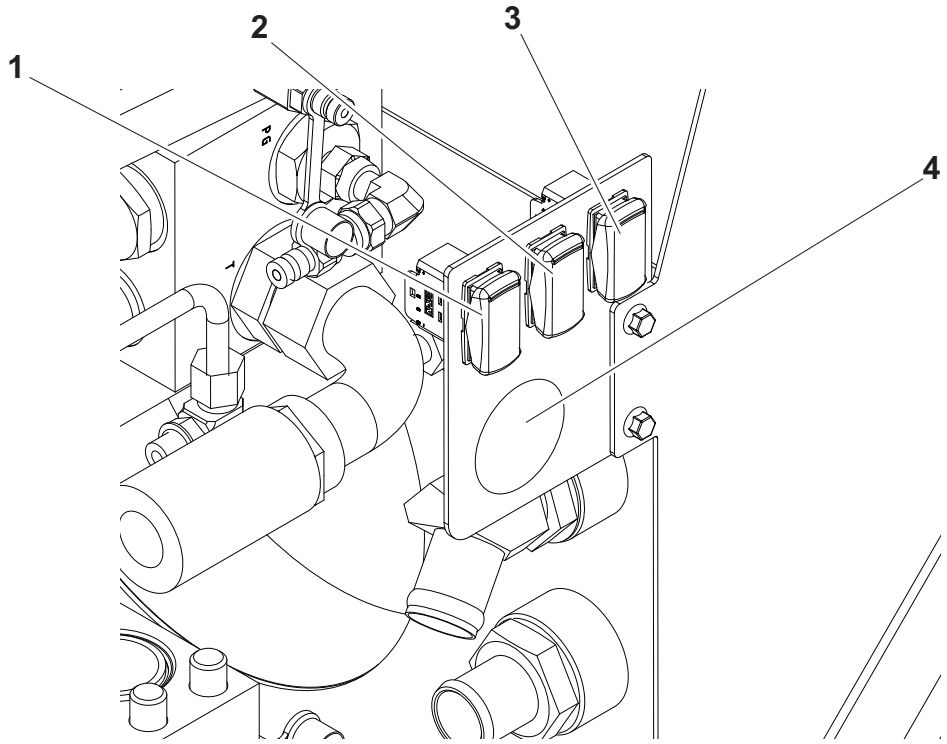
Battery



j40om019w.eps

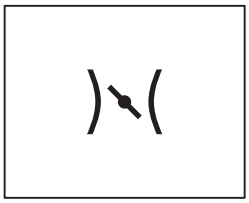
Item	Description	Notes
1. Battery disconnect switch  c00ic097h.eps	To disconnect, turn switch counterclockwise. To connect, turn switch clockwise.	**IMPORTANT:** Use when servicing unit and during long-term storage.

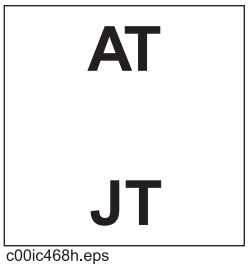
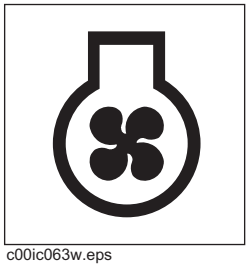
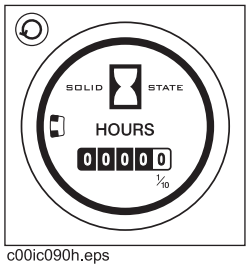
Engine Compartment



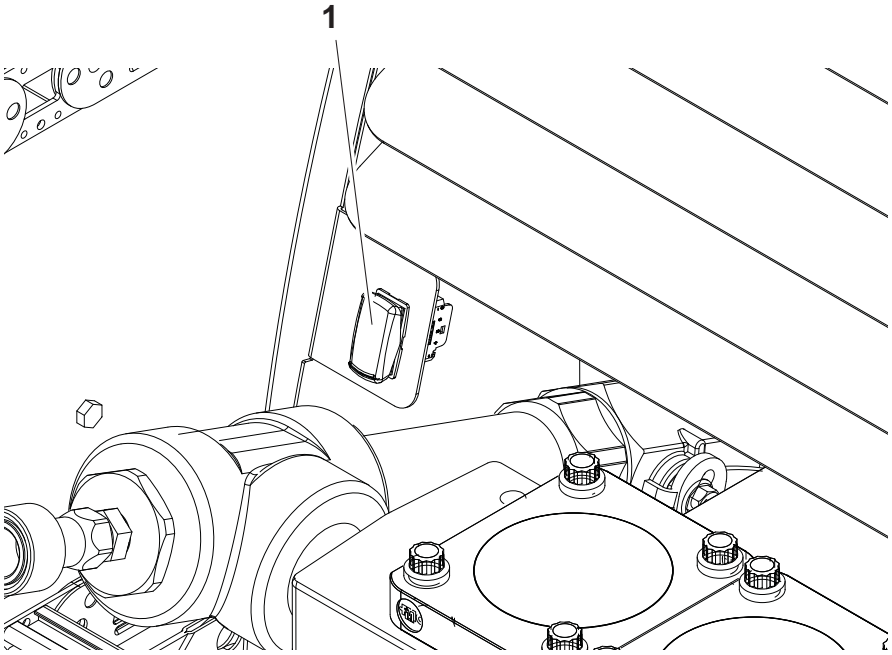
j40om009w.eps

1. Manual throttle switch
2. Drill mode switch (optional)
3. Fan speed switch
4. Inner rotation hour meter (optional)

Item	Description	Notes
1. Manual throttle switch  c00ic130a.eps	To throttle up, press top of switch. To throttle down, press bottom of switch.	**IMPORTANT:** Switch only functions if CAN communication is not operable.

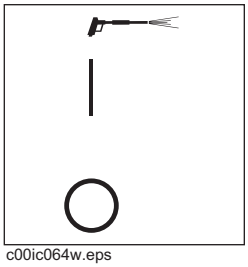
Item	Description	Notes
2. Drill mode switch  c00ic468h.eps	To select **AT Rock** mode, press top. To select **AT Dirt** mode, move to middle. To select **JT** mode, press bottom.	Use **AT Rock** mode when using AT pipe with inner rod and rock drilling bits. Use **AT Dirt** mode when using AT pipe with inner rod and adapter to use dirt tool head. Use **JT** drilling mode when using JT pipe without inner rod. **IMPORTANT:** See "Prepare Drilling Unit" on page 79 for how to set up unit for each drilling mode.
3. Fan speed switch  c00ic063w.eps	For high speed, press top. For automatic speed, press bottom.	**IMPORTANT:** 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.
4. Inner rotation hour meter  c00ic090h.eps	Displays inner rotation operating time.	Use these times to schedule service for downhole tool and inner shaft. See "Service" on page 161.

Rear Console



j40om010w.eps

1. Pressure wand on/off switch

Item	Description	Notes
1. Pressure wand on/off switch  c00ic064w.eps	To turn pressure wand on, press top. To turn pressure wand off, press bottom.	

Operation Overview

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Leaving Jobsite 58

Storing Equipment 58

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 66.
5. Select drilling mode based on jobsite conditions. See page 78.
6. Check supplies and prepare equipment. See page 76.
7. Load equipment. See page 87.

Setting Up at Jobsite

1. Prepare jobsite. See page 75.
2. Unload drilling unit from trailer. See page 89.
3. Assemble drill string. See page 97.
4. Position drilling unit and frame. See page 93.
5. Assemble strike system. See page 121.
6. Anchor drilling unit. See page 117.
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 93.
2. Engage tracker control if desired. See page 131.
3. Drill first pipe. See page 100.
   - JT mode
   - AT dirt mode
   - AT mode
4. Swab the hole to remove cuttings (AT mode only). See page 101.
5. Record bore path. See page 108.
6. Add pipe. See page 102.
7. Drill remaining pipes in pipe box.
   - Correct direction. See page 104.
   - Engage cruise control. See page 150.
8. Remove empty pipe box and add full box (see page 143) or add up to a single row of drill pipe to empty box (see page 145) to complete bore.
9. Surface drill head. See page 108.
   - Remove drill head.
   - Grease downhole tool (AT mode).

Backreaming

1. Assemble backream string. See page 97.
2. Start drilling unit and adjust throttle.
3. Set drilling fluid flow. Check that fluid flows through all nozzles. See page 132.
4. Remove pipe from bore. See page 112.
5. Remove full pipe box and add empty box (see page 143) or remove up to a single row of drill pipe from full box (see page 145) to complete backream.
6. Remove pullback device. See page 114.

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.
2. Remove anchors. See page 119.
3. Rinse unit and downhole tools. See page 158.
4. Disassemble strike system and disconnect from fluid system. See page 122.
5. Stow tools. See page 159.
6. Load unit onto trailer. See page 87.

Storing Equipment

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

Prepare

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- Examine Pullback Material 61
- Arrange for Traffic Control 61
- Plan for Emergency Services 61

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Classify Jobsite. 64

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- Entry Pitch 71
- Minimum Setback 71
- Minimum Depth 72
- Bore Path Calculator 72

Prepare Jobsite 75

- Mark Bore Path 75
- Prepare Entry Point. 75

Check Supplies and Prepare Equipment 76

- Check Supplies 76
- Prepare Equipment 77
- Select Drilling Mode 78
- Prepare Drilling Unit 79
- Assemble Accessories 80

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

Contact your local One-Call (811 in USA) or the One-Call referral number (888-258-0808 in USA and Canada) to have underground utilities located before digging. Also contact any utilities that do not participate in the One-Call service.



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

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 (See "Inspect Jobsite" on page 64.)
- traffic
- access
- soil type and condition
- water supply
- sources of locator interference (rebar, railroad tracks, etc.)

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

Identify Hazards

Identify safety hazards and classify jobsite. See "Classify Jobsite" on page 64.





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 Start and End Points

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

Slope

Always level machine before drilling. 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 71.



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

Inspect Jobsite

- Follow U.S. Department of Labor regulations on excavating and trenching (Part 1926, Subpart P) and other similar regulations.
- Contact your local One-Call (811 in USA) or the One-Call referral number (888-258-0808 in USA and Canada) to have underground utilities located before digging. Also contact any utilities that do not participate in the One-Call service.
- Inspect jobsite and perimeter for evidence of underground hazards, such as:
  - "buried utility" notices
  - utility facilities without overhead lines
  - gas or water meters
  - junction boxes
  - drop boxes
  - light poles
  - manhole covers
  - sunken ground
- Have an experienced locating equipment operator sweep area within 20' (6 m) to each side of bore path. Verify previously marked line and cable locations.
- Mark location of all buried utilities and obstructions.
- Classify jobsite.

Select a Classification

Jobsites are classified according to underground hazards present.

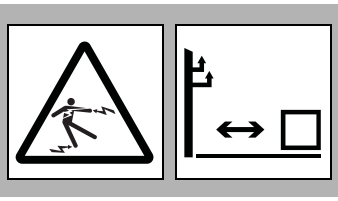
If working . . .	then classify jobsite as . . .
within 10' (3 m) of a buried electric line	electric
within 10' (3 m) of a natural gas line	natural gas
in sand, granite, or concrete which is capable of producing crystalline silica (quartz) dust	crystalline silica (quartz) dust
within 10' (3 m) of any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

IMPORTANT: 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.

Electric Jobsite Precautions

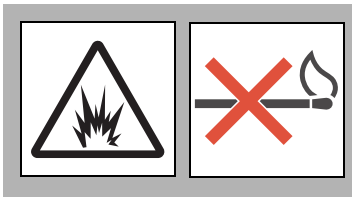


DANGER Electric shock will cause death or serious injury. Stay away. 274-049

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. Have someone observe clearance between drill head and backreamer when crossing a line.
- Have service shut down while work is in progress. Have electric company test lines before returning them to service.

Natural Gas Jobsite Precautions

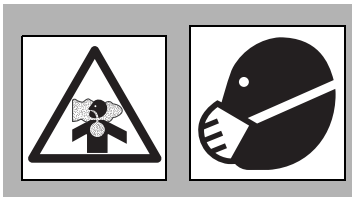


WARNING Fire or explosion possible. Fumes could ignite and cause burns. No smoking, no flame, no spark. 275-419 (2P)

In addition to using a directional drilling system and 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 someone observe clearance between drill head and backreamer when crossing a line.
- 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 Use breathing protection when exposed to silica dust.

270-4952

Follow OSHA or other guidelines for exposure to crystalline silica when trenching, sawing or drilling through material that might produce dust containing crystalline silica (quartz).

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. 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 72 and use these measurements to help plan your bore.

Recommended Bend Limits

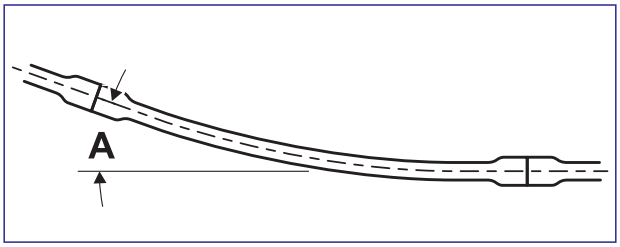
NOTICE: Only use approved JT60 Power Pipe® HD, All Terrain Power Pipe, or Power Pipe Forged with this drilling unit.

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. For JT60 or JT60 All Terrain drill pipe, make sure pitch (A) changes no more than percentages shown below over the full length of each pipe.



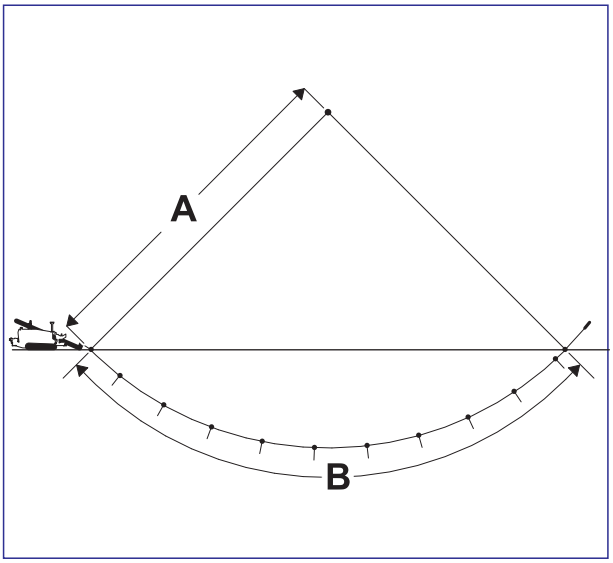
j07om003c.eps

- JT60 Power Pipe HD: 8.8%
- JT60 Power Pipe Forged: 8.9%
- JT60 Power Pipe All Terrain: 7%

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. (See tracking system operation instructions.)

Bend Radius



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JT60 Power Pipe® HD drill pipes have a tested minimum bend radius of 170' (57.8 m). This means that a 90-degree bend in the bore path:

- has a radius (A) of 170' (57.8 m)
- requires approximately 267' (81.4 m) of drill pipe (B).

JT60 Power Pipe Forged drill pipes have a tested minimum bend radius of 169' (51.4 m). This means that a 90-degree bend in the bore path:

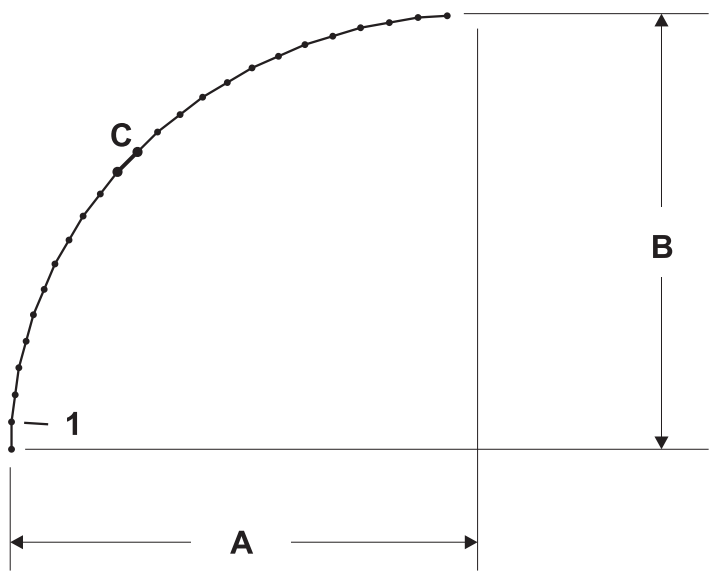
- has a radius (A) of 169' (51.4 m)
- requires approximately 265' (80.8 m) of drill pipe (B).

JT60 Power Pipe All Terrain drill pipes have a tested minimum bend radius of **205' (63 m)**. This means that a 90- degree bend in the bore path:

- has a radius (A) of 205' (63 m)
- requires approximately 471' (143.6 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.



PlanBorePath.eps

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

Pipe-By-Pipe Bend Limits - JT60 Power Pipe® HD

Pipe (C)	Deflection (A)	Forward (B)	Pipe (C)	Deflection (A)	Forward (B)
1	0' 7.9" (0.20 m)	14' 11.8" (4.57 m)	**10**	61' 11.9" (18.90 m)	131' 3.4" (40.02 m)
2	2' 7.7" (0.81 m)	29' 10.1" (9.10 m)	**11**	73' 11.8" (22.55 m)	140' 3.4' (42.76 m)
3	5' 11.1" (1.81)	44' 5.7" (13.56 m)	**12**	86' 8.6" (26.43 m)	148' 2.4" (45.17 m)
4	10' 5.7" (3.19 m)	58' 9.1" (17.91 m)	**13**	100' 1.2" (30.51 m)	154' 11.6" (47.23 m)
5	16' 3.3" (4.05 m)	72' 7.1" (22.13 m)	**14**	114' 0.3" (34.75 m)	160' 6.3" (48.93 m)
6	23' 3.3" (7.09 m)	85' 10.3" (26.17 m)	**15**	128' 4.7" (39.13 m)	164' 10.0" (50.24 m)
7	31' 4.9" (9.57 m)	98' 5.4" (30.01 m)	**16**	143' 0.9" (43.61 m)	167' 10.3" (51.16 m)
8	40' 7.5" (12.38 m)	110' 3.4" (33.61 m)	**17**	157' 11.7" (48.15 m)	169' 6.9" (51.69 m)
9	50' 10.1" (15.50 m)	121' 3.0" (36.96 m)	**18**	170' 0" (51.82 m)	170' 0" (51.82 m)

Pipe-By-Pipe Bend Limits - JT60 Power Pipe® Forged

Pipe (C)	Deflection (A)	Forward (B	Pipe (C)	Deflection (A)	Forward (B)
1	0' 8.0" (0.20 m)	14' 11.8" (4.57 m)	**10**	62' 3.7" (19.00 m).	131' 0.8" (39.95 m)
2	2' 7.9" (0.81 m)	29' 10.1" (9.10 m)	**11**	74' 4.2" (22.66 m)	140' 0.1" (42.67 m)
3	5' 11.5" (1.82 m)	44' 5.6" (13.55 m)	**12**	87' 1.6" (26.56 m)	147' 10.2" (45.06 m)
4	10' 6.5" (3.21 m)	58' 9.0" (17.91 m)	**13**	100' 6.7" (30.65 m)	154' 6.3" (47.10 m)
5	16' 4.4" (5.00 m)	72' 6.7" (22.12 m)	**14**	114' 6.3" (3491 m)	157' 11.8" (48.15 m)
6	23' 4.8" (7.13 m)	85' 9.7" (26.15 m)	**15**	128' 11.1" (39.30 m)	164' 2.1" (50.04 m)
7	31' 7.0" (9.63 m)	98' 4.5" (29.98 m)	**16**	143' 7.6" (43.78 m)	167' 1.0" (50.93 m)
8	40' 10.1" (12.45 m)	110' 2.0" (33.58 m)	**17**	158' 6.5" (48.32 m)	168' 8.1" (51.41 m)
9	51' 1.4" (15.58 m)	121' 1.1" (36.91 m)	**18**	169' 0" (51.51 m)	169' 0" (51.51 m)

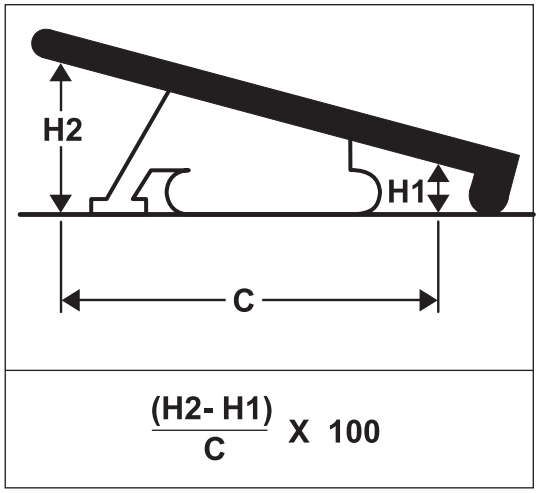
Pipe-By-Pipe Bend Limits - JT60 Power Pipe All Terrain

Pipe (C)	Deflection (A)	Forward (B)	Pipe (C)	Deflection (A)	Forward (B)
1	0' 5.9" (0.15 m)	14' 3.0" (4.34 m)	**13**	78' 3.1" (23.85 m)	161' 1.5" (49.11m)
2	1' 11.8" (0.60 m)	28' 5.1" (28.66 m)	**14**	89' 9.2" (27.36 m)	169' 6.6" (51.68 m)
3	4' 5.4" (1.36 m)	42' 5.6" (12.94 m)	**15**	101' 9.9" (31.04 m)	177' 1.8" (54.00 m)
4	7' 10.6" (2.40 m)	56' 3.7" (17.16 m)	**16**	114' 4.7" (34.87 m)	183' 10.7" (56.05 m)
5	12' 3.3" (3.74 m)	69' 10.5" (21.30 m)	**17**	127' 4.7" (38.83 m)	189' 8.9" (57.83 m)
6	17' 7.2" (5.36 m)	83' 1.2" (25.33 m)	**18**	140' 9.2" (42.91 m)	194' 8.1" (59.34 m)
7	23' 9.9" (7.26 m)	95' 11.1" (29.24 m)	**19**	154' 5.4" (47.08 m)	198' 8.0" (60.55 m)
8	30' 11.2" (9.43 m)	108' 3.4" (33.00 m)	**20**	168' 4.6" (51.32 m)	201' 8.4' (61.48 m)
9	38' 10.5" (11.85 m)	120' 1.4" (36.61 m)	**21**	182' 5.9" (55.62 m)	203' 9.1" (62.10 m)
10	47' 7.5" (14.52 m)	131' 4.5" (40.04 m)	**22**	196' 8.5" (59.96 m)	204' 10.0" 62.43 m)
11	57' 1.7" (17.42 m)	141' 11.9" (43.28 m)	**23**	205' 0" (62.48 m)	205' 0" (62.48 m)
12	67' 4.4" (20.53 m)	151' 11.1" (46.31 m)			

Entry Pitch

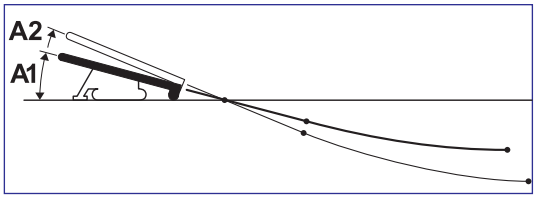
Entry pitch is the slope of the drill frame compared with the slope of the ground. Determine entry pitch one of two ways:

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 minimum setback longer and deeper.

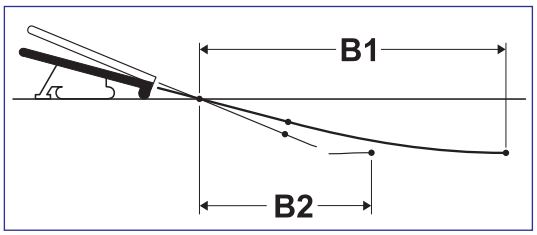


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Minimum Setback

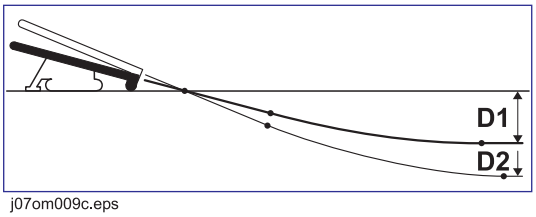
Setback is the distance from the entry point to where pipe becomes horizontal (B1).

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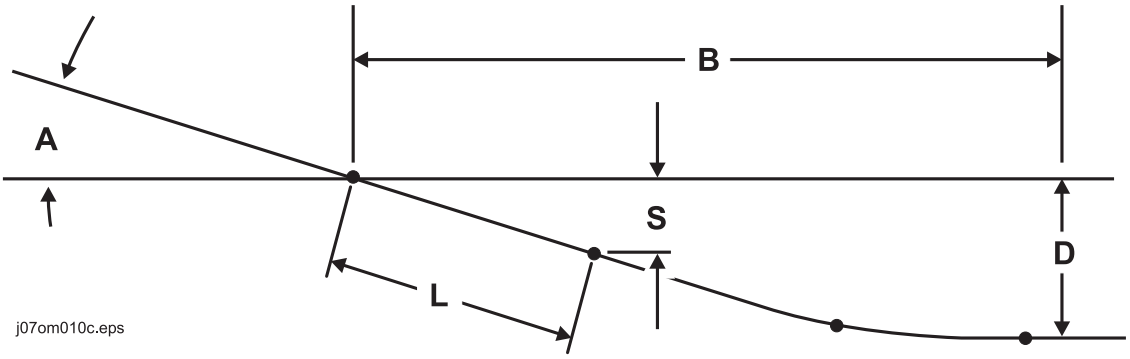
Because you must bend pipe gradually, entry pitch and bend limits determine how deep the pipe will be when it becomes horizontal. This is called the **minimum depth**.

- 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.

JT60 Power Pipe® HD

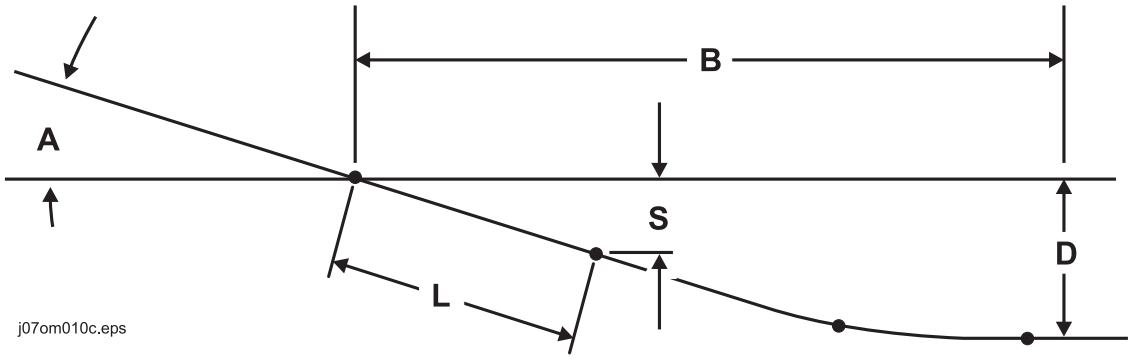


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Minimum depth (D)	Entry pitch (A)	Setback (B)	Depth to begin steering (S)
4’ 10” (1.47 m)	18%/10.0°	42’ 2”(12.85 m)	2’ 3” (0.69 m)
5’ 7” (1.70 m)	19%/11.0°	45’ 1” (13.74 m)	2’ 6” (.076 m)
6’ 5” (1.96 m)	21%/12.0°	47’ 11” (14.61 m)	2’ 8” (0.81 m)
7’ 3” (2.21 m)	23%/13.0°	50’ 9” (15.47 m)	2’ 11” (0.89 m)
8’ 2” (2.49 m)	25%/14.0°	53’ 7” (16.33 m)	3’ 2” (0.97 m)
9’ 2” (2.79 m)	27%/15.0°	56’ 5” (17.20 m)	3’ 4” (1.01 m)
10’ 2” (3.10 m)	29%/16.0°	59’ 3” (18.06 m)	3’ 7” (1.09 m)

IMPORTANT: Numbers in table based on **170’ (51.8 m) minimum bend radius**, beacon housing, EZ-Connect, connector, transition sub, and 1/3 of first drill pipe (L, totaling 12’ 10” [3.9 m]) in the ground before steering.

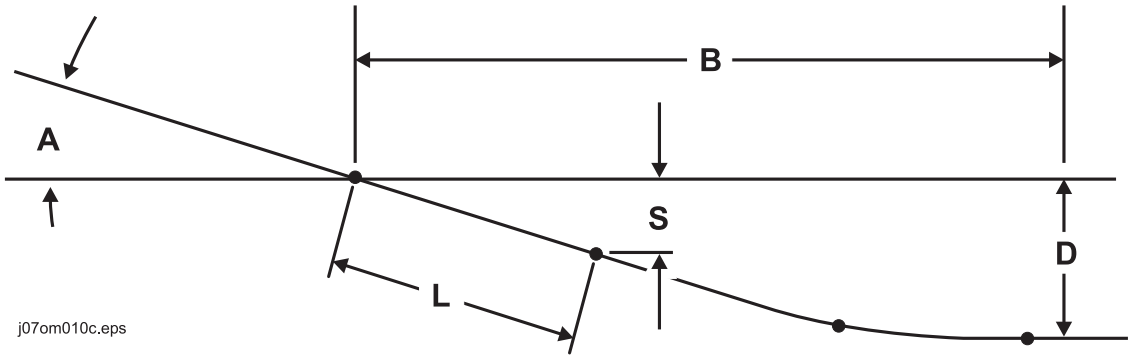
JT60 Power Pipe® Forged



Minimum depth (D)	Entry pitch (A)	Setback (B)	Depth to begin steering (S)
4' 10" (1.47 m)	18%/10.0°	42' 0" (12.80 m)	2' 3" (0.69 m)
5' 7" (1.70 m)	19%/11.0°	44' 10" (13.67 m)	2' 6" (.076 m)
6' 5" (1.96 m)	21%/12.0°	47' 9" (14.55 m)	2' 8" (0.81 m)
7' 3" (2.21 m)	23%/13.0°	50' 6" (15.39 m)	2' 11" (0.89 m)
8' 2" (2.49 m)	25%/14.0°	53' 4" (16.25 m)	3' 2" (0.97 m)
9' 1" (2.77 m)	27%/15.0°	56' 2" (17.12 m)	3' 4" (1.01 m)
10' 1" (3.07 m)	29%/16.0°	58' 11" (17.96 m)	3' 7" (1.09 m)

IMPORTANT: Numbers in table based on **168.7' (51.4 m) minimum bend radius**, beacon housing, EZ-Connect, connector, transition sub, and 1/3 of first drill pipe (L, totaling 12' 10" [3.9 m]) in the ground before steering.

JT60 Power Pipe® All Terrain



Minimum depth (D)	Entry pitch (A)	Setback (B)	Depth to begin steering (S)
5' 4" (1.62 m)	18%/10.0°	48' 0" (14.63 m)	2' 3" (0.69 m)
6' 2" (1.88 m)	19%/11.0°	51' 6" (15.70 m)	2' 5" (0.74 m)
7' 2" (2.18 m)	21%/12.0°	54' 11" (16.74 m)	2' 8" (0.81 m)
8'1" (2.46 m)	23%/13.0°	58' 5" (17.81 m)	2' 10" (0.86 m)
9' 2" (2.79 m)	25%/14.0°	61' 10" (18.84 m)	3' 1" (0.94 m)
10' 3" (3.12 m)	27%/15.0°	65' 3" (19.89 m)	3' 4" (1.01 m)
11' 5" (3.48 m)	29%/16.0°	68' 7" (20.90 m)	3' 6" (1.07 m)

IMPORTANT: Numbers in table based on **168.7' (51.4 m) minimum bend radius**, beacon housing, EZ-Connect, connector, transition sub, and 1/3 of first drill pipe (L, totaling 12' 10" [3.9 m]) in the ground before steering.

Prepare Jobsite




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

To help prevent injury:

- Classify jobsite as electric if jobsite classification is in question or if the possibility of unmarked electric utilities exists.
- Cutting high voltage cable can cause electrocution. Expose lines by hand before digging.

Mark Bore Path

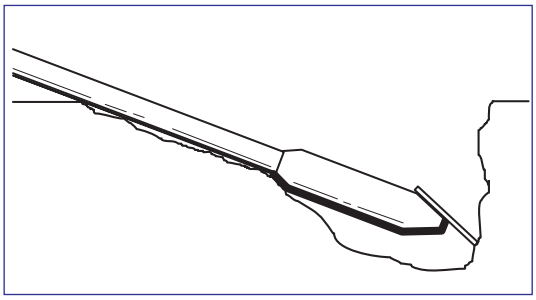
Mark your planned bore path and all located utility lines with flags or paint.

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

- receiver/transmitter or tracker with spare batteries
- beacons with new and spare batteries
- two-way radios with new and spare batteries
- hydraulic wrench (see "Hydratong Wrenches" on page 137)
- transition sub
- anchoring equipment and accessories
- bits, screens, nozzles (see "Downhole Tools" on page 132)
- adapters, pipe, beacon housings
- marking flags or paint
- water and additional hoses
- fuel
- drilling fluid additives (see "Drilling Fluid" on page 126)
- spare fuses
- keys
- backreamers, swivels, pulling devices (see "Backreamers" on page 134)
- wash down hose and spray gun
- duct tape
- spray lubricant
- tool joint compound (see "Recommended Lubricants/Service Key" on page 164)
- electrically insulating boots and gloves. Boots must have high tops and meet the electric hazard protection requirements of ASTM F2413 when tested at 14,000 volts. Tuck legs of pants completely inside boots.
- 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



Select Drilling Mode

Three drilling setups are available with this unit:

- AT rock mode
- AT dirt mode
- JT mode

Select the best setup based on jobsite conditions.

Mode	Situation used	Downhole tools	Capabilities
AT Rock	Rock, soft rock, other non-compressible soils. Any other situation with difficult steering because of hard soil conditions.	• All Terrain drill pipe • Rockmaster™ tool	• 60,000 lb (266 kN) of thrust • dither • inner rotation
AT dirt	When one bore out of several can be better or more quickly done with conventional downhole tools. This bore is such that changing to JT pipe is not practical.	• All Terrain drill pipe • beacon housing • transition sub • standard JT tools	• 60,000 lb (266 kN) of thrust • dither • no inner rotation
JT	Soft or intermittent soft rock or other compressible soils.	• JT drill pipe • standard JT tools	• 60,000 lb (266 kN) of thrust • no dither • no inner rotation

Once drilling mode has been selected, configure drilling unit to match mode.

Prepare Drilling Unit

AT Rock Mode

- Verify unit has not been converted to JT mode. Ensure All Terrain SaverLok System®, shuttle stops, pipe gripper pads, pipe guide blocks, pipe wiper, shuttle stop, wrench jaw blocks, and pipe lifter pads are installed.
- Inspect Rockmaster tool and select bit based on jobsite conditions.
- Use drill bit type anchors.
- Load All Terrain pipe and pipe box onto unit.
- Move mode selector switch to AT Rock position.

AT Dirt Mode



- Verify unit has not been converted to JT mode. Ensure All Terrain SaverLok System, shuttle stops, pipe gripper pads, pipe guide blocks, pipe wiper, shuttle stop, wrench jaw blocks, and pipe lifter pads are installed.
- Use transition sub between All Terrain pipe and beacon housing. Select soil bit based on jobsite conditions.
- Use auger type anchors if in soft soil conditions.
- Load All Terrain pipe and pipe box onto unit.
- Move mode selector switch to AT DIRT position.

JT Mode

IMPORTANT: Use conversion kit (p/n 101-136) and refer to installation instructions (p/n 051-329).

- Install SaverLok System®, pipe gripper pads, pipe guide blocks, pipe wiper, shuttle stop, wrench jaw blocks, and pipe lifter pads sized to handle Mach 1 pipe.
- Use standard transition sub and beacon housing. Select soil bit based on jobsite conditions.
- Use auger type anchors.
- Load JT pipe and pipe box onto unit.

NOTICE: Do not put JT pipe into a large All Terrain pipe box. Pipe can jam and box can be damaged. Use JT pipe box.

- Move mode selector switch to JT position.

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 82

Steer Unit 82

Shut Down Unit 84

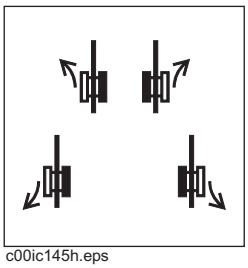
Start Unit

1. Insert key.
2. Turn ignition switch to the run position (key on, engine off). Engine preheat indicator (on engine display) will light.
3. Wait for engine preheat indicator to go off before starting.
4. Run engine at low throttle for 5 minutes.

Steer Unit

IMPORTANT: Survey field of vision before operating the machine and position all mirrors provided to ensure that visibility is not restricted.

To steer drilling unit, follow instructions for type of steering desired.

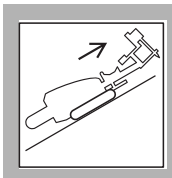
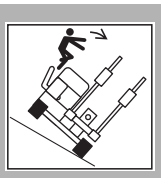

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To steer while moving forward, push forward and then move to left or right. Drilling unit will gradually turn to left or right.

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 a corner. Tracks will counter-rotate and turn drilling unit in a tight circle.

Safe Slope Operation

WARNING Tipover possible. Machine can tip over and crush you.

To help avoid injury:

- Always operate with heavy end uphill.
- Drive cautiously at all times.
- Never jerk control levers. Use a steady even motion.
- Do not park unit on slope without lowering anchor frame to the ground, returning all controls to neutral position, shutting down unit, and applying parking brake.

Operating safely on a slope depends upon many factors including:

- Distribution of machine weight, including front loading and absence of load
- Height of load
- Even or rough ground conditions
- Potential for ground giving way causing unplanned tilt forward, reverse or sideways
- Nearness of ditches, ruts, stumps or other obstructions and sudden changes in slope
- Speed
- Turning
- Braking performance
- Operator skill

These varying factors make it impractical to specify a maximum safe operating angle in this manual. It is therefore important for the operator to be aware of these conditions and adjust operation accordingly. Maximum engine angle and braking performance are two absolute limits which must never be exceeded. These maximums are stated below since they are design limits. These design limits usually exceed the operating limits and must never be used alone to establish safe operating angle for variable conditions.

Maximum engine lubrication angle – 43°

Maximum service brake retarding force – equal to traction of both tracks.

Maximum secondary brake retarding force – equal to traction of one track.

Maximum park brake holding force – equal to traction of both tracks.

Shut Down Unit

1. Stop track movement.
2. Engage parking brake.
3. Run engine at low throttle for 3 minutes to cool.
4. Turn ignition switch to STOP.
5. Remove key.

Transport

Chapter Contents

Lift 86

Haul 87

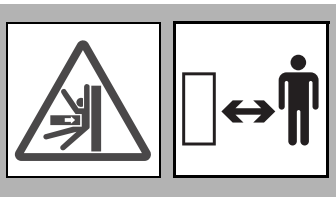
- Load 87
- Tie Down 88
- Unload 89

Tow 89

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" for weight of machine.

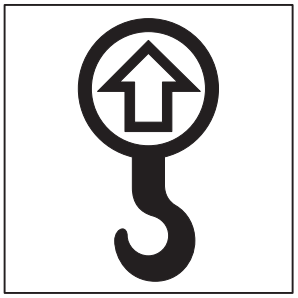
Pipe Box Lifting Procedure



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

Pipe box lifting points are identified by lifting decals. Lifting at other points is unsafe and can damage equipment.

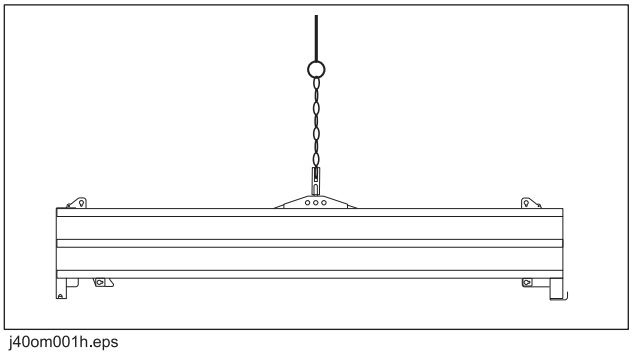
Ensure that proper remove/install procedure is followed. See "Remove/ Install Pipe Box" on page 143.



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Use crane capable of supporting the equipment's size and weight. See "Specifications" on page 201 or measure and weigh equipment before lifting.

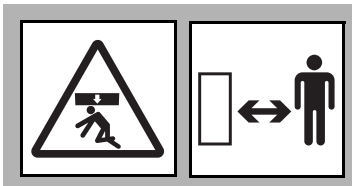
IMPORTANT: Lift only one box of pipe at a time.



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Haul

Load



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:

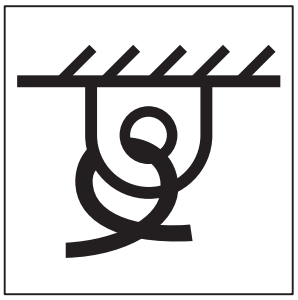
- Load and unload trailer on level ground.
- Verify that trailer wheels are blocked.
- Attach trailer to vehicle before loading or unloading.
- Place ten to fifteen percent of total vehicle weight (equipment plus trailer) on tongue to help prevent trailer sway.

1. Fasten and adjust seat belt.
2. Start drilling unit engine.
3. Move drilling unit to rear of trailer and align with ramps or center of trailer bed.
4. Slow engine to low throttle and slowly drive unit onto trailer.
5. Lower stabilizers to trailer floor.
6. Lower drill frame to trailer floor.
7. Stop engine when unit is safely positioned on trailer bed.
8. Attach tiedowns to drilling unit where tiedown decals are located.

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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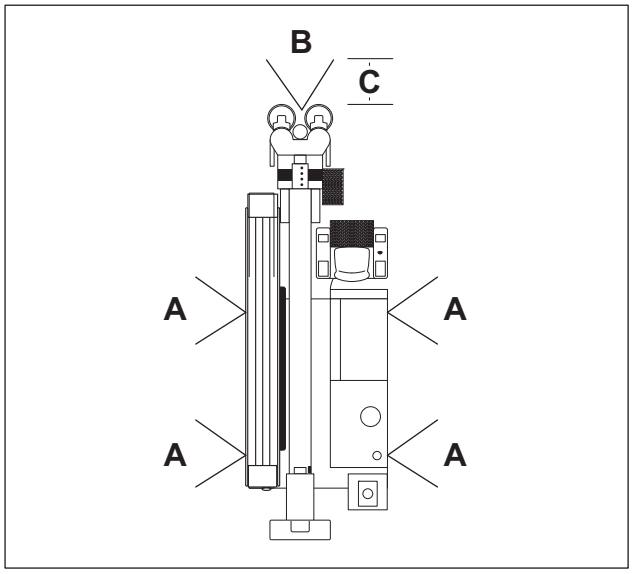
Procedure

NOTICE:

- Wrenches can open after engine shutdown. Ensure that any pipe in wrenches is attached to spindle and downhole tools are removed from the pipe before transport.
- Use Grade 7-3/8" (18.7 cm) transport chain to secure drilling unit.

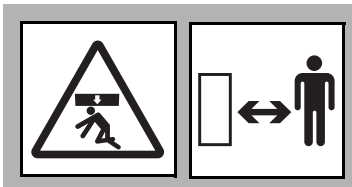
Loop a transport chain around each tie down point. See chart below for correct distances between tiedown ends. Make sure tiedowns are tight before transporting.

Distance	Measurement
A	greater than 18"
B	less than 50"
C	greater than 10"



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Unload



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:

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

1. Lower trailer or ramps.
2. Fasten and adjust seat belt.
3. Remove tiedowns.
4. Start drilling unit engine.
5. Raise stabilizers.
6. Raise drill frame.
7. Slow engine to low throttle and slowly back unit down trailer or ramps.

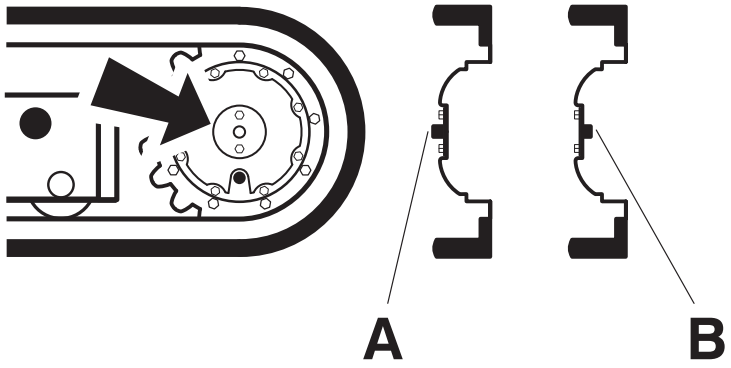
Tow

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

- tow for short distances at less than 1 mph (1.6 km/h),
- attach chains to indicated tow points facing towing vehicle,
- use maximum towing force of 1.5 times unit weight,
- disengage track planetaries.

To disengage track planetaries, reverse small cover plate in center of planetary on each track drive.

IMPORTANT: When planetaries are disengaged, unit has no brakes.

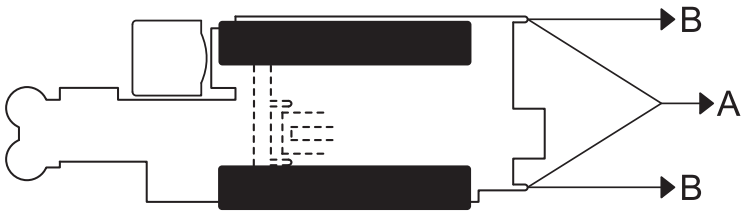


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A. Normal operation B. Towing

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

If **back** tow points are facing towing vehicle, choose option A or B.

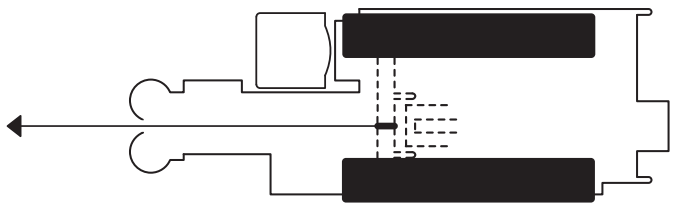


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Option A: Loop chain through both tow points and attach to common cross member. Always pull straight back.

Option B: Loop chain through each tow point and attach chains to towing vehicle. Always pull straight back.

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



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Conduct a Bore

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Position Equipment

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

Connect Fluid System

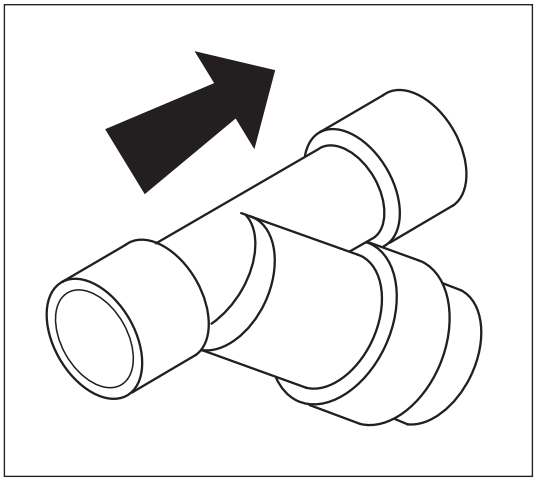


DANGER Electric shock. Contacting electric lines will cause death or serious injury. Know location of lines and stay away.

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 3" (76 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.



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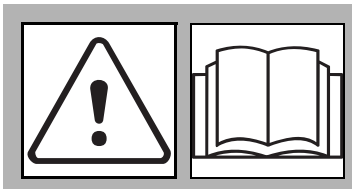
Start System

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

IMPORTANT: Ensure that mixture of drilling fluid matches drilling conditions.

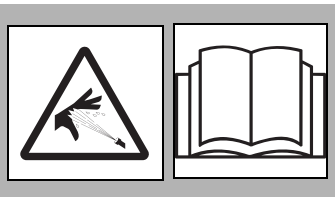
2. Enable tracker control mode if desired. See "DrillLok™ System/Tracker Control" on page 131.
3. Press top of drilling unit throttle switch until engine is at full throttle.
4. Press and hold quick fill fluid pump switch until pipe fills and fluid pressure begins to rise.

Prime Drilling Fluid Pump



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

To help avoid injury: Prime the drilling fluid pump to lessen flow fluctuations, which can make it difficult to control the washwand.

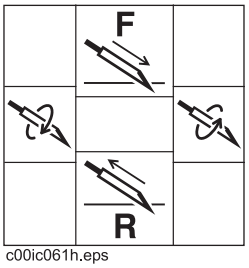


WARNING Pressurized fluid or air could pierce skin and cause severe injury. Refer to operator's manual for proper use. 270-6035

Prime drilling fluid pump each time the 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

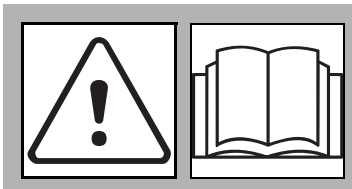


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The thrust/rotation control has eight zones that allow four basic functions (forward, backward, clockwise, counterclockwise) to be combined. The chart below summarizes functions that occur when control is put at a combined position. Operator must be in seat for control to function.

Carriage Movement	Rotation Direction	
forward	clockwise	 ic1102a.eps
backward	counterclockwise	 ic1104a.eps

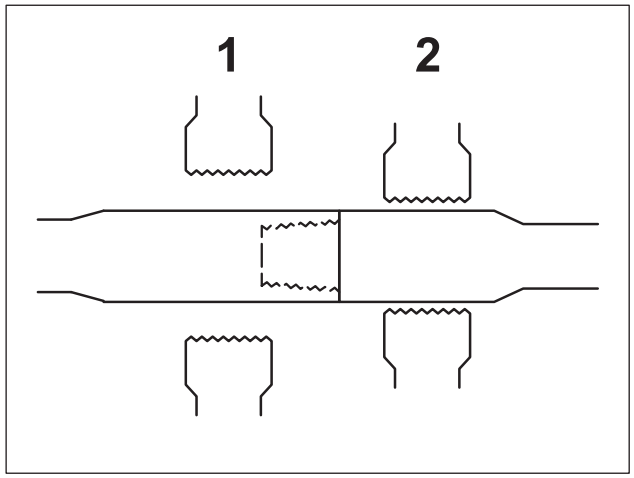
Clamp Pipe



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

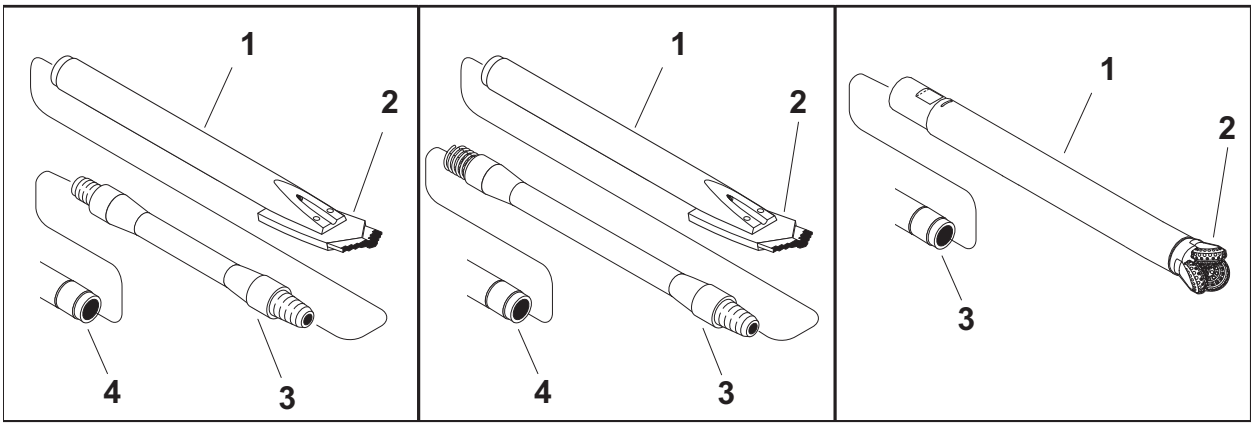
To help avoid injury: Clamp only where indicated. Clamping anywhere else on the pipe will weaken the pipe. Pipe can later break, even when operating under normal loads.

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.



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Assemble Drill String



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JT mode	AT Dirt mode	AT Rock mode
1. beacon housing	1. beacon housing	1. Rockmaster™ tool
2. bit	2. bit	2. bit
3. transition sub	3. transition sub	3. JT60 All Terrain drill pipe
4. JT60 drill pipe	4. JT60 All Terrain drill pipe	

IMPORTANT: If no part number is listed, contact your Ditch Witch® dealer about available options.

Prepare Beacon Housing

1. Select nozzles (JT and AT Dirt modes only) and bit.

   IMPORTANT: A variety of nozzles and bits are available to suit your particular job conditions. See "Downhole Tools" on page 132 for more information, or contact your Ditch Witch dealer.

2. Insert nozzle into beacon housing (JT and AT Dirt modes only).
3. Attach bit to beacon housing.
4. Install beacon, following beacon instructions for:
   - battery replacement
   - beacon positioning
5. Install beacon housing lid. See "Beacon Housings" on page 133.
6. Follow beacon instructions to check beacon operation.
7. Follow tracker instructions to calibrate beacon.

Attach Transition Sub

Use either machine torque or Hydratong wrenches to attach transition sub.

Machine Torque

1. Pull transition sub into front wrench.
2. Close wrench.
3. Lube joints.
4. Slowly make up joint.
5. Use full machine torque to tighten joint fully.

Hydratong

1. Lube joints with TJC.
2. Attach Hydratong to the joint in the join position and tighten joint. See "Hydratong Wrenches" on page 137.

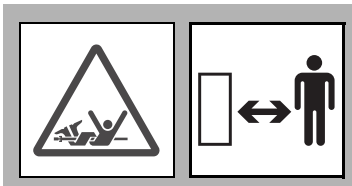
Attach Beacon Housing

1. Attach downhole tool to transition sub and hand tighten.
2. Attach Hydratong to the joint in the join position and tighten joint. See "Hydratong Wrenches" on page 137.

Connect Drill Pipe

1. Start drilling unit engine.
2. Align transition sub in front wrench.
3. Clamp tool in front wrench. See "Clamp Pipe" on page 96.
4. Load pipe.
   - Make sure shuttle stop is positioned correctly.
   - Lubricate threads in front wrench.
   - Grip pipe.
   - Move pipe to spindle.
5. Connect pipe.
   - Move carriage forward until SaverLok® body nears male pipe thread.
   - Continue to move carriage forward and rotate spindle until pipe screws into SaverLok body.
   - Relax grippers.
   - Move carriage forward until front end of pipe is aligned with transition sub male thread.
   - Use machine power to slowly rotate spindle and drill pipe onto transition sub male thread.
   - Raise pipe that is in pipe box.
   - Open grippers.
   - Move shuttle back against shuttle stop.
   - Lower pipe completely into shuttle.
6. Slowly tighten to full machine torque.
7. Disengage rear wrench and move carriage back to top of frame.
8. Stop drilling unit engine.
9. Reinstall blocks on guides.

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)

JT Mode/AT Dirt Mode

1. Turn on drilling fluid.
2. Visually check for drilling fluid flow.
3. Turn drill bit to starting position. See "Prepare Entry Point" on page 75.
4. Slowly move carriage forward. Drill in 13' (4 m) before steering.
5. Monitor gauges.

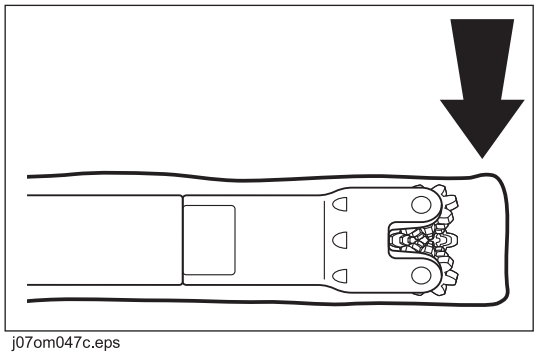
AT Rock Mode

1. Turn on drilling fluid.
2. Visually check for drilling fluid flow.
3. Choose clock position and set spindle brake.
4. Rotate inner spindle clockwise.
5. Slowly move carriage forward. Drill first pipe as straight as possible.
6. Monitor gauges.
    - If inner rotation pressure approaches 1600 psi (110 bar), slow carriage travel.
    - If inner rotation stalls, stop carriage thrust. If inner rotation does not resume, pull pipe back.

Swab the Hole

IMPORTANT: Swab hole after each pipe is drilled to remove cuttings and keep the hole clear (AT Rock mode only). Some conditions may require more frequent swabbing.

1. Move carriage forward until wrench springs are fully compressed.
2. Move carriage to rear of drill frame with drilling fluid and inner rotation on.
3. Move carriage forward until carriage touches rear wrench to leave gap between end of bore and drill head (shown).


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Enable Automated Pipeloader System

Add Pipe	Remove Pipe
1. Open front wrench and retract shuttles for add pipe function to work.	1. Open front wrench and retract shuttles 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, turn automated pipeloader system off (switch to manual control) and then 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 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 101.
3. Break joint at SaverLok® body.

Manual Pipeloader Controls	Automated Pipeloader Control
• Clamp pipe joint. See "Clamp Pipe" on page 96. • 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. See "Clamp Pipe" on page 96. • 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, pipe will be lubed, 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. • Move pipe to spindle and lube lower threads. • Raise pipe in box.	• Make sure shuttle stop is properly positioned on pipeloader. • When carriage is moved to back of drill frame, press RESUME. Green control cycle light will come on. • Pipe will be moved to spindle, front threads will be lubed, pipe in box will be lifted, and then green control cycle light will flash.

5. Connect pipe to SaverLok® body.

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

6. Connect new pipe.

Manual Pipeloader Controls	Automated Pipeloader Control
• Slowly move carriage forward and rotate spindle until pipe threads tighten. • To fully torque joint, slowly rotate pipe until spindle stops turning. • Open wrench. • Open grippers fully. • Retract shuttles against shuttle stop. • Lower pipe lifters.	• Slowly move carriage forward and rotate spindle until pipe threads tighten. • To fully torque joint, slowly rotate pipe until spindle stops turning. • Open 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.

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 150.
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

General

- 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 67.
- 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.

JT Mode/AT Dirt Mode

- Do not push an entire piece of drill pipe into ground without rotation. This can exceed bend radius and cause pipe failure.

AT Rock Mode

- Steering in rock is slower than steering in other soil conditions. Be patient.
- Inner shaft is rotating at all times when AT mode is selected and inner rotation switch is on.
- Engage spindle brake when making directional changes.
- Depth estimate and pitch accuracy improve if drill head is at 3 o'clock when reading is taken.
- Pull back 6" (152 mm) of pipe before checking pitch.

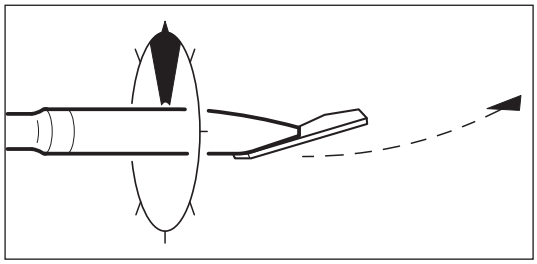
Procedure

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

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.


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To change direction:

JT mode/AT dirt mode	AT mode
1. Rotate pipe to clock position you intend to travel. 2. Push pipe into ground.	1. Rotate outer pipe to clock position you intend to travel. 2. Engage spindle brake. 3. Engage inner rotation and push pipe into ground.

To move forward without changing direction:

JT mode/AT dirt mode	AT mode
1. Rotate pipe. 2. Push pipe into ground.	1. Rotate outer pipe. 2. Engage inner rotation and 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 thrust control 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.** Move thrust control to full forward and 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 rotation control to full clockwise rotation. 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.** Move thrust control back from neutral.
8. **Resume carving.** Move thrust control to full forward and 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 button and m**o**ve rotation control to full clockwise rotation 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

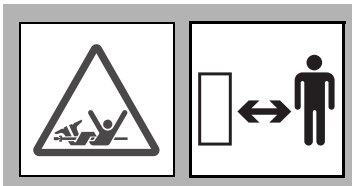
Locate drill head every half-length of pipe. As the job is completed, record the actual data for each drill pipe. List pitch and depth of each joint and a brief description of the procedure. In addition, draw a simple sketch of the site and record depth and rough location of pullback.

The Trac Management System Plus is also available for plotting and tracking your bore path. It utilizes the tracking system, a tracking beacon, and special software. The tracking display can store jobs in its memory or the system can be run in the field using a laptop computer. 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:

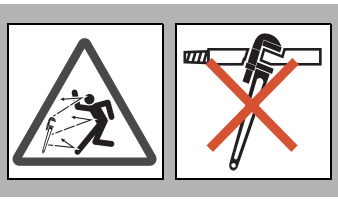
- Tracker operator and drill operator should maintain two-way communication.
- Keep everyone clear of the exposed drill string.
- No one should enter pit until clear communication is given by the drill operator that the drill unit is shut down. If using DrillLok™/tracker control, do not enter pit until 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. See "Recommended Bend Limits" on page 67.
2. Clean area around exit point.
3. If using tracker control mode, tracker operator remotely disables drilling unit thrust/pullback and rotation hydraulics using DrillLok™/tracker control. Tracker operator waits for green light to enter pit and change tools.

   If not using tracker control mode, tracker operator signals to drilling unit operator to stop engine before changing downhole tools.
4. Turn fluid flow control to off position as soon as drill head emerges.
5. Clean drill head especially around threads.
6. Use Hydratong to remove drill head. Keep threads clean. See "Hydratong Wrenches" on page 137.

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.

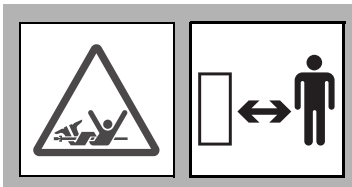


DANGER Moving tools will kill or injure. Never use pipe wrenches on drill string. 273-278



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)

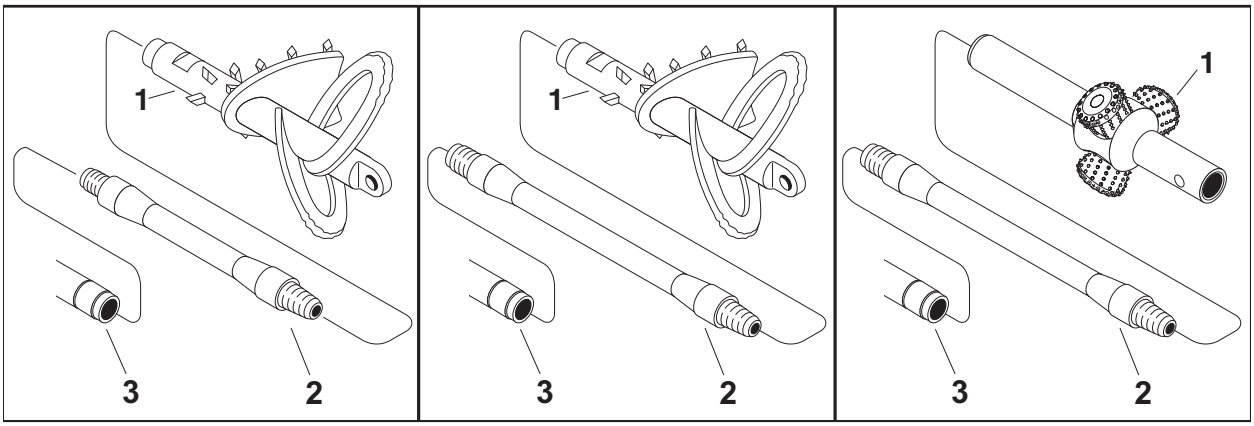
To help avoid injury: Continue to use strike system during backreaming.



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 (see page 160).
- 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.



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JT mode	AT Dirt mode	AT Rock mode
1. backreamer	1. backreamer	1. backreamer
2. transition sub	2. transition sub	2. transition sub
3. JT60 drill pipe	3. JT60 All Terrain drill pipe	3. JT60 All Terrain drill pipe

IMPORTANT: If no part number is listed, contact your Ditch Witch® dealer about available options.

1. Select backreaming devices. See "Backreamers" on page 134.
2. Determine fluid rate requirements and install appropriate nozzles to provide sufficient flow. See "Backream Fluid Requirements" on page 135 and "Nozzles" on page 132.
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 "Beacon Housings" on page 133.
6. Follow beacon instructions to check beacon operation.
7. Follow tracker instructions to calibrate beacon.
8. Use Hydratong wrenches to attach transition sub to drill pipe string. See "Hydratong Wrenches" on page 147.
9. Use Hydratong wrenches to attach backreamer/beacon housing assembly to transition sub. See "Hydratong Wrenches" on page 147.
10. Attach additional pullback devices or product to end of backreamer/beacon housing assembly.

Remove Pipe

1. Enable automated pipeloader system (automated pipeloader control only). See "Enable Automated Pipeloader System" on page 101.
2. Clamp pipes. See "Clamp Pipe" on page 96.
3. Break front joint:
   - Turn rear wrench counterclockwise to break joint.
   - Disengage rear wrench and rotate wrench clockwise.
4. Grip pipe:

Manual Pipeloader Controls	Automated Pipeloader Control
• Open grippers. • Lift pipe off shuttles. • Extend shuttles to spindle position. • Close grippers. Leave grippers loose enough to allow pipe to rotate. • 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.

5. Separate front joint:
   - Slowly rotate spindle counterclockwise and move carriage back to separate pipe.
   - When pipe threads are clear, move carriage back slightly and position pipe to be gripped by rear wrench while breaking rear joint.

6. 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 and move carriage back until SaverLok® body 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 SaverLok body is separated from pipe. • Move carriage to back of frame.

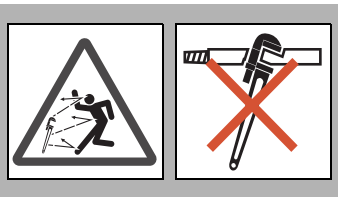
7. Ensure shuttle stop is positioned correctly.
8. Load pipe into pipe box:

Manual Pipeloader Controls	Automated Pipeloader Control
• Move shuttle under pipe box to shuttle stop. • Release grippers. • 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 to shuttle stop, 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.

9. Attach SaverLok body to next pipe:
   - Move carriage forward until SaverLok body touches pipe.
   - Rotate spindle and move carriage forward just enough to allow SaverLok body to connect to pipe.
   - Slowly tighten joint to full machine torque.
10. 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. Turn off drilling unit engine.
4. Clean pullback device.
5. Use Hydratong wrenches to remove pullback device. See "Hydratong Wrenches" on page 137.

Systems and Equipment

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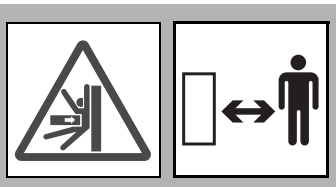
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Anchor System

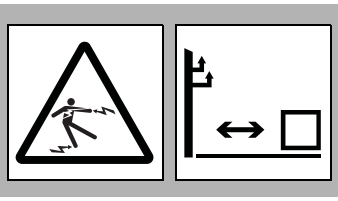
Three methods for anchoring this unit are available: anchors, alternate anchors, and a combination of both. Choose the correct method based on jobsite conditions.



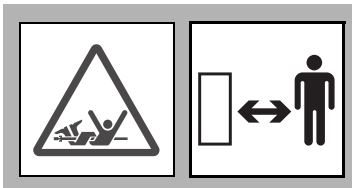
WARNING Crushing weight could cause death or serious injury. Use proper procedures and equipment or stay away 274-204.

To help avoid injury:

- Set stabilizers prior to driving anchors.
- Drive anchors properly and/or tie off unit before drilling.
- Stand on platform when operating anchor controls.
- Wear high-top protective boots with legs of pants completely tucked inside.
- Wear protective gloves.
- Only swing cab after setup is complete.
- 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 Electric shock will cause death or serious injury. Stay away. 274-049



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.

Anchors

Select Anchor

Two anchor types are available. Choose the correct anchor type based on jobsite conditions.

Anchor type	Situation used
rock bit	hard/soft rock, asphalt, concrete, cobble
auger bit	soft soil to hard soil, soft rock

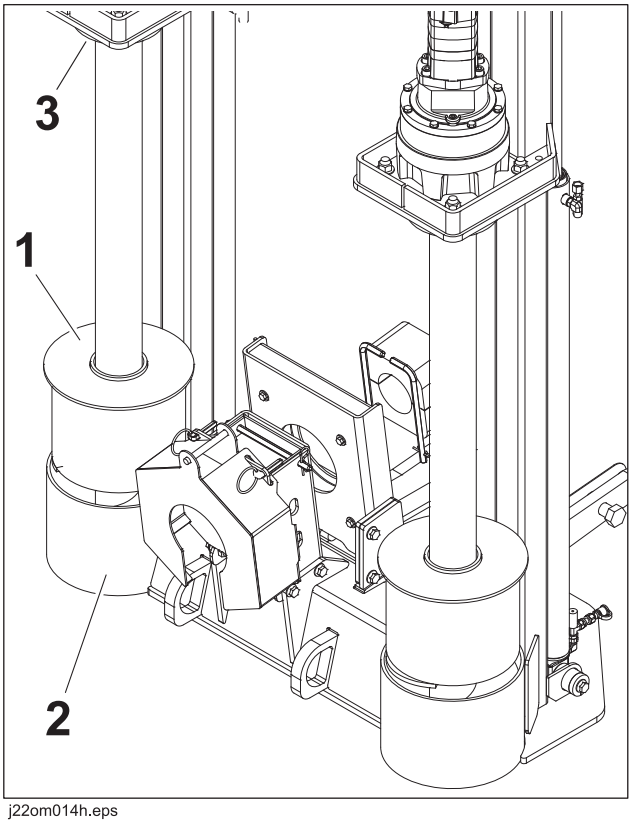
IMPORTANT: Do not attempt to operate anchor controls while drill fluid is on. Drill fluid operation may divert power from anchor system so that anchor controls perform poorly.

Drive Anchors (Rock)

1. Raise anchor shaft to top of anchor frame.

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

2. Use high speed rotation and low thrust speed to drive anchor into ground.
3. When cap (1) reaches centering tube (2), stop driving the anchor. Carefully position cap into centering tube, then finish driving the anchor.
4. Anchor is set when auger shaft flange (3) rests firmly on cap (1) and centering tube (2).
5. Repeat process for other anchor.
6. Leave anchors attached to anchor drivers.



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Drive Anchors (Soil)

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



1. Raise anchor shaft to top of anchor frame.
2. Use rotation and thrust controls to drive anchor into ground.

NOTICE:

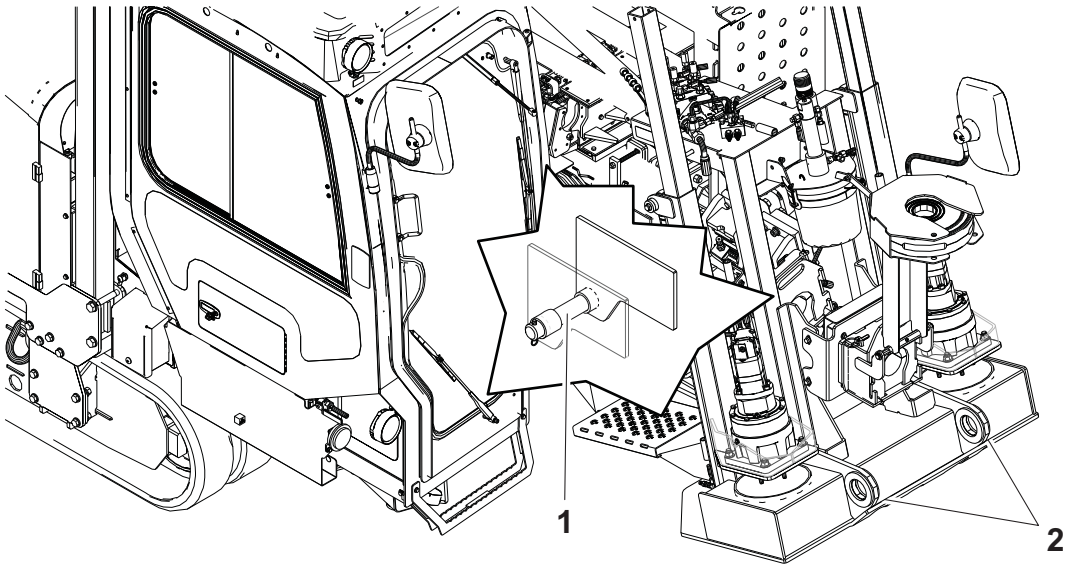
- Rotate augers slowly and thrust hard to thread auger into the ground.
- Centering cap **MUST** be positioned in centering tube to prevent damage to anchor.

3. Carefully position cap (1) into centering tube (2) as anchor is being driven into the ground.
4. Anchor is set when auger shaft flange (3) rests firmly on cap (1) and centering tube (2).
5. Repeat process for other anchor.

Remove Anchors

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

Alternate Anchoring



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Use tie-off points on machine (shown) in situations where anchors cannot be used or in combination with the anchors in situations where additional anchoring is needed. Contact a rigging specialist for assistance with this process to ensure the rigging can withstand potential forces.

NOTICE:

- If using remote tie-offs instead of anchors, additional grounding of the machine will need to be done using kit 100-794.
- Avoid drill string when implementing remote tie-off option.
- Rigging must be able to withstand forces of up to 60,000 lb (267kN).

1. Use front alternate anchoring option (1) when backreaming. Connect chain to pin and run straight forward from machine.

NOTICE: Ensure that pin is secure before attaching chain to it.

2. Use rings located on front of anchor frame (2) to anchor machine when drilling out. Connect a chain to each ear and run straight back from machine.

NOTICE: Looping the chain through the ears will cause damage to the frame.

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.

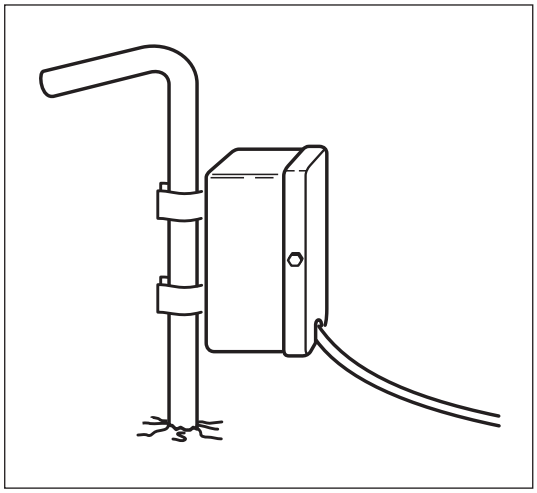
FCC Statement

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 the following page. Do not drill until test is completed successfully.

1. Turn on drilling unit.
2. Verify that display is connected to ESID control module.
3. To test alarms and strobe, press the test button on the left console.
4. Press the ESID soft key to view test results and historical data stored in the ESID module. This data includes:
   - ESID bar graph
   - alphanumeric readout showing volts and amps
   - current diagnostic codes, or diagnostic codes detected during previous tests
5. Use Electric Strike Simulator to test voltage and current sensors. See page 124.

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 ESID connection 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
	Defective CAN bus connection	Ensure CAN cable from drilling unit to ESID control module is connected
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

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. On engine display, use soft keys to select ESID.
4. Move simulator switch to "current" and press test button.
5. Watch display:
   - ESID graph should show on display
   - ESID % and Current "AMPS" should show 30-50% on 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 a strike detection warning and alarm and strobe should turn on.

   With two loops:
   - Current 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 display screen:
    - 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, strike detection warning should go off and alarm and strobe should stop. If the level drifts above strike level again, warning, 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 protections, 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 130.

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 cup (.25 L) 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.

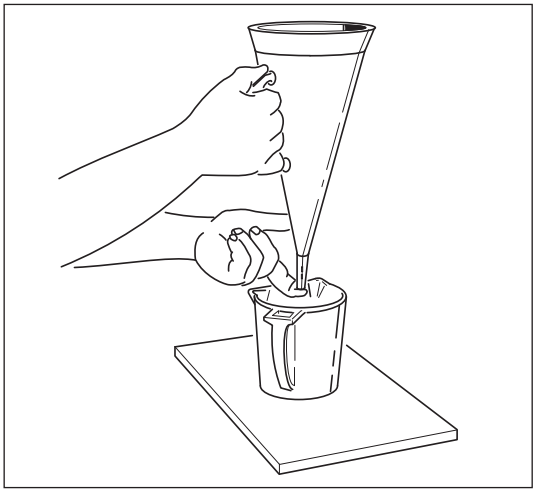
Funnel Viscosity

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.

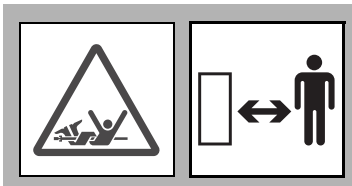
1. Using wash hose and a clean container, take a fresh sample of drilling fluid. The sample must be at least 1.5 qt (1.4 L).
2. With finger over bottom of funnel, fill with fluid from the container through the screen until fluid reaches the bottom of the screen.
3. Move funnel over 1 qt (.95 L) container.
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™ System/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.

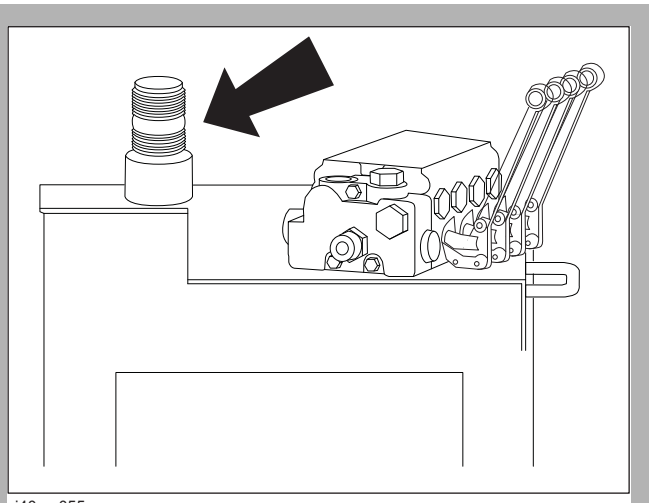
This mode allows the tracker operator to disable hydraulic power to drilling unit thrust and rotation.

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 Rock 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 107-284) and torque bolts to 580 ft•lb (800 N•m).

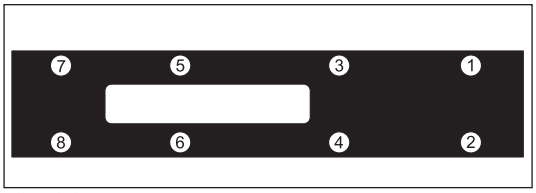
Beacon Housings

Beacon Installation

To ensure beacon is installed correctly in rock housing, place battery end of beacon away from bit end of housing.

Lid Installation

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



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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-in 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

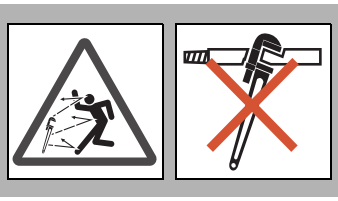
IMPORTANT: After you have determined how much fluid you will need, see your Ditch Witch® dealer for nozzle recommendations.

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

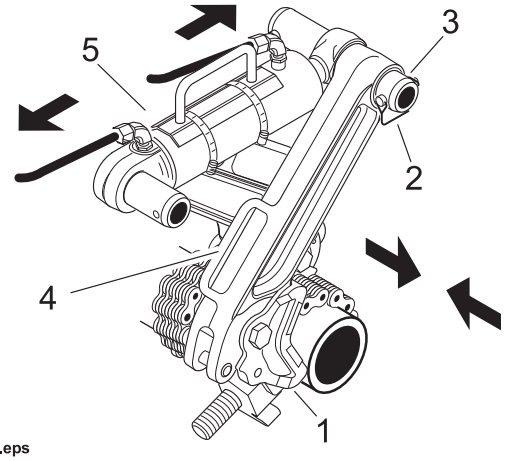
Hydratong Wrenches

To attach or remove downhole tools, use the Hydratong wrenches to join or break the joint.



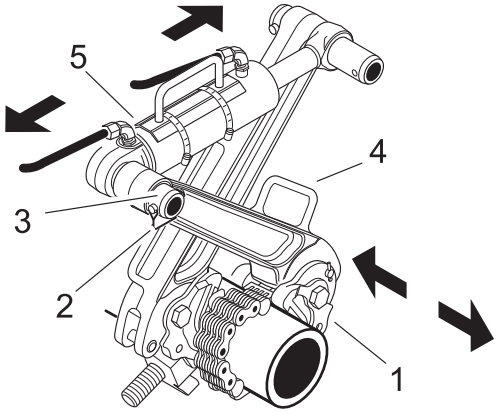
DANGER Moving tools will kill or injure. Shut off drill string power when anyone can be struck by moving or thrown tools. Never use pipe wrenches on drill string.

1. To join, apply TJC to threads and hand tighten joint.
2. Attach Hydratong in either the join or break position.



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Join



Break

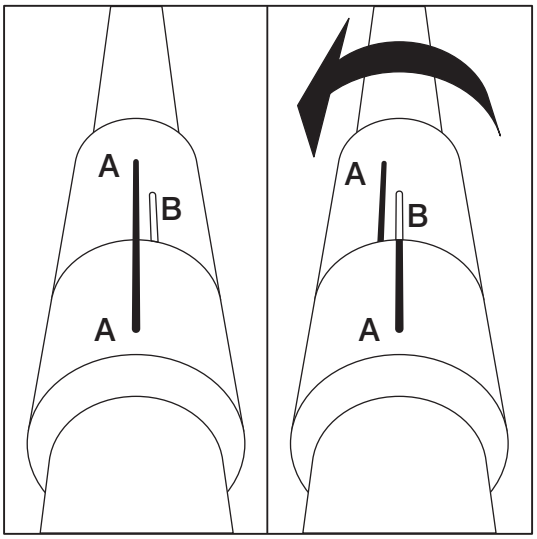
IMPORTANT: Ensure arms are crossed before using wrench.

- Attach chain tongs (1) to both sides of joint. Place tongs as close to joint as possible.
- Remove snapper pins (2) from slide pins (3), and insert slide pins into wrench handles (4).
- Attach each end of hydraulic cylinder (5) to slide pins and insert snapper pins.

3. Remove all slack from wrench and joint.

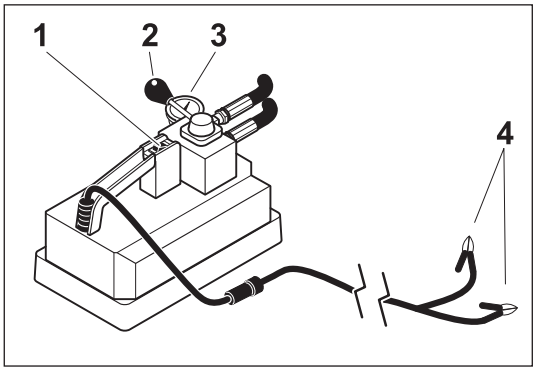
4. To join, scribe straight line across joint on both sides of separating line (A).
5. To join, scribe second line (B) on moveable side of joint in the opposite direction of tightening action. Refer to table for correct dimension.

Connection	Dimension
transition sub to JT60 All Terrain pipe	3/8" (9.5 mm)
transition sub to beacon housing	1/2" (13 mm)
transition sub to JT60 pipe	3/8" (9.5 mm)



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6. Connect Hydratong power pack.
   - Attach hoses from power pack to cylinder.
   - Attach leads (4) to 12V battery.
7. To tighten or loosen joint, move shuttle valve handle (2) toward gauge (3) and press power switch (1).
8. To reposition chain tongs and continue tightening or loosening joint, move handle away from gauge, then back toward gauge, and then press power switch.
9. Monitor gauge and refer to decal to achieve approximately 7000 ft•lb (9491 N•m) of torque. Then tighten joint until second line (B) meets first (A).



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IMPORTANT: Gauge gives an estimate of torque. Use scribe line to get exact torque.

10. Move handle to center (neutral) position to relieve pressure.
11. Disconnect hoses and remove Hydratong components.

Drill Pipe

NOTICE: Do not remove pipe blocks from pipe box. See "Pipe Box Capacities" on page 202.

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 "Recommended Lubricants/Service Key" on page 164 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 "Recommended Lubricants/Service Key" on page 164 for correct lubricant.

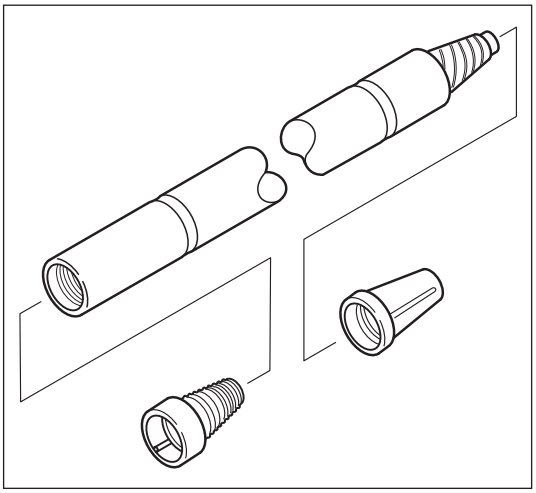
Clean the Threads

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.

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 SaverLok® body.



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Replace Worn SaverLok® Body

Because each pipe comes in contact with the SaverLok body, check SaverLok body regularly for wear. Replace it when it is worn, or it will damage your drill pipe. See Service chapter for replacement procedure.

Precondition a new SaverLok body the same way you do new pipe. See "Precondition New Pipe" on page 139.

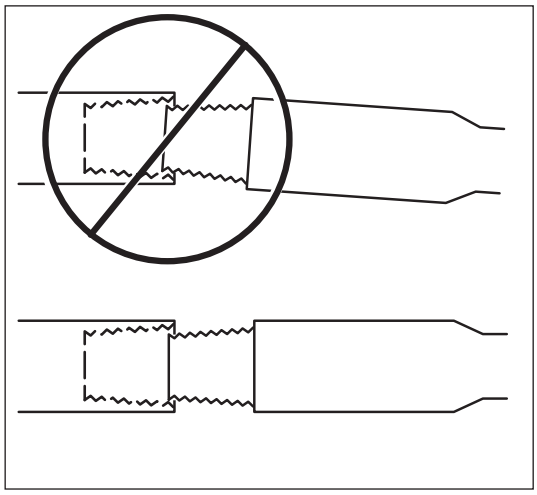
Rotate Pipe Order

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 to the back of the string, and move every other pipe forward one position.

Use Drill Pipe Correctly

Align the Joints

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

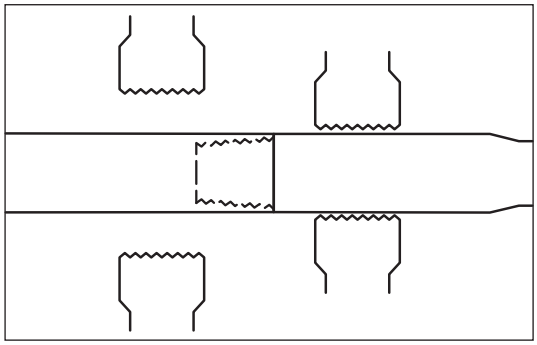


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Clamp Pipe Correctly

Clamp on pipe when joint is between wrenches but as near front wrench as possible. 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.



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See "Clamp Pipe" on page 96 for more information.

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 during makeup, and use floating carriage to lessen stress on threads during breakout. Always connect and disconnect joints slowly and deliberately. This will help prevent thread crossing, galling, and shoulder swelling.
- **Torque joints fully.** Once the joint is connected and the shoulder faces are touching, torque them to full machine torque. Improperly torqued joints will damage the shoulder faces and threads, and will cause joints to leak or break while drilling or backreaming.

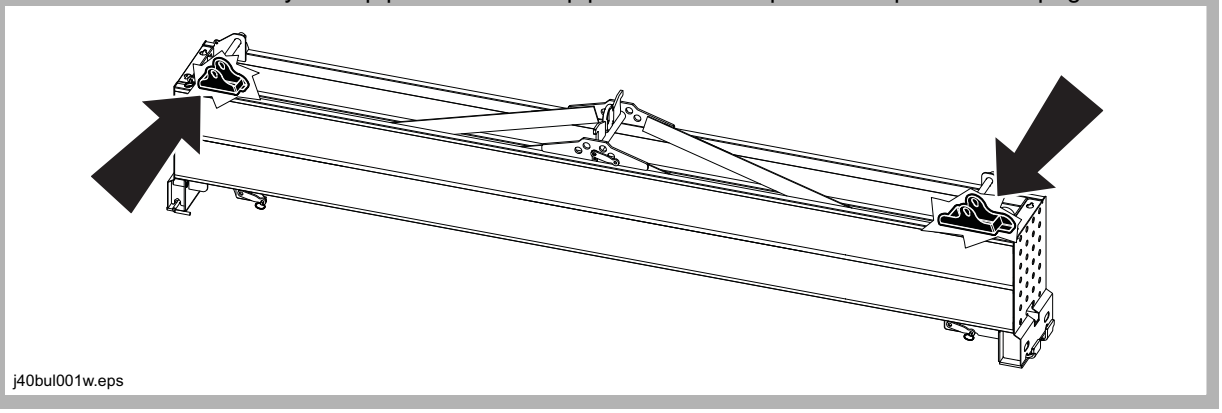
Do not Overwork the Pipe

Never exceed the bend radius for your pipe. See "Plan Bore Path" on page 66. Do not oversteer.

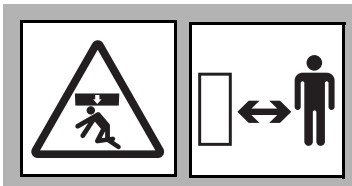
NOTICE: Bending pipe more sharply than recommended will damage pipe and cause failure.

Pipe Boxes

NOTICE: Do not remove yellow pipe blocks from pipe box. See "Pipe Box Capacities" on page 202.



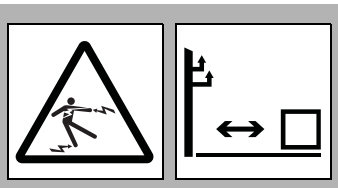
Remove/Install Pipe Box



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:

- Lift only one box of pipe at a time.
- Use crane capable of supporting the equipment's size and weight. See page 223 or measure and weigh equipment before lifting.



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.

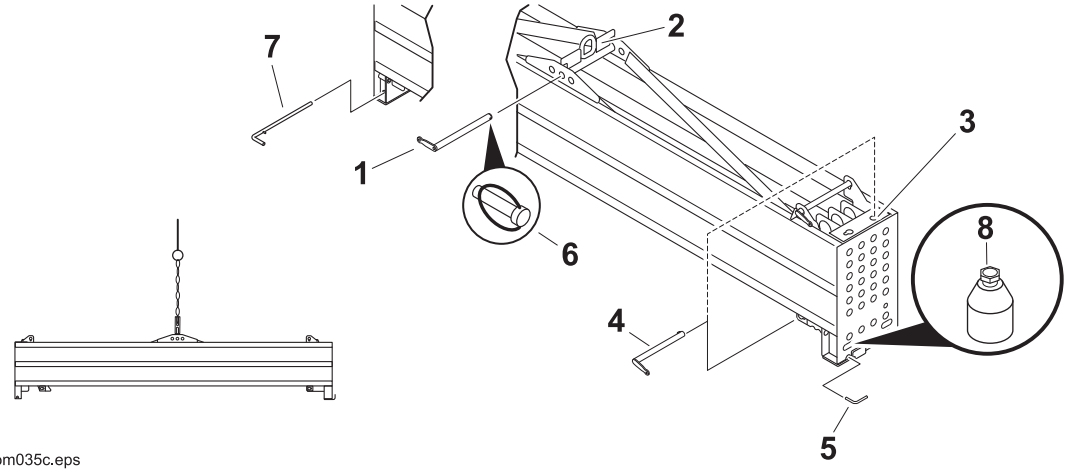
Position Lift Pin Block

The pipe box has 3 lift pin block holes.

- Use center hole to keep pipe box level for transporting pipe boxes and loading onto level drill frame.
- Use side holes to angle box for loading onto angled drill frame.

Remove Pipe Box

1. Insert lift pin block (2) (see page 144) and secure with lift pin (1) and lynch pin (6).
2. Raise pipe with pipe lifter on machine.
3. Move support pins (4) from top of pipe box (3) and insert under both ends of pipe box. Secure with lynch pins.
4. Attach chain to lift pin block.
5. Loosen four pin retainer bolts (8). Two bolts are located on each end of the pipe box.
6. Pull rear pins (5) and front pin (7) and lift box off drill frame. See "Pipe Box Lifting Procedure" on page 86 for more information.



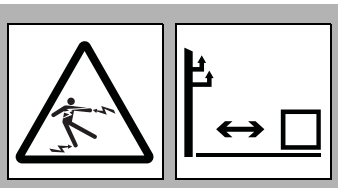
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Install Pipe Box

1. Guide pipe box onto centering pin on rear of pipeloader frame. Lower completely onto frame.
2. Insert rear and front pins (5, 7).
3. To bolt pipe box onto drill frame, tighten four retainer bolts (8). Two bolts are located on each end of the pipe box.
4. Raise pipe with pipe lifter on machine.
5. Remove bottom support pins (4) from both ends of pipe box. Store support pins in holes on top of pipe box (3).

Add/Remove Single Pipe

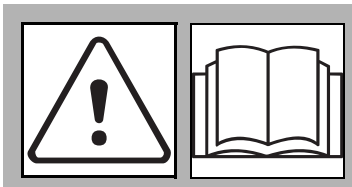
Load a single drill pipe or up to a whole row of drill pipe into outer row (fourth row of JT pipe box, third row AT pipe box) to finish bore without changing pipe boxes. Pipe can be added as soon as outer row of pipe has been started and other rows are empty.



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.



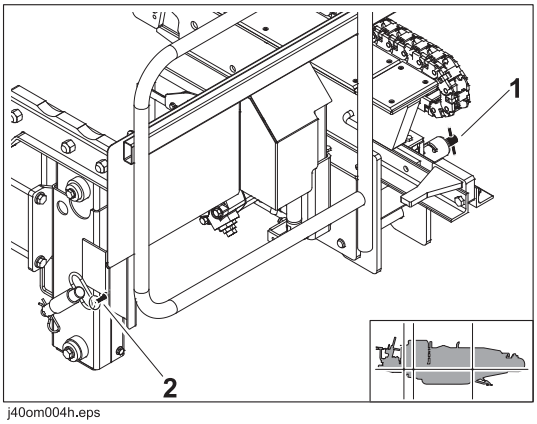
WARNING Read operator's manual. Know how to use all controls. Your safety is at stake. 273-475

To help avoid injury:

- Do not add pipe without first installing pipe stop.
- Lock out shuttle operation before approaching auxiliary pipe loaders. 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.
- Have enough people on hand to manually add or remove single pipe.

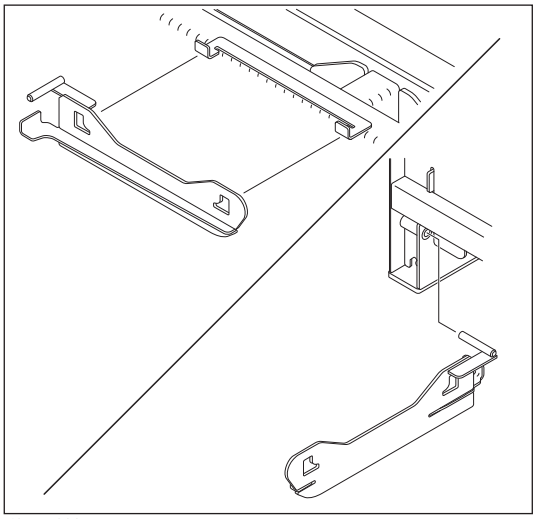
Add Single Pipe

1. Position additional drill pipe box near machine.
2. Stop drilling.
3. Ensure shuttle stop is fully lowered.
4. Press top of shuttle lockout switch to prevent shuttle operation. See "Shuttle lockout switch" on page 26.
5. Unpin (1) and raise shuttle guard.

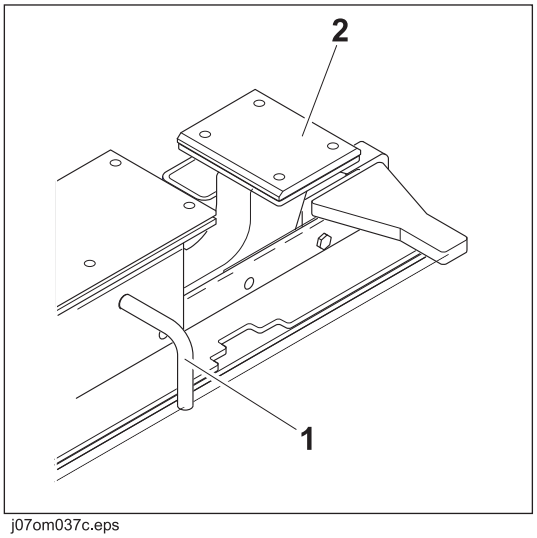


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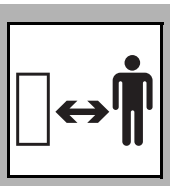
6. Remove pipe stop (shown, stored on outside of drill frame).
7. Unpin (1) and lower shuttle guard. Unpin (2) drill pipe lifter cover at both ends and lower.
8. Press bottom of shuttle lockout switch to allow shuttle movement and move at least 10' (3 m) away from the machine.
9. Move shuttles out fully.
10. Press top of shuttle lockout switch to prevent shuttle operation.
11. Attach pipe stop to front of pipe box.


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12. Pull and hold pins (1) on each shuttle and slide out auxiliary pipe loaders (2).



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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:

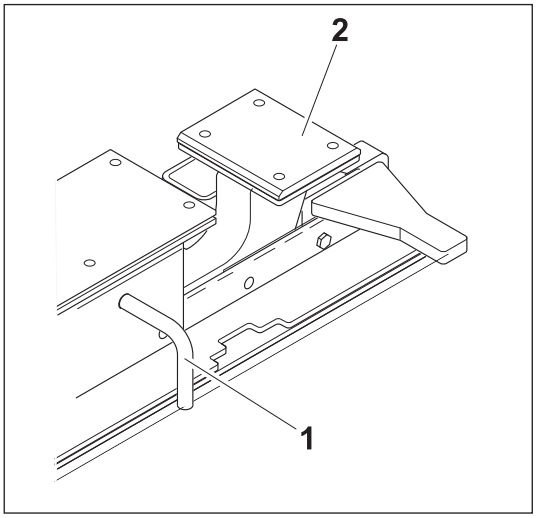
- Have enough people on hand to manually add or remove single pipe to pipe box.
- Move 10' away from machine after pipe is placed in auxiliary pipe loaders.

13. Load a pipe in auxiliary pipe loaders and rest it against pipe stop.
14. Press bottom of shuttle lockout switch to allow shuttle movement and move at least 10' (3 m) away from the machine.
15. Move auxiliary pipe loaders under outer row (fourth row if using JT pipe, third row if using AT pipe).
16. Raise pipe into outer row.
17. Move shuttles all the way out.
18. Press top of shuttle lockout switch to prevent shuttle operation.
19. Repeat steps 13-18 to load more pieces of pipe into outer row.
20. After loading last extra drill pipe, move pipe to pipeloader grippers.
    - Press bottom of shuttle lockout switch to allow shuttle movement and move at least 10' (3 m) away from the machine.
    - Raise last pipe into outer row.
    - Move shuttles out.
    - Lower pipe into front grippers.
21. Before operating pipeloader:
    - Press top of shuttle lockout switch to prevent shuttle movement.
    - Close both auxiliary pipe loaders.
    - Press bottom of shuttle lockout switch to allow shuttle movement and step away from drilling unit.

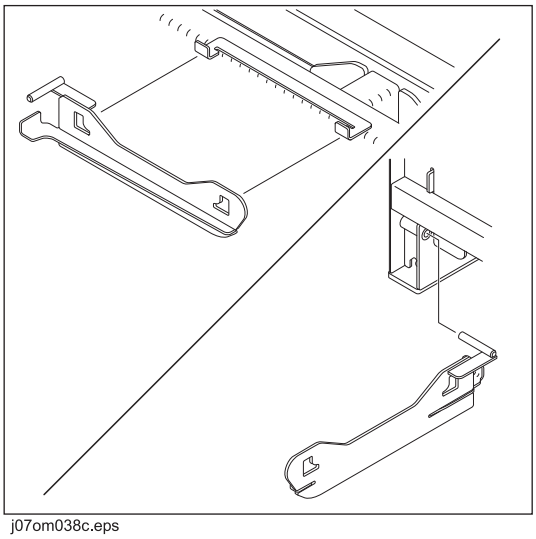
Remove Single Pipe

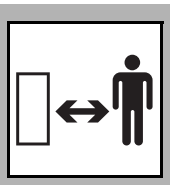
Unload all drill pipe loaded with auxiliary pipe loaders. Pipe in outer row (fourth row of JT pipe box, third row of AT box) can be unloaded only when all other rows are empty.

1. Ensure shuttle stop is fully lowered.
2. Move shuttles out fully.
3. Press top of shuttle lockout switch to prevent shuttle operation.
4. Pull and hold pins (1) on each shuttle and slide out auxiliary pipe loaders (2).
5. Unpin both ends of drill pipe lifter cover and lower.
6. Ensure pipe stop (shown) is still attached to front of pipe box.
7. Press bottom of shuttle lockout switch to allow shuttle movement and move at least 10' (3 m) away from the machine.
8. Raise pipe in outer row.
9. Move pipe to auxiliary pipe loaders.
    - Move shuttles in.
    - Lower pipe into auxiliary pipe loaders.
10. Move shuttles out.
11. Press top of shuttle lockout switch to prevent shuttle operation.



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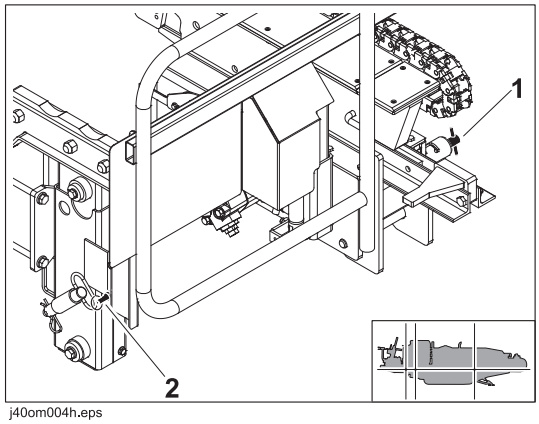



WARNING Crushing weight could cause death or serious injury. Use proper procedures and equipment or stay away.

To help avoid injury:

- Have enough people on hand to manually add or remove single pipe to pipe box.
- Move 10' away from machine after pipe is placed in auxiliary pipe loaders.

12. Remove pipe from auxiliary pipe loaders and store properly.
13. Repeat steps 7-12 to unload remaining added drill pipe.
14. After all added drill pipe is unloaded with auxiliary pipe loaders:
    - Close both auxiliary pipe loaders.
    - Raise drill pipe lifter cover and pin (2) at both ends. Unpin (1) and raise shuttle guard.
    - Remove pipe stop and store it on drill frame.
    - Unpin and lower shuttle guard into drilling position.
    - Press bottom of shuttle lockout switch to allow shuttle movement and move at least 10' (3 m) away from the machine.
    - Finish loading remaining drill pipe into outer row using standard procedure. See "Remove Pipe" on page 112.



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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 Outer Rotation Control	Thrust/Pullback Control Only
1. Position joystick so that thrust or pullback and outer 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.

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.
Outer Rotation	• To increase outer rotation speed, move joystick to left and press RESUME. • To decrease outer rotation speed, move joystick to left and press SET.
Outer Rotation Speed Limit (AT Rock Mode)	**IMPORTANT:** Outer pipe rotation speed is automatically limited when inner rotation is on. • To increase outer rotation speed limit, move joystick to left and press RESUME. • To decrease outer rotation speed limit, 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 the joystick 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 direction of prior cruise (forward or backward).
2. Press RESUME. Green control cycle light will come on.

Machine Diagnostic Codes

Diagnostic Light

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 and flash off every three seconds to indicate an essential code. If the light remains on, power to the controller has been lost.

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 RESUME for two seconds. 3. The green control cycle light will come on and the diagnostic light will flash code 12 (flash, pause, flash, flash, longer pause) to indicate review mode is operational. 4. After flashing code 12, the green control cycle light will go out and 12 will be flashed two more times. This process is repeated for all diagnostic codes detected since the last time the ignition was turned on. 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 SET 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 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. Cycle is complete when code 12 flashes again. 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 12 signals successful entry into and exit from review mode.

Complete the Job

Chapter Contents

Antifreeze Drilling Unit 156

- Add Antifreeze 156
- Reclaim Antifreeze 157

Rinse Equipment 158

Disconnect 159

Stow Tools 159

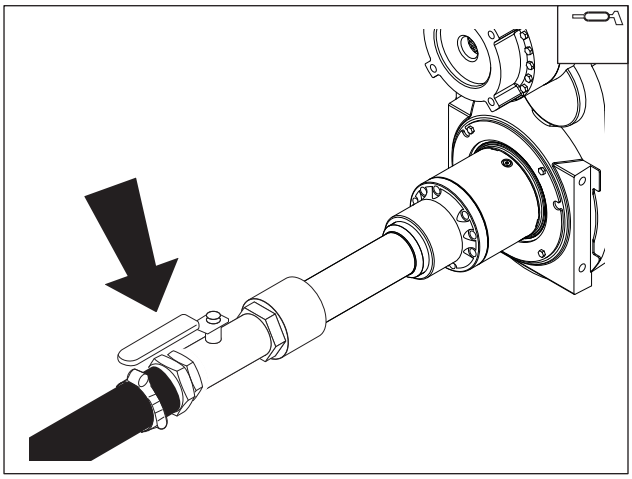


Antifreeze Drilling Unit

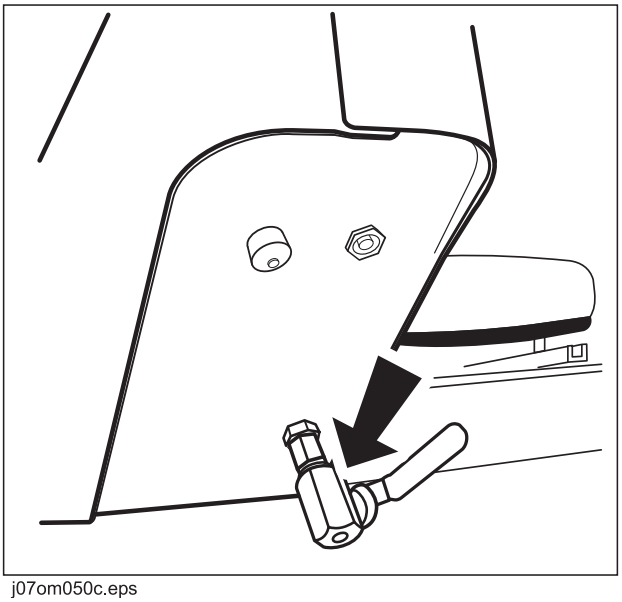
Your drilling unit can be left overnight in freezing conditions by filling fluid lines with a polyproplyene-based antifreeze (p/n 265-644) with optional antifreeze system before shutdown.

Add Antifreeze

1. Fill antifreeze tank with 8 gal (30 L) of approved antifreeze.
2. Install plug on suction side of drilling fluid pump.
3. Open valve below antifreeze tank.
4. Install antifreeze reclaimer adapter in spindle. Ensure valve (shown) is open.
5. Turn drilling fluid potentiometer counterclockwise to zero position.
6. Start unit and set throttle to slow position.
7. Set drilling fluid pump switch to on 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 pump switch to off position. Close valve on antifreeze reclaimer adapter.
11. Open valve below right operator's console (shown).
12. Repeat steps 5-8.
13. Close valve below right console when antifreeze runs out of valve below right console.
14. Turn drilling fluid pump switch to off position.



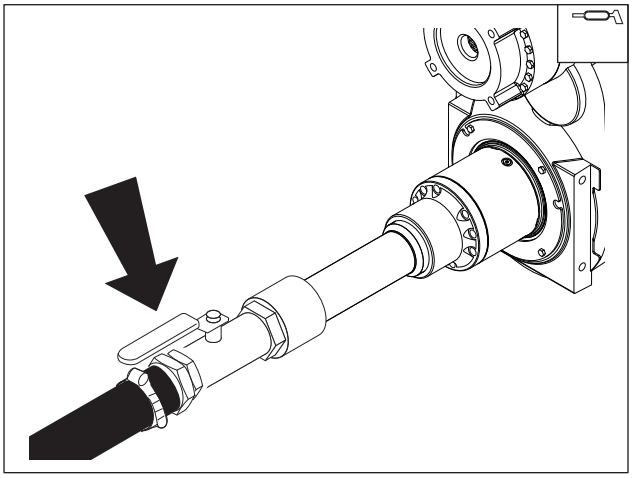
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Reclaim Antifreeze

1. Hold hose on antifreeze reclaimer over top of antifreeze tank.
2. Open valve on reclaimer (shown).
3. Connect drilling fluid transfer hose from tanks to drilling fluid pump inlet.
4. Close valve below antifreeze tank.
5. Start unit and run at low throttle.
6. Turn drilling fluid pump on low speed.
7. Turn drilling fluid pump off when drilling fluid comes out of reclaimer hose.
8. Remove antifreeze reclaimer.

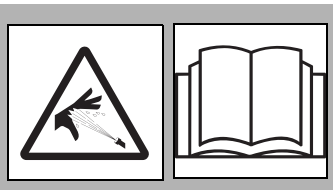


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IMPORTANT: Antifreeze can be removed from antifreeze tank and disposed of properly or it can be reused until it is too diluted with drilling fluid to protect against freezing.

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

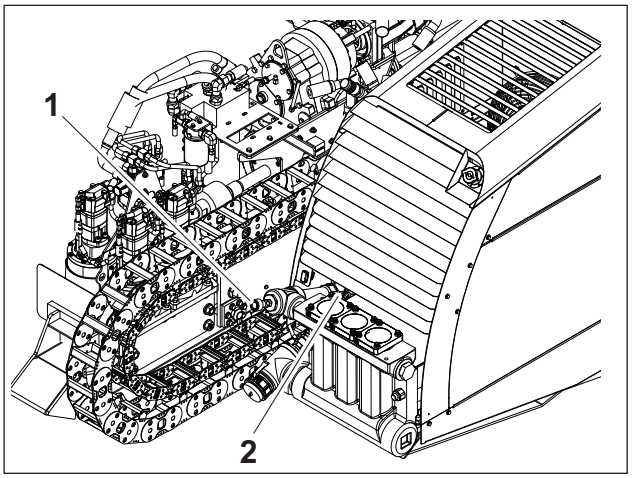
To help avoid injury:

- 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 "Connect Fluid System" on page 99.

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

Connect the washwand at quick connect (1) at rear of unit. Open valve (2) to start water flow. Close valve to stop water flow.

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 cable
- electric strike system voltage stake
- fluid hose



Stow Tools

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

Service

Chapter Contents

Service Precautions 162

- Welding Precaution 162
- Washing Precaution 162
- Working Under Drilling Unit 163

Recommended Lubricants/Service Key 164

- Engine Oil Temperature Chart 165
- Approved Coolant 165
- Approved Fuel 166

Each Use 167

Startup/10 Hour 168

25 Hour 175

50 Hour 176

250 Hour 182

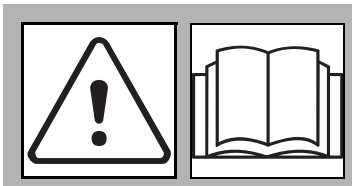
500 Hour 184

1000 Hour 186

2000 Hour 190

As Needed 191

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

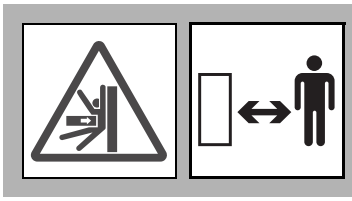
NOTICE: Welding can damage electronics.

- Welding currents can damage electronic components. Always disconnect the ECU ground connection from the frame, harness connections to the ECU, and other electronic components prior to welding on machine or attachments. Connect welder ground close to welding point and make sure no electronic components are in the ground path. We recommend that NO WELDING signs be prominently displayed on machine.
- Disconnect battery at battery disconnect switch before welding to prevent damage to battery.
- Do not turn off battery disconnect switch with engine running, or alternator and other electronic devices may be damaged.

Washing Precaution

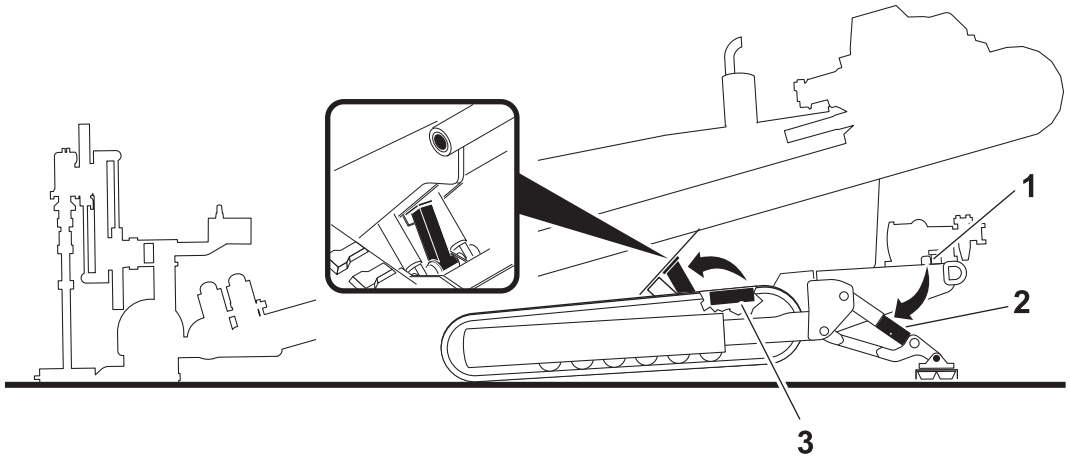
NOTICE: Water can damage electronics. When cleaning equipment, do not spray electrical components with water.

Working Under Drilling Unit



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

Use safety supports as indicated when working under drilling unit.



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Before working under **front end of drill frame**, install jackstands under frame.

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

1. Remove cylinder lock pinned to frame (1) and place over extended cylinder rod (2).
2. Reinstall pins to secure cylinder lock to rod.
3. Raise stabilizer until load is supported by cylinder lock.

Before working under area of drilling unit **supported by frame tilt cylinder**, make sure drilling unit is parked on hard surface.

1. Remove drill frame support tube stored under frame (3) and place under drill frame (shown in inset).
2. Lower drill frame until load is supported by drill frame support tube.

Recommended Lubricants/Service Key

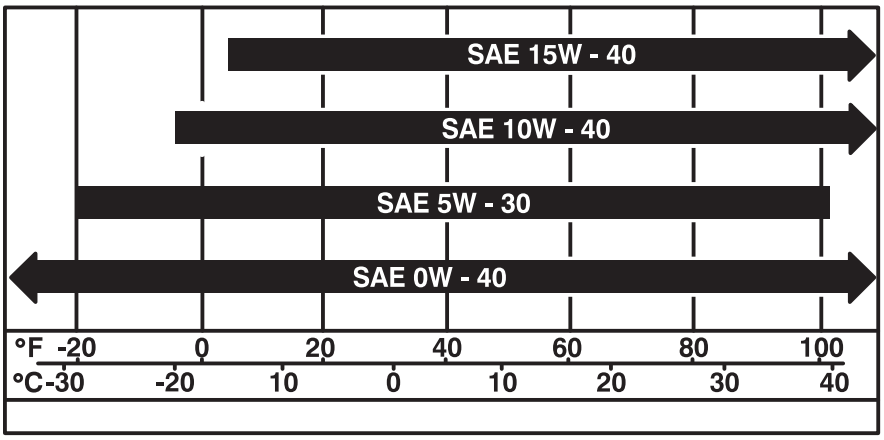
Item	Description		
Tier 4i DEO	Diesel engine oil meeting or exceeding Cummins® 20081, API CJ-4, ACEA E9. • Engine must use low SAPS oil (ash will plug aftertreatment device.) • Use viscosity grade SAE 15W40 unless ambient temperatures below 5° F (-15° C) are expected. Lower viscosity oils must meet the performance specifications shown above. API American Petroleum Institute, ACEA European Automobile Manufacturer's Association.		
Tier 3 DEO	Diesel engine oil meeting or exceeding Cummins 20078, API CH-4, ACEA E5. ***NOTICE:*** Shipped from factory with CJ-4 DEO. Change oil initially at 250 hrs. Use viscosity grade SAE 15W40 unless ambient temperatures below 5° F (-15° C) are expected. Lower viscosity oils must meet the performance specifications shown above. API American Petroleum Institute, ACEA European Automobile Manufacturer's Association.		
TF30	Phillips 66® Torque Fluid, 30W		
MPG	Multipurpose grease. Use polyurea based NLGI GC-LB Grade 1.5 or lithium based NLGI GC-LB Grade 2.		
MPG	Pump seal grease, similar to 94050 Philube blue multipurpose		
MPL	Multipurpose gear oil meeting API service classification GL-5 (SAE 80W90)		
THF	Tractor hydraulic fluid, similar to Phillips 66 HG, Mobilfluid® 423, Chevron® Tractor Hydraulic Fluid, Texaco® TDH Oil, or equivalent		
TJC	Tool joint compound: Ditch Witch® standard (p/n 259-858) or summer grade (p/n 256-031)		
DEAC	Diesel engine antifreeze/coolant meeting ASTM D5345 (prediluted) or D4985 (concentrate)		
	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 "Fluid Capacities" on page 225.

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

IMPORTANT: Use the "Service Record" on page 211 to record all required service to your machine.

Engine Oil Temperature Chart



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Temperature range anticipated before next oil change

Approved Coolant

This unit was filled with John Deere® Cool-Gard® II coolant before shipment from factory. Add only John Deere Cool-Gard II (p/n 255-006) or any fully-formulated, ethylene glycol based, low-silicate, heavy-duty diesel engine coolant meeting ASTM specification D5345 (prediluted) or D4985 (concentrate).

NOTICE:

- Do not use water or high-silicate automotive-type coolant. This will lead to engine damage or premature engine failure.
- Use only distilled water for mixing coolants. Do not use tap water.

Approved Fuel

Tier 4i Engine (U.S., Canada, EU, and Japan)

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.

NOTICE: Use only Ultra Low Sulfur Diesel (less than 15ppm sulfur content) in this unit. Operating with higher sulfur content will damage the engine and aftertreatment device.

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.

Tier 3 Engine (Rest of World)

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: Worldwide, fuel sulfur regulations vary widely. Fuel used should always comply with local regulations. Prior to shipping, Tier 3 units were filled with Tier 4i DEO. If operating fuel with sulfur content above 15 ppm (0.0015%), change oil initially at 250 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.

Each Use

Location	Task	Notes
DOWNHOLE TOOLS	Lube drill head	pump seal grease (p/n 255-1019)

NOTICE: See "Drill Pipe" on page 139 for information and precautions regarding drill pipe.

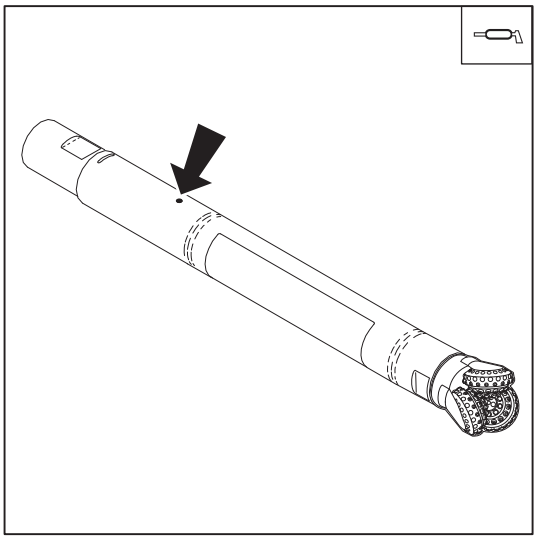
Downhole Tools

Lube Drill Head

Lube drill head with pump seal grease (p/n 255-1019) every 8 hours and after every bore.

To lube:

1. Remove hex plug.
2. Install zerk.
3. Rotate drill head by hand and fill with pump seal grease until it comes out at front seal.
4. Remove zerk.
5. Replace hex plug.



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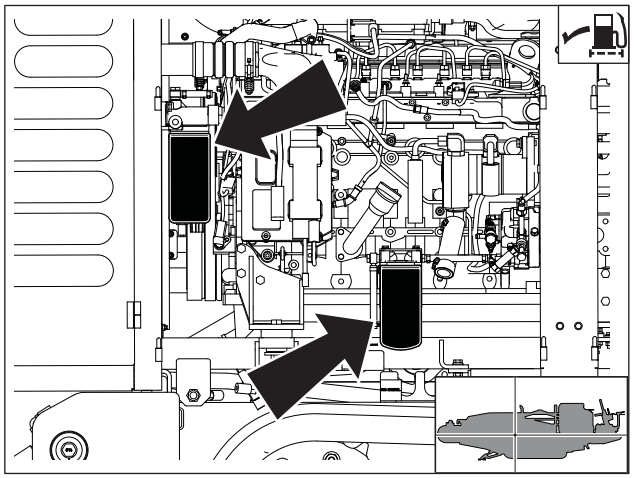
Startup/10 Hour

Location	Task	Notes
DRILLING UNIT	Check fuel filter water separators	
	Check engine oil level	DEO
	Check engine coolant level	DEAC
	Check air filter indicator and clean dust trap	
	Check hydraulic hoses	
	Check hydraulic fluid level	THF
	Check fluid pump oil level	TF30
	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	

Drilling Unit

Check Fuel Filter Water Separators

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

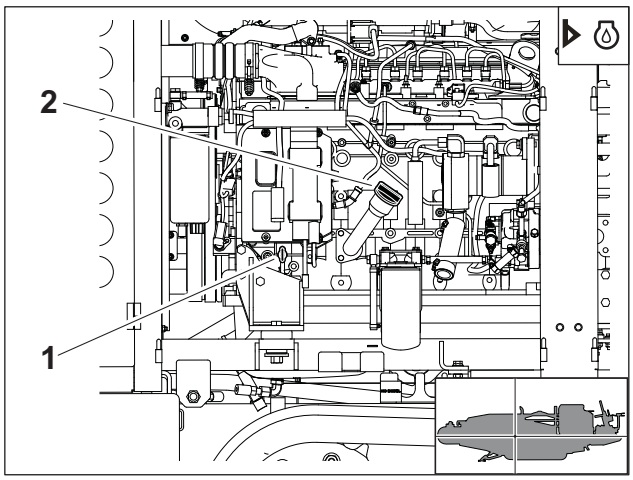


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Check Engine Oil Level

Check engine oil at dipstick (1) before startup and every 10 hours of operation. If low, fill with DEO at oil fill (2)

IMPORTANT: See "Recommended Lubricants/ Service Key" on page 164 for more information on engine oil.

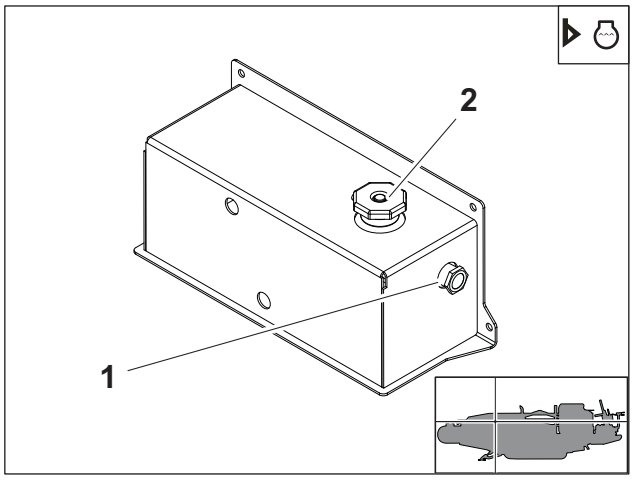


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Check Engine Coolant Level

With engine cool, check coolant level at fill neck in expansion tank before startup and every 10 hours of operation. Maintain coolant level at bottom of fill neck. If low, fill with approved coolant.

IMPORTANT: See "Approved Coolant" on page 165 for information on approved coolant.



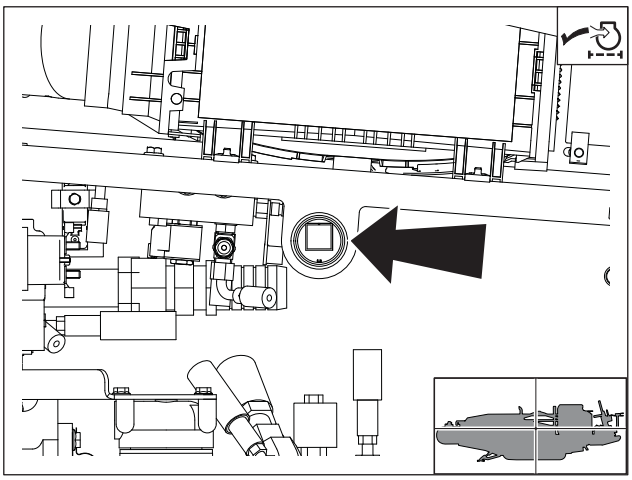
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Check Air Filter Indicator and Clean Dust Trap

Check air filter indicator (1) and clean dust trap (4) before startup and every 10 hours of operation. Change filter elements (2, 3) when red flag pops up. Reset air filter service indicator after changing filter.

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

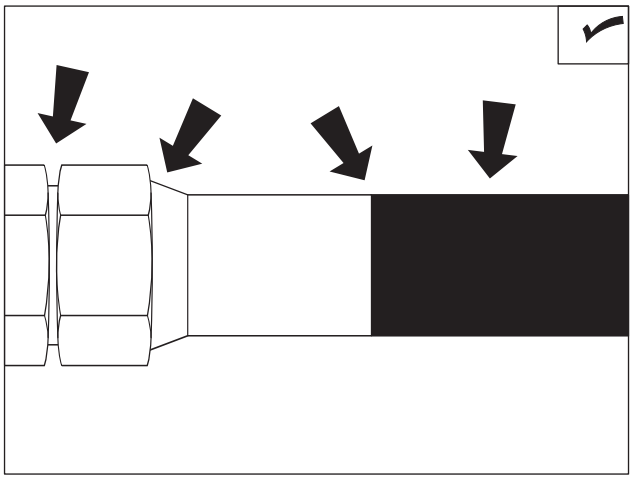
- Compressed air or water may damage filter elements.
- Tapping filter elements to loosen dirt may damage the elements.

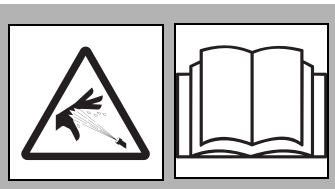


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Check Hydraulic Hoses

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


CheckHoses.eps



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

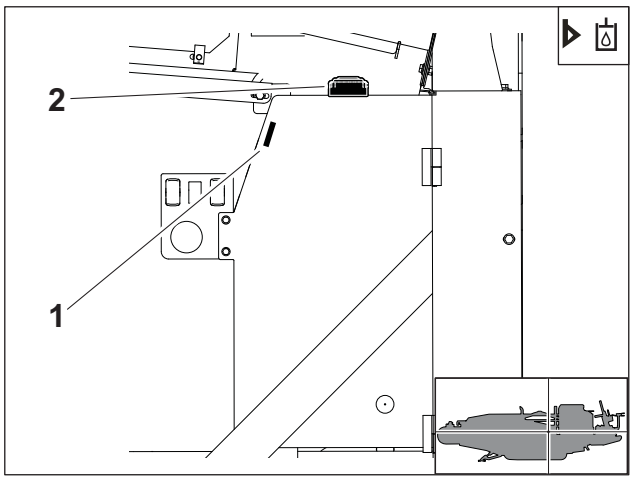
To help avoid injury:

- Use a piece of cardboard or wood, rather than hands, to search for leaks.
- Wear protective clothing, including gloves and eye protection.
- 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.
- If you are injured, seek immediate medical attention from a doctor familiar with this type of injury.

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 (1), when engine is off and fluid is cool. Refill with THF at hydraulic fluid fill (2).

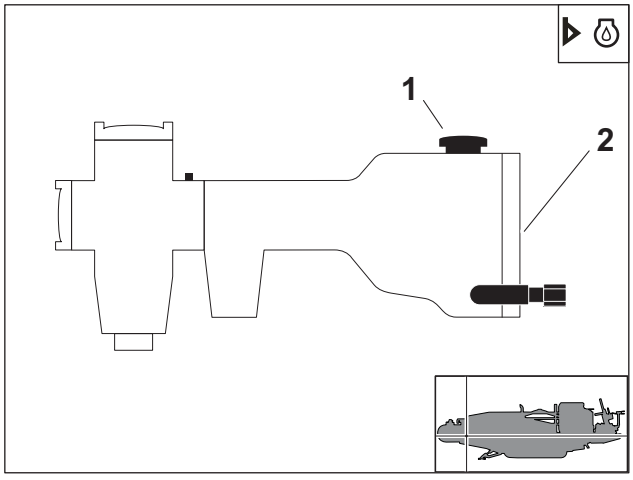
IMPORTANT: If hydraulic system must be opened for repair, install new filter (p/n 157-486) for first 50 hours of operation. If this filter becomes plugged in fewer than 20 hours, replace with clean filter. After 50 hours of normal operation, replace with clean filter.



j40om025w.eps

Check Fluid Pump Oil Level

Check fluid pump oil level at sight glass or petcock (2) before startup and every 10 hours of operation. Maintain fluid level at halfway point on sight glass or at petcock level. Fill at cap (1) with TF30.

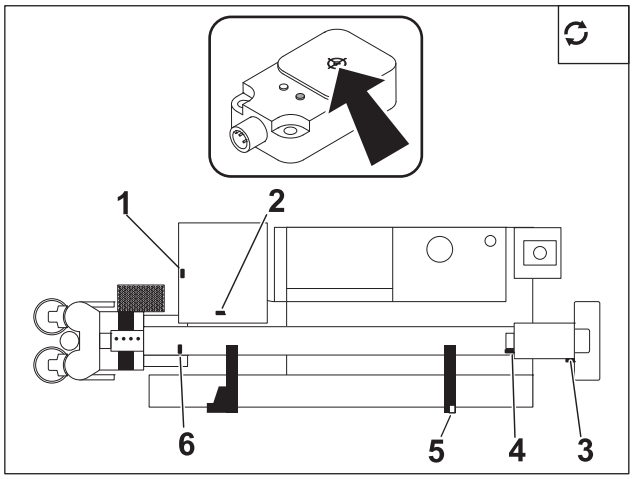


j40om026w.eps

Test Control Switches

Test control proximity switches every 10 hours.

1. Drive position switch
2. Drill position switch
3. Rear stop switch
4. Rear home switch
5. Shuttle home switch
6. Front home switch



j40om027w.eps

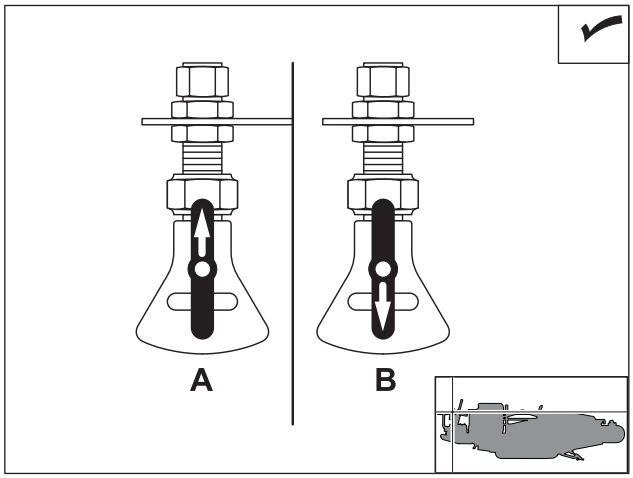
To test:

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 164 for more information.



j40om029w.eps

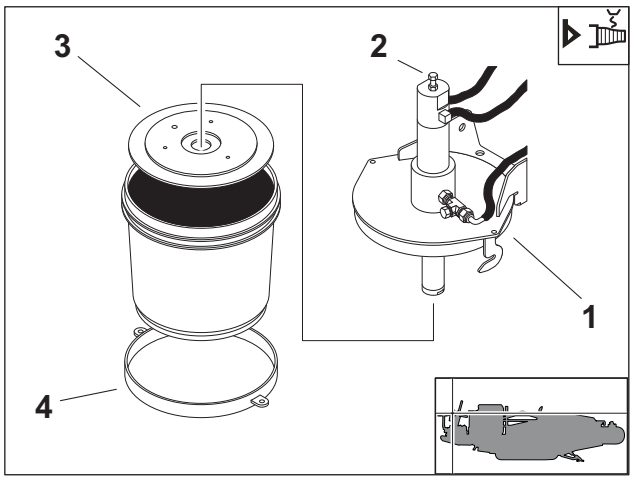
To clean:

1. Rotate handle to the upward, or clean out, 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 192 for procedure

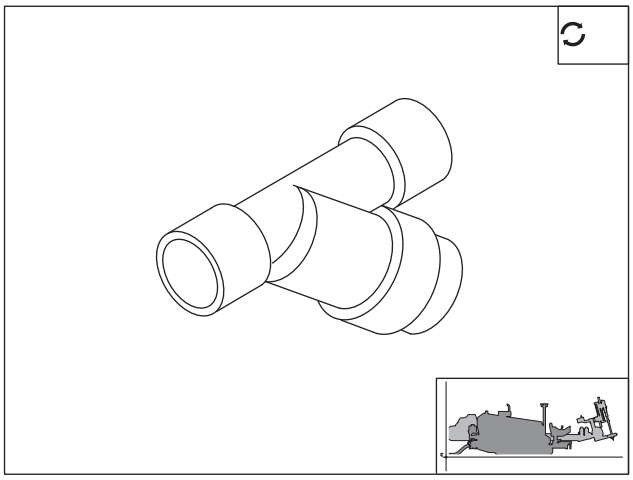
NOTICE: Ditch Witch® tool joint compound is specially formulated to work with Ditch Witch pipe lubrication system. Use of other tool joint compounds will clog system. See "Recommended Lubricants/Service Key" on page 164 for more information.



j40om030w.eps

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.



j29om020h.eps

25 Hour

Location	Task	Notes
DOWNHOLE TOOLS	Rebuild 2° tool	2500' (760 m)

Downhole Tools

Rebuild 2° Tool

Rebuild downhole tool every 25 hours or 2500' (760 m) as measured by inner rotation hour meter. Use rebuild kit (p/n 191-120) or seal kit (p/n 191-239) available at your Ditch Witch® dealer.



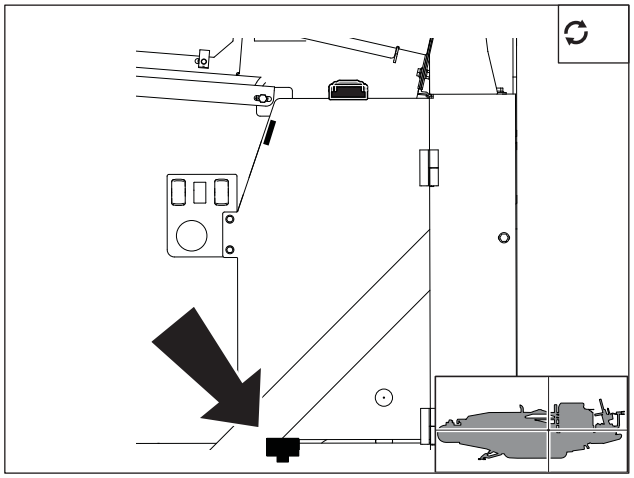
50 Hour

Location	Task	Notes
DRILLING UNIT	Drain water from hydraulic tank	
	Change fluid pump oil	initial service, TF30
	Change hydraulic filters	initial service
	Check ground drive gearbox oil level	2 gearboxes, MPL
	Check rotation gearbox oil level	MPL
	Check thrust drive gearbox oil level	4 gearboxes, MPL
	Check anchor gearbox oil level	
	Check radiator for debris	
	Check hex	EPL spray
	Clean liner washer tank strainer	
DOWNHOLE TOOLS	Rebuild 1.5° and grade tools	5,000' (1524 m)

Drilling Unit

Drain Water from Hydraulic Tank

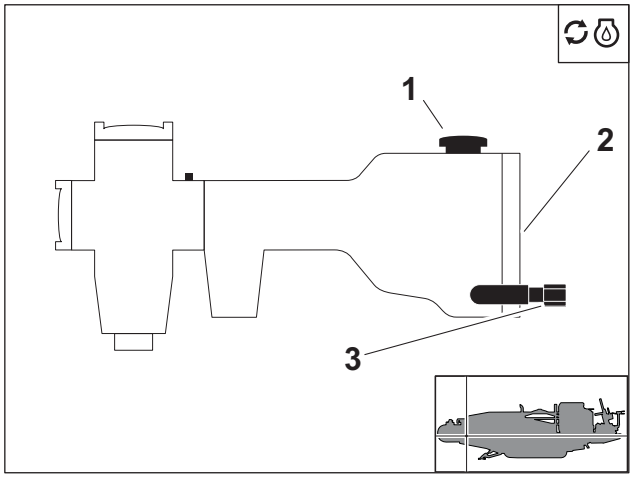
Drain water out of tank every 50 hours. To drain, turn plug slightly until water comes out. After all water has drained, tighten plug.



j40om032w.eps

Change Fluid Pump Oil (Initial Service)

Change fluid pump oil after first 50 hours and every 1000 hours thereafter. Maintain fluid level at halfway point on sight glass or at petcock level (2). Drain at plug (3). Fill at cap (1) with SAE 30 non-detergent engine oil. Capacity for 150 gpm pump is 10 qt (9.4 L).

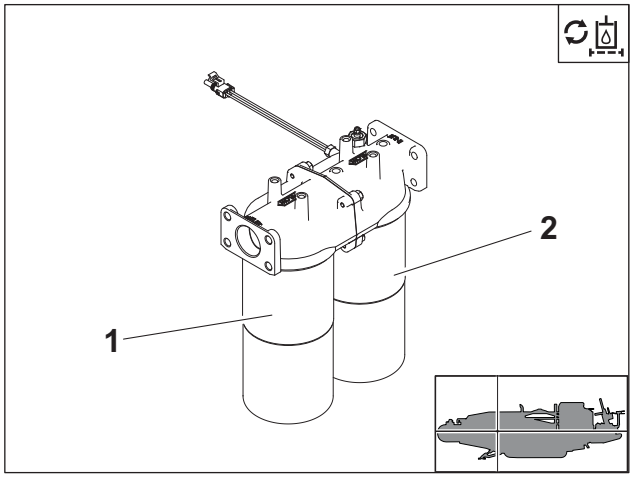


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Change Hydraulic Filters (Initial Service)

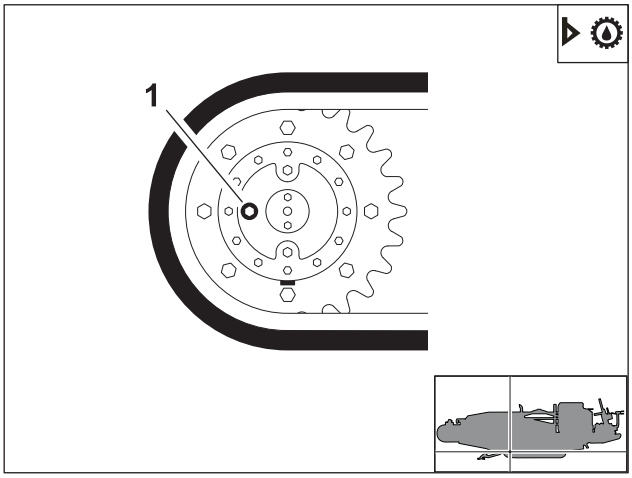
Change three hydraulic filters after first 50 hours. Replace filters every 250 hours thereafter. Change filters more often if indicated by filter indicator.

IMPORTANT: If hydraulic system must be opened for repair, install new filter (p/n 157-486) for first 50 hours of operation. If this filter becomes plugged in fewer than 20 hours, replace with clean filter. After 50 hours of normal operation, replace with clean filter.



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Check Ground Drive Gearbox Oil Level



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

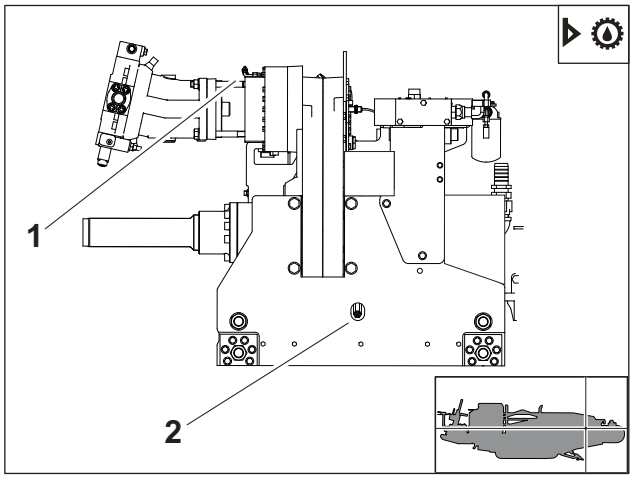
To check:

1. Drive unit to rotate plug (1) until level with center of gearbox.
2. Open plug and fill with MPL until level with plug opening.
3. Replace plug.

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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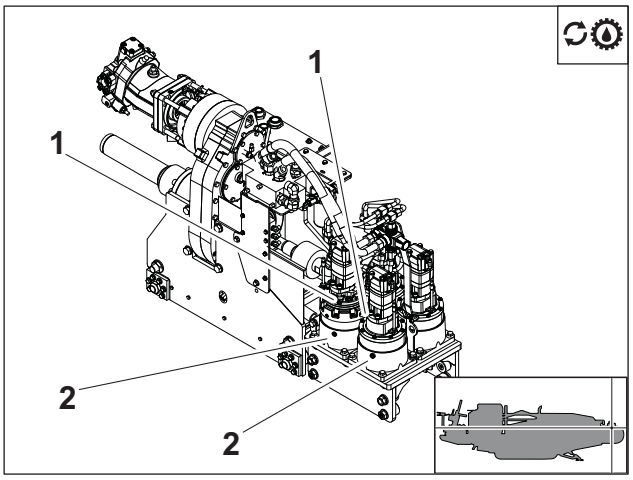
Check rotation gearbox oil level every 50 hours. Fill through plug (1) to level of sight plug (2) with MPL as needed.

IMPORTANT: Drill frame must be level for accurate reading.

Check Thrust Drive Gearbox Oil Level

Check oil level in four thrust drive gearboxes every 50 hours. Fill to level of fill plug (1) with MPL as needed.

IMPORTANT: Drill frame must be level for accurate reading.

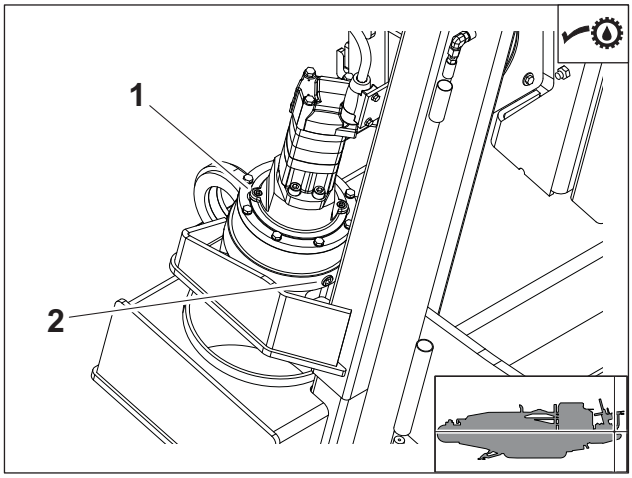


j40om035w.eps

Check Anchor Gearbox Oil Level

Check oil level in two anchor drive gearboxes every 50 hours. Fill to level of fill plug (1) with MPL as needed. Drain at plug (2).

IMPORTANT: Drill frame must be level for accurate reading.

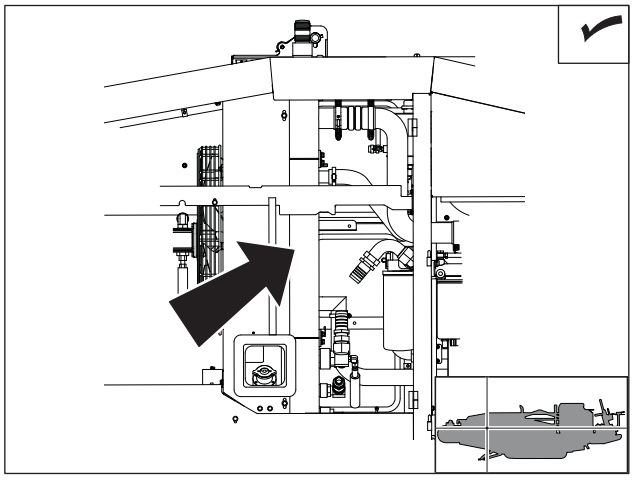


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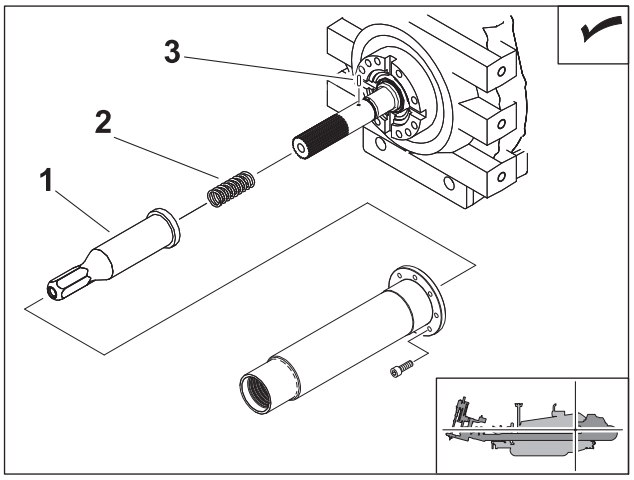
Check Radiator For Debris

Check radiator for dirt, grass, and other foreign matter every 50 hours. Clean out with compressed air or spray wash if required. Be careful not to damage fins with high-pressure air or water. Check more often if operating in dusty or grassy conditions.

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


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Check Hex



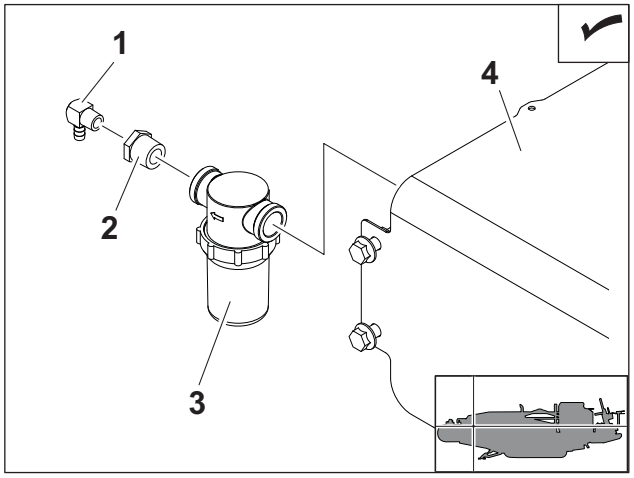
j29om029h.eps

Shine flashlight into spindle and check condition of hex (1) every 50 hours. Replace if rounded.

To replace:

1. Remove SaverLok® body. Do not remove indexing dowels from spindle.
2. Slide hex (1) and spring (2) off of drive shaft.
3. Check condition of drive pin (3) and replace if needed. Lubricate drive shaft.
4. Check o-ring on inner water swivel (seal kit) and replace if needed.
5. Install new spring and hex.
6. Install SaverLok body. See page 195.

Clean Liner Washer Tank Strainer



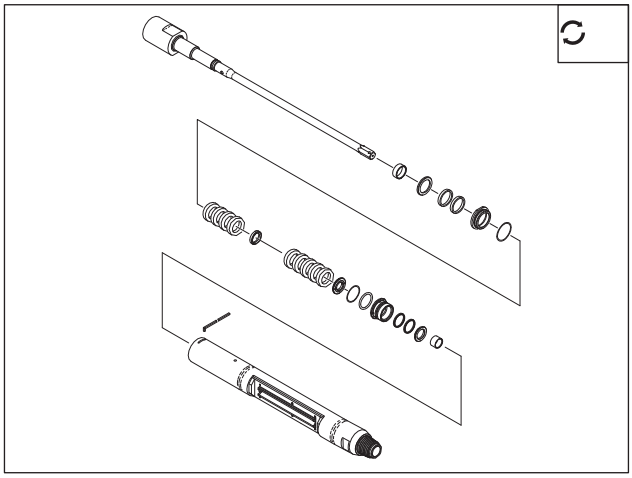
j40om075w.eps

Remove strainer (3) and clean every 50 hours. Remove coupler (1) and reducer (2) to remove strainer. Clean out with compressed air or spray wash if required. Be careful not to damage with high-pressure air or water.

Downhole Tools

Rebuild 1.5° and Grade Tools

Rebuild downhole tool every 50 hours or 5,000' (1524 m) as measured by inner rotation hourmeter. Use rebuild kit (p/n 191-120) or seal kit (p/n 191-239) available at your Ditch Witch® dealer.



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250 Hour

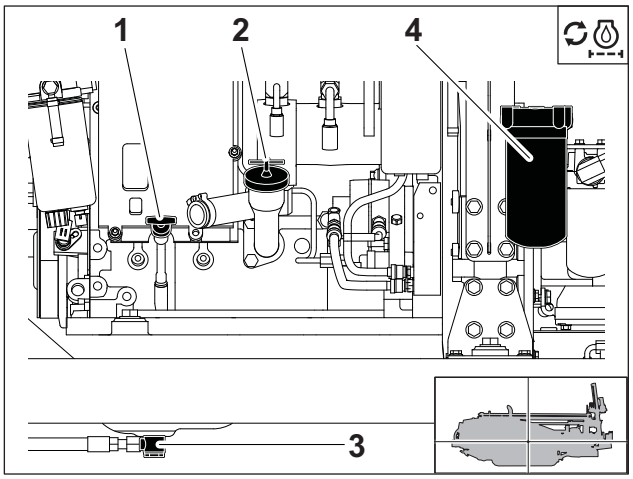
Location	Task	Notes
DRILLING UNIT	Change Tier 3 engine oil (initial)	Only applies to units with Tier 3 engines operating with high sulfur fuel (sulfur content >15 ppm).
	Change hydraulic filters	
	Change rotation gearbox oil	MPL

Tier 3: Change Engine Oil and Filter

NOTICE: Units are initially filled with Tier 4i DEO engine oil. If operating with high sulfur fuel (greater than15 ppm sulfur, found outside of US, Canada, EU and Japan), change oil initially at 250 hours.

Drain oil (3), change filter (4), and add 11.5 qt (10.9 L) of Tier 3 DEO at fill (2). Check oil level at dipstick (1).

IMPORTANT: Use oil specified in temperature chart found in "Recommended Lubricants/ Service Key" on page 164.

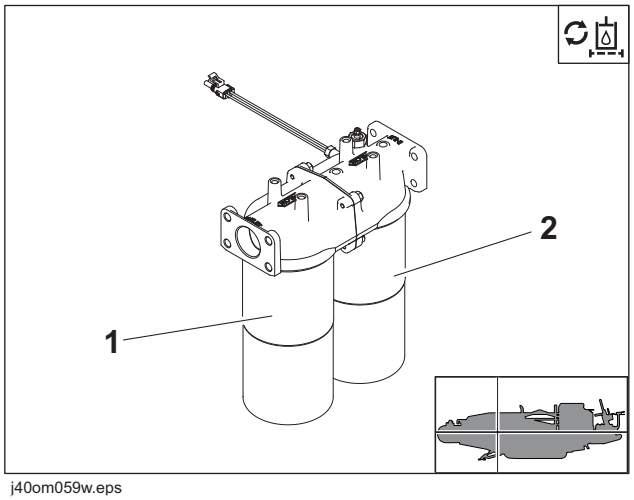


j34om009w.eps

Change Hydraulic Filters

Change three hydraulic filters (1, 2) every 250 hours. Change filters more often if indicated by filter indicator.

IMPORTANT: If hydraulic system must be opened for repair, install new filter (p/n 157-486) for first 50 hours of operation. If this filter becomes plugged in fewer than 20 hours, replace with clean filter. After 50 hours of normal operation, replace with clean filter.

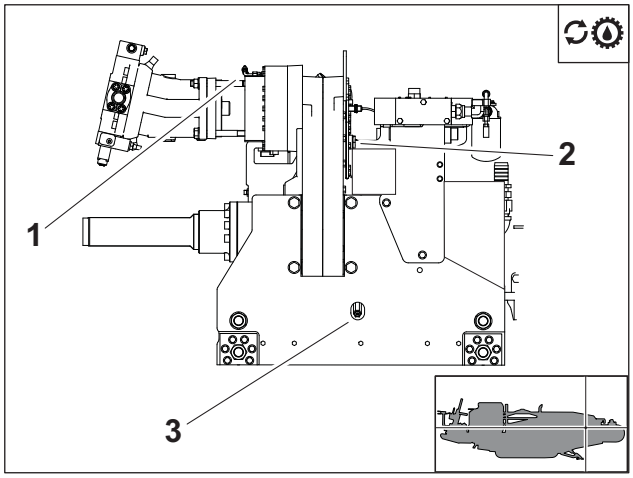


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Change Rotation Gearbox Oil

Drain oil at gearbox oil drain (3) every 250 hours. Fill with MPL at fill plug (1) until oil is level with sight plug opening (2). Replace plugs. Capacity is 9 qt (8.5 L).

IMPORTANT: Drill frame must be level for accurate reading.



j40om042w.eps

500 Hour

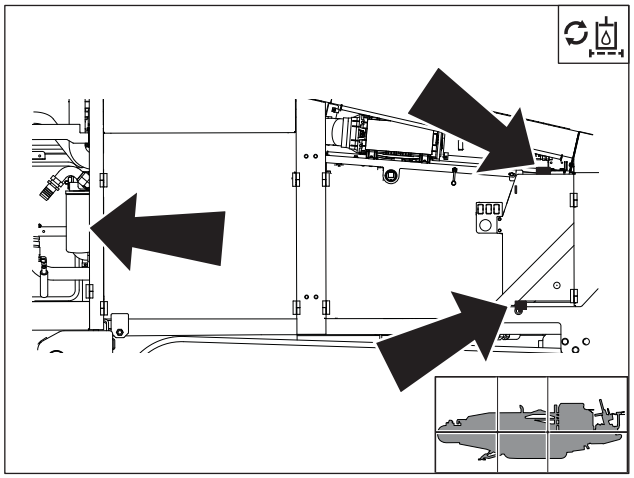
Location	Task	Notes
DRILLING UNIT	Change hydraulic fluid and filters	THF, extreme temperatures
	Change engine oil and filter	DEO
	Change fuel filters	

Drilling Unit

Change Hydraulic Fluid and Filters (Extreme Temperatures)

Change hydraulic fluid and three filters every 500 hours if jobsite temperature exceeds 100° F (38° C) more than 50% of the time. Drain hydraulic fluid, change filters (1, 2), and refill with THF at hydraulic fluid fill. Tank capacity is 36 gal (136 L).

IMPORTANT: If hydraulic system must be opened for repair, install new filter (p/n 157-486) for first 50 hours of operation. If this filter becomes plugged in fewer than 20 hours, replace with clean filter. After 50 hours of normal operation, replace with clean filter.



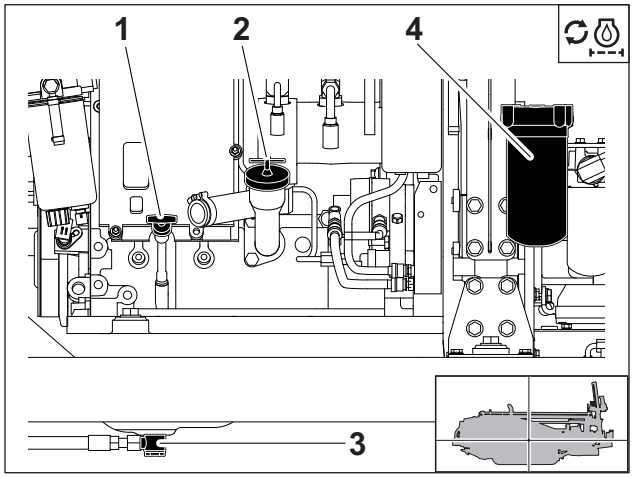
j40om061w.eps

Change Engine Oil and Filter

NOTICE: Incorrect fuel and oil combinations can damage engine.

- Tier 4i: Use Tier 4i DEO and ULSD. Change oil every 500 hours. DO NOT use high sulfur fuel (greater than 15 ppm).
- Tier 3: If using Tier 3 DEO, change oil every 500 hours.

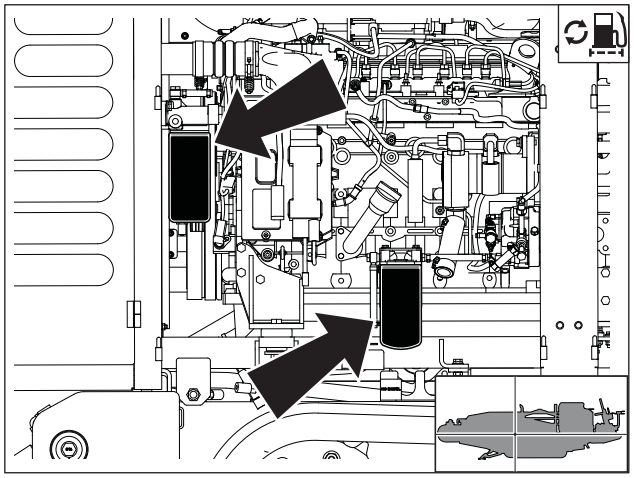
Drain oil (3), change filter (4), and add 11.5 qt (10.9 L) of DEO at fill (2). Check oil level at dipstick (1).



j34om009w.eps

Change Fuel Filters

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



j40om060w.eps

1000 Hour

Location	Task	Notes
DRILLING UNIT	Change hydraulic fluid and filters	normal conditions
	Change ground drive gearbox oil	2 gearboxes, MPL
	Change spindle brake oil	THF
	Change fluid pump oil	SAE 30 non-detergent
	Change anchor driver gearbox oil	
	Lube SaverLok® wrench collar and sliding output shaft	EPL (gel)
	Check engine drive belt	

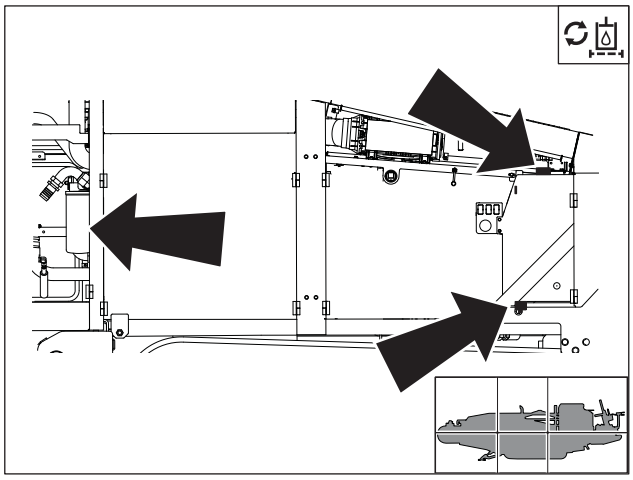
Drilling Unit

Change Hydraulic Fluid and Filters (Normal Conditions)

Change hydraulic fluid and three filters every 1000 hours for normal service. Drain hydraulic fluid, change filters (1, 2), and refill with THF at hydraulic fluid fill. Tank capacity is 36 gal (136 L).

IMPORTANT:

- If ambient temperature exceeds 100°F (37°C) for 50% of time, change oil and filter every 500 hours.
- If hydraulic system must be opened for repair, install new filter (p/n 157-486) for first 50 hours of operation. If this filter becomes plugged in fewer than 20 hours, replace with clean filter. After 50 hours of normal operation, replace with clean filter.



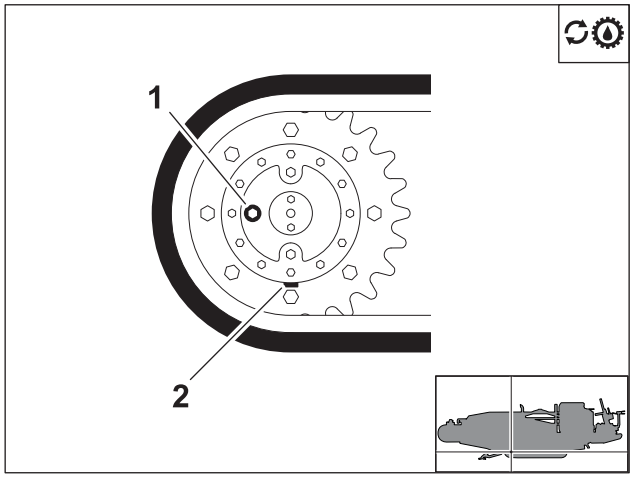
j40om061w.eps

Change Ground Drive Gearbox Oil

Change oil in both ground drive gearboxes every 1000 hours. Capacity is 1.6 qt (1.5 L).

To change:

1. Remove drain plug (2) and drain oil.
2. Replace drain plug.
3. Drive unit to rotate fill plug (1) until level with center of gearbox.
4. Open fill plug and fill with MPL until level with plug opening.
5. Replace fill plug.



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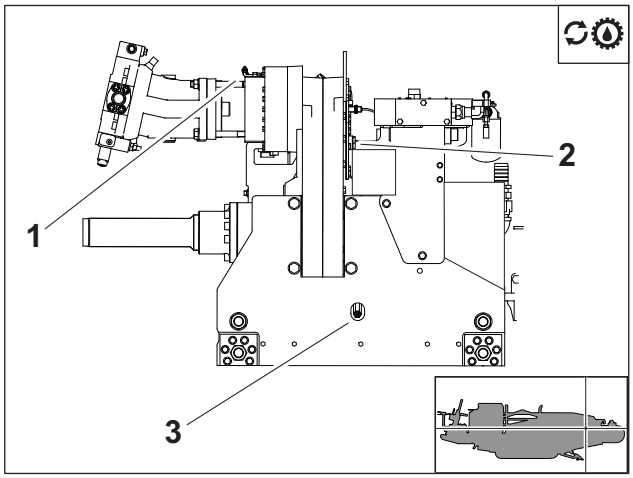
IMPORTANT:

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

Change Rotation Gearbox Oil

Drain oil at gearbox oil drain (3) every 1000 hours. Fill with MPL at fill plug (1) until oil is level with sight plug opening (2). Replace plugs. Capacity is 9 qt (8.5 L).

IMPORTANT: Drill frame must be level for accurate reading.



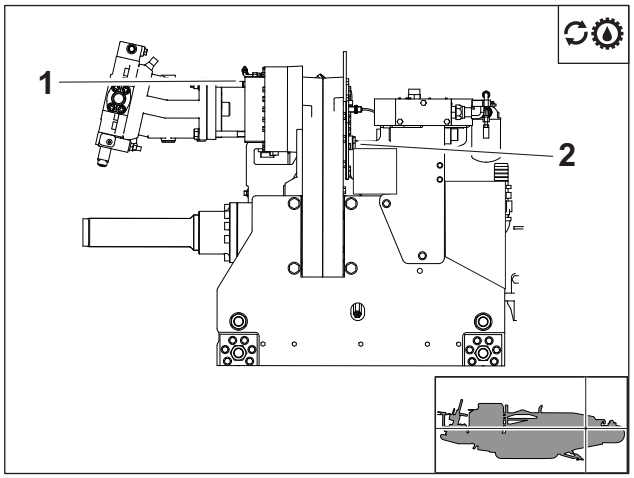
j40om042w.eps

Change Spindle Brake Oil

Change oil every 1000 hours. Capacity is 9 oz (275 mL) of THF.

To change:

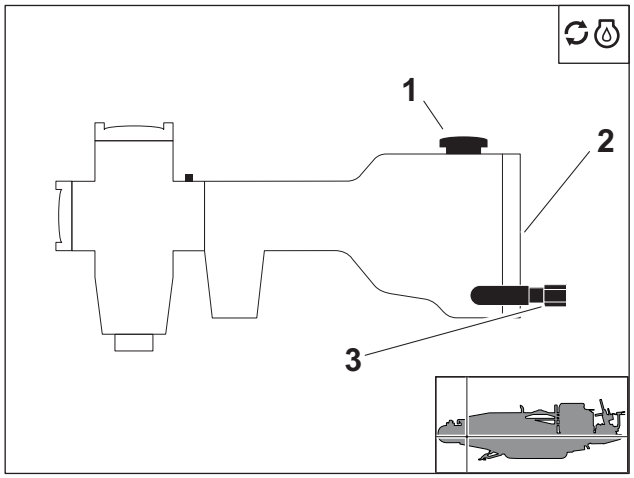
1. Remove plug on bottom of brake.
2. Refill with THF at fill plug (2). Do not overfill.
3. Reinstall outer rotation motor.



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Change Fluid Pump Oil

Change oil after first 50 hours and every 1000 hours thereafter. Maintain fluid level at halfway point on sight glass (2). Drain at plug (3). Fill at cap (1) with TF30.

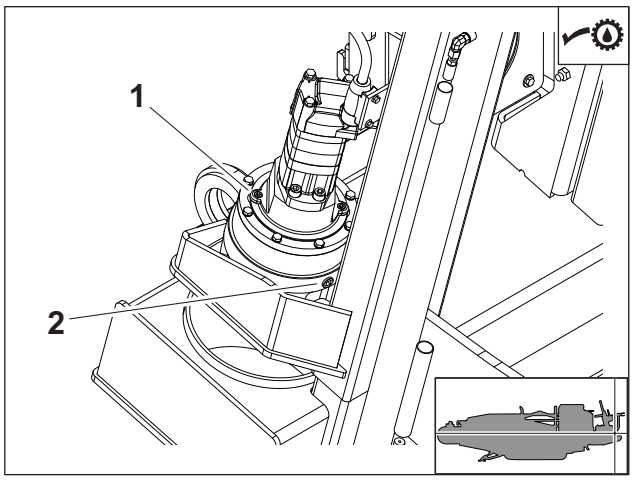


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Change Anchor Gearbox Oil

Change oil in two anchor drive gearboxes every 1000 hours. Drain at plug (2). Fill to level of plug (1) with MPL as needed. .

IMPORTANT: Drill frame must be level for accurate reading.



j40om072w.eps

Check Engine Drive Belt

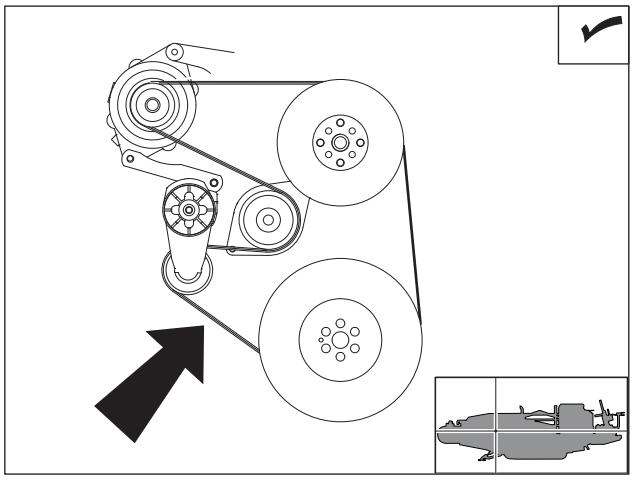
Check engine drive belt every 1000 hours. Check for cracked, stretched, or loose belt. Replace belt as needed. Belt tensioner cannot be adjusted or repaired. Replace if faulty.

To check belt tension:

- Visually check gap between stops.
- Replace belt before stops touch.

IMPORTANT:

- As belt stretches, stops will move closer together.
- See engine manual for information on checking automatic tensioner and changing belts.



j40om045w.eps

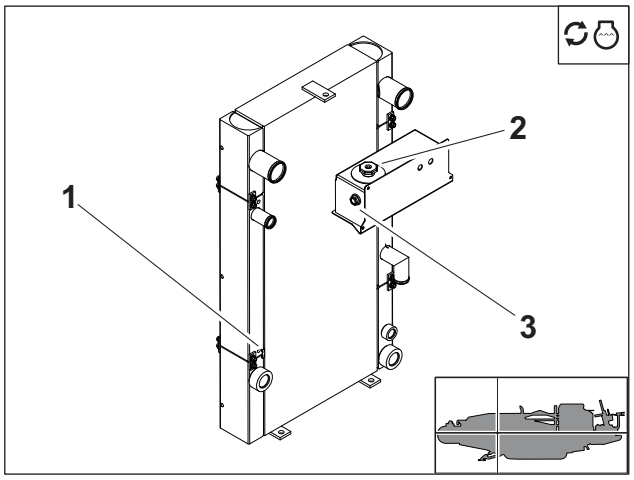
2000 Hour

Location	Task	Notes
DRILLING UNIT	Change engine coolant	

Drilling Unit

Change Engine Coolant

Drain cooling system at drain every two years or 2000 hours. Drain cooling system at drain (3) and refill at radiator cap (2) with approved coolant. Capacity is 7.7 gal (29 L). Check level at sight glass (1).



j40om062w.eps

NOTICE:

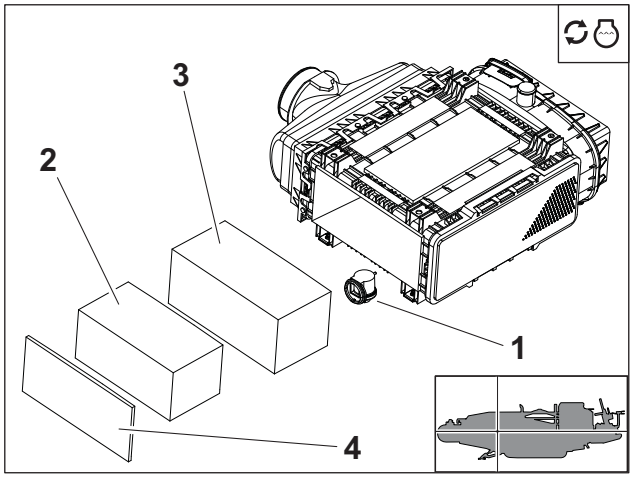
- Coolant change interval depends on coolant used and whether SCA levels are properly maintained. Read note above carefully to ensure coolant is changed at the correct interval.
- The use of non-approved coolant may lead to engine damage or premature engine failure and will void engine warranty.
- Use only distilled water for mixing coolants. Do not use tap water.
- See "Recommended Lubricants/Service Key" on page 164 for list of approved coolants.

As Needed

Location	Task	Notes
DRILLING UNIT	Change air filter	
	Change auto lubricator TJC pail	TJC
	Change hydraulic filters	any time system is opened
	Check pipeloader inserts	
	Check and adjust carriage rollers and slide bars	
	Check front pipe glide blocks	
	Check pipe lubricator insert	
	Check fluid pump ball valve	
	Check track tension and condition	
	Check track support slide pads	
	Check SaverLok System®	
	Replace fuses	
	Change inner water swivel (seal kit)	
	Fill washer liner fluid level	DEAC
	Inspect battery	
	Check batteries	
	Charge battery	

Drilling Unit

Change Air Filter



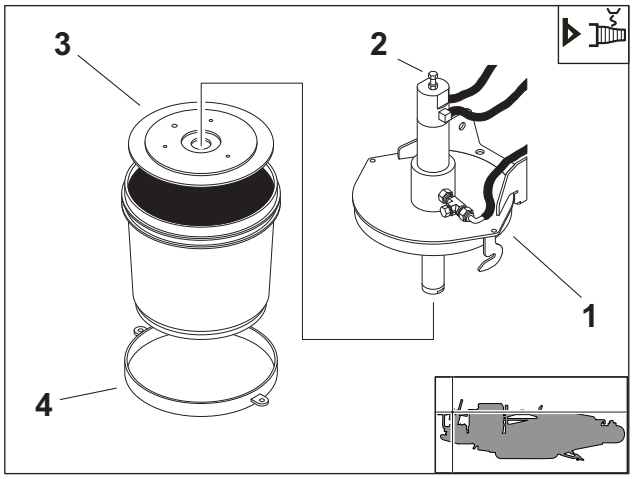
j40om063w.eps

Change air filter when red band on air filter service indicator (1) pops up.

To change:

1. Unclip and remove end cap (4).
2. Remove elements (2, 3).
3. Wipe inside of housing and wash end cap.
4. Install new elements.
5. Install end cap and tighten clamp ring.
6. Reset air filter service indicator.

Change Auto Lubricator TJC Pail



j40om030w.eps

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.
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.

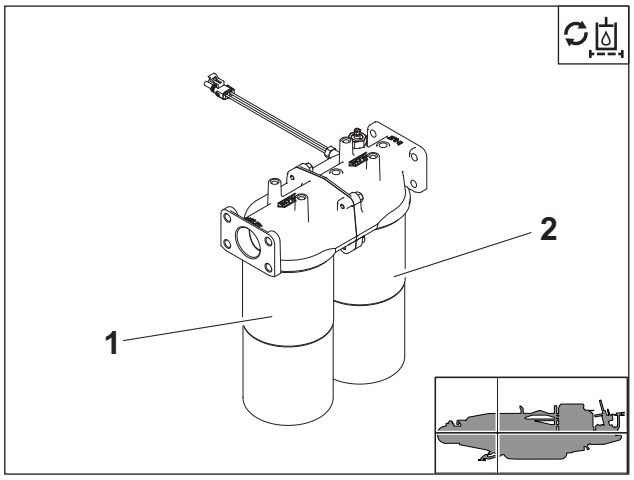
IMPORTANT: Use only genuine Ditch Witch® tool joint compound to maintain warranty. See "Recommended Lubricants/Service Key" on page 164 for more information.

Change Hydraulic Filters (Anytime System Opened)

Change three hydraulic filters anytime system is opened for repair. Change filters (1, 2). Check fluid level, and add THF at hydraulic oil fill, if necessary.

IMPORTANT:

- If ambient temperature exceeds 100°F (37°C) for 50% of time, change oil and filter every 500 hours.
- If hydraulic system must be opened for repair, install new filter (p/n 157-486) for first 50 hours of operation. If this filter becomes plugged in fewer than 20 hours, replace with clean filter. After 50 hours of normal operation, replace with clean filter.
- For major repairs with likely system contamination, change hydraulic fluid also.



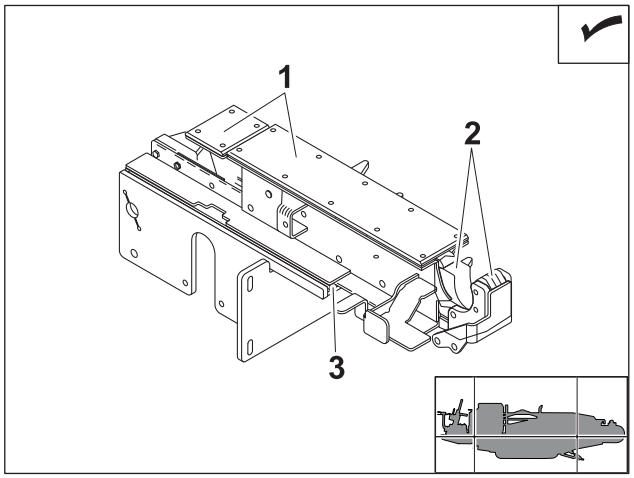
j40om059w.eps

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. Shuttle wear pads
2. Pipe gripper inserts
3. Slide pads

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



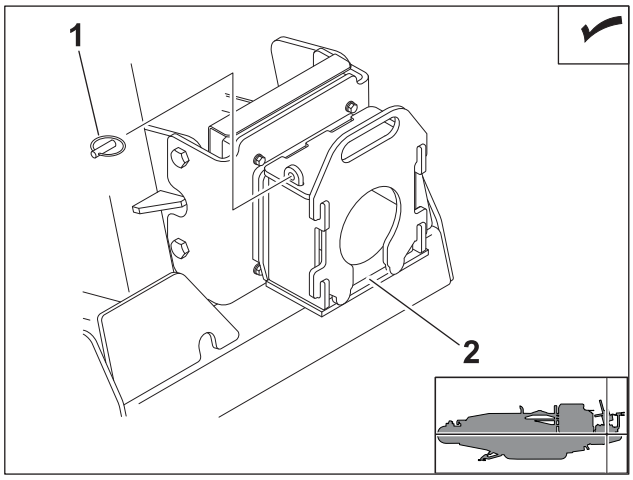
j40om046w.eps

Check Front Pipe Guide Blocks

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

To replace:

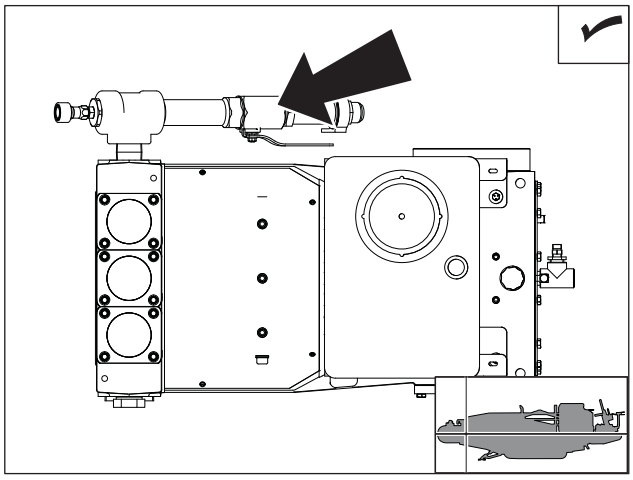
1. Remove lynch pins (1, one on each side).
2. Remove guide blocks (2).
3. Replace in reverse order.



j40om049w.eps

Check Fluid Pump Ball Valve

Check hydraulic ball valve for leaks. Tighten stem packing as needed. See your Ditch Witch dealer for replacement packing.

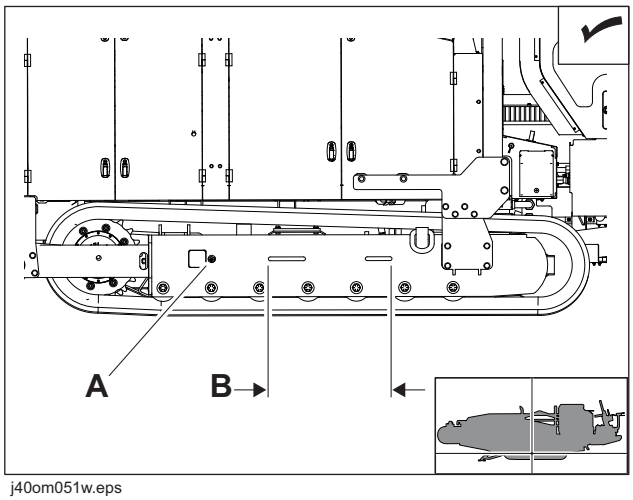

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Check Track Tension and Condition

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

To adjust:

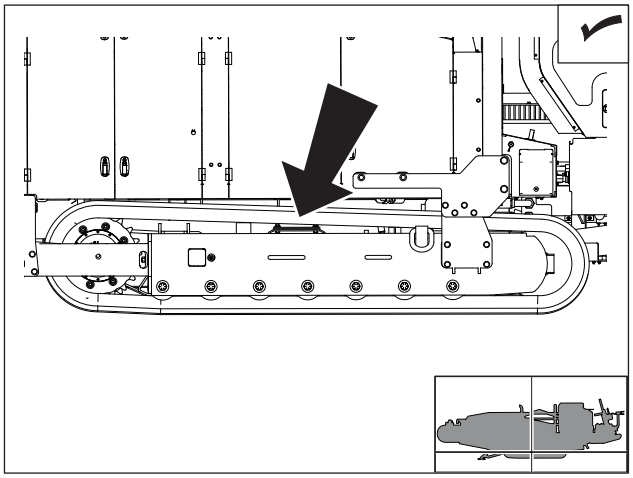
1. Pump MPG into fitting (A) until spring height is 17 3/4-18" (451-457 mm) when measured through windows (B).
2. Drive straight forward one machine length and check tension again.



j40om051w.eps

Check Track Support Slide Pads

Check track support slide pads. Replace as needed. See your Ditch Witch® dealer for replacement parts.



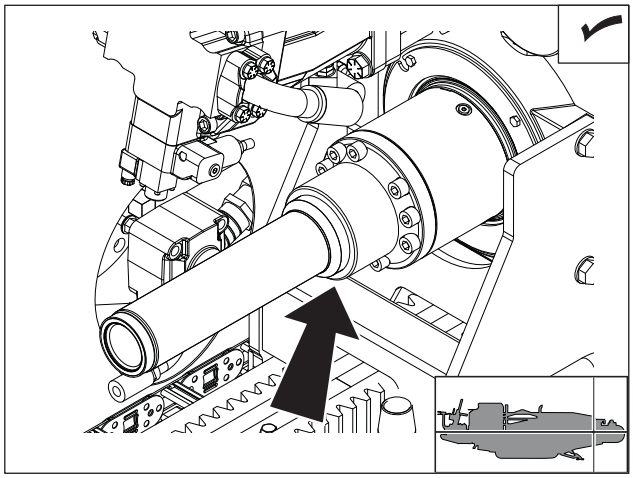
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Check SaverLok System®

Check SaverLok System and replace as needed. See your Ditch Witch dealer for replacement parts.

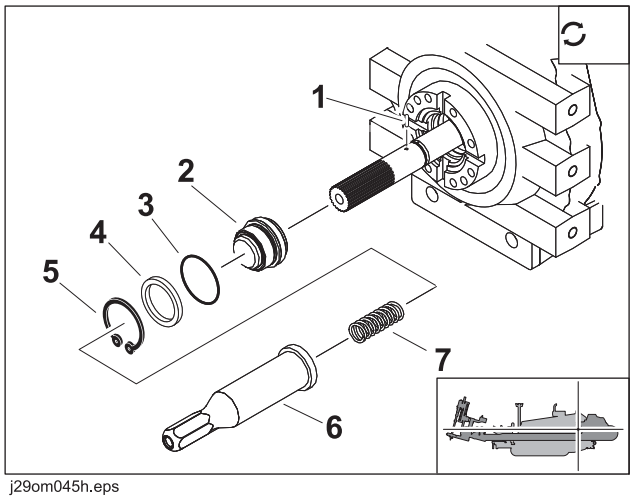
To replace:

1. Remove nine bolts (shown) from the flange, then remove the flange and SaverLok® body from connection.
2. Remove and replace o-ring, if necessary.
3. Reuse the flange to attach the SaverLok body. Apply hydraulic fluid or Loctite® 242 or equivalent to threads and install bolts and tighten in a crisscross pattern to 240 ft•lb (325 N•m). If hydraulic fluid or thread locker aren't available, tighten dry threads to 300 ft•lb (407 N•m).



j40om052w.eps

Change Inner Water Swivel (Seal Kit)



j29om045h.eps

Replace inner water swivel (seal kit) as needed. See your Ditch Witch® dealer for replacement parts.

To replace:

1. Remove SaverLok® connection. Do not remove indexing dowels from spindle.
2. Remove hex (6) and spring (7) from drive shaft.
3. Remove seal (4) and main body (2).

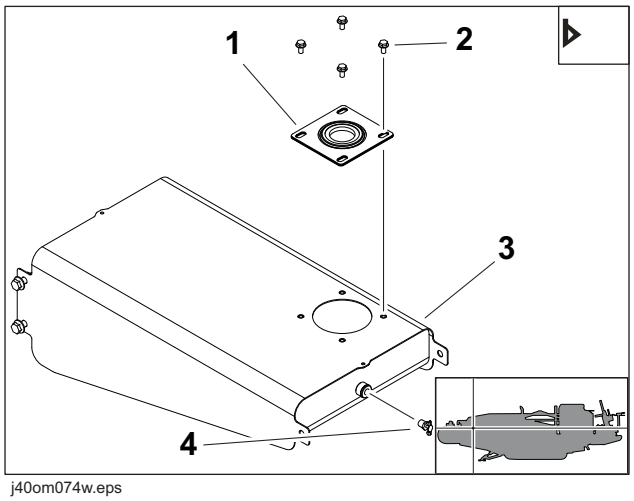
IMPORTANT: Use care when handling main body to avoid seal contamination. Do not allow grease to touch inner seals during installation.

4. Inspect dowel pin (1). To replace, drive new pin into different hole until top of pin is flush with shaft larger diameter.
5. Slide new main body (2) onto drive shaft. Replace o-ring (3).
6. Lightly coat seal (3) with SAE 30 engine oil and install onto main body.

NOTICE: Do not run seals without lubrication. Damage will occur.

7. Slide snap ring (4) onto main body.
8. Compress seal kit until snap ring is properly seated.
9. Install hex (5) and spring (6).
10. Install SaverLok body. See page 195.

Check Liner Washer Fluid Level



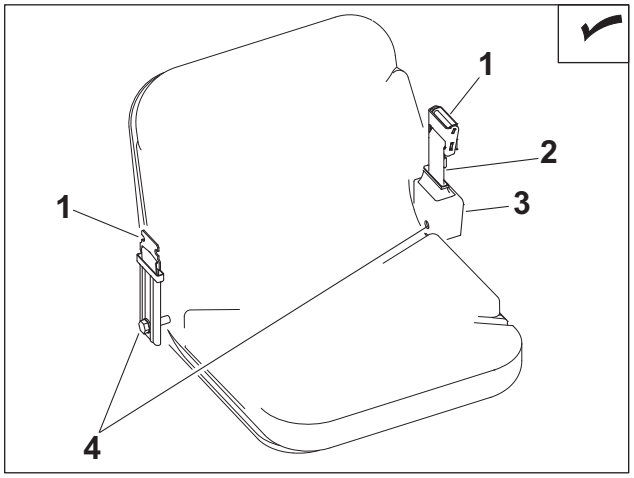
j40om074w.eps

Check liner washer fluid and fill as needed.

To fill:

1. Remove tank flange (1) from wash tank (3) by removing screws (2).
2. Fill with DEAC to drain valve (4).

Inspect Seat Belt



SeatBelt.eps

Check seat belt and mounting hardware as needed. Inspect the webbing, buckle and latch, retractor, and mounting hardware.

Buckle and Latch

Check that the buckle and latch (1) are not broken or corroded. When inserting the latch into the buckle, the latch should insert smoothly until an audible click is heard. Latch should not release when the seat belt is tugged.

Webbing

Inspect seat belt webbing (2) to ensure that it is not cut, frayed or showing signs of extreme or unusual wear. Check the area near the buckle and latch and anywhere the seat belt has contact with equipment or seat.

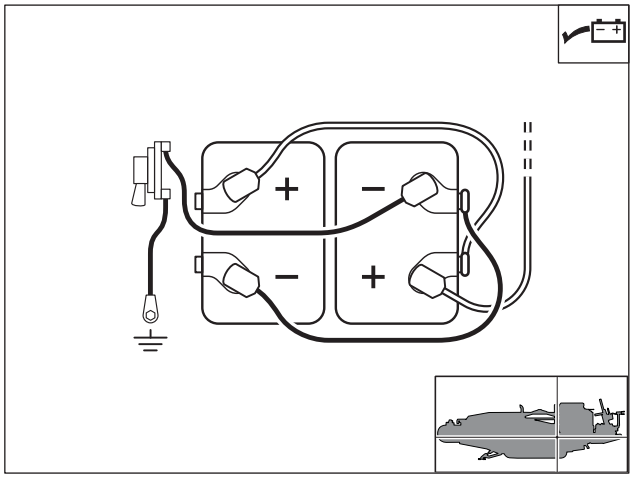
Retractor

Check that the retractor (3) operates smoothly when the belt is pulled and released. Retractor should spool belt without locking.

Mounting Hardware

Inspect the seat belt mounting bolts (4) on both sides of the seat to ensure they are tight. Replace missing, damaged, or corroded bolts.

Check Batteries



j40om040w.eps

Check batteries every 500 hours. Keep batteries clean and terminals free of corrosion.

To clean:

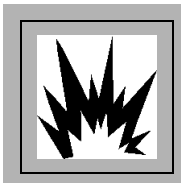
1. Turn battery disconnect switch, if equipped, to the off position.
2. Ensure that no ignition sources are near batteries.
3. Loosen and remove battery cable clamps carefully, **negative (-)** cable first.
4. Clean cable clamps and terminals to remove dull glaze.
5. Check for signs of internal corrosion in cables.
6. Apply MPG to terminals after cleaning to reduce corrosion.
7. Connect battery cable clamps, **positive (+)** cable first.
8. Tighten any loose connections.
9. Ensure that battery tiedowns are secure.
10. 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.

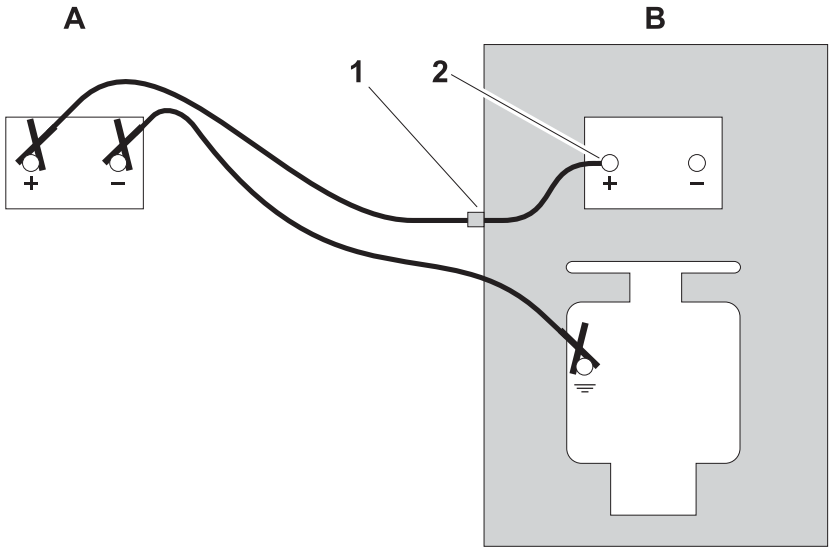
Before You Start

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.



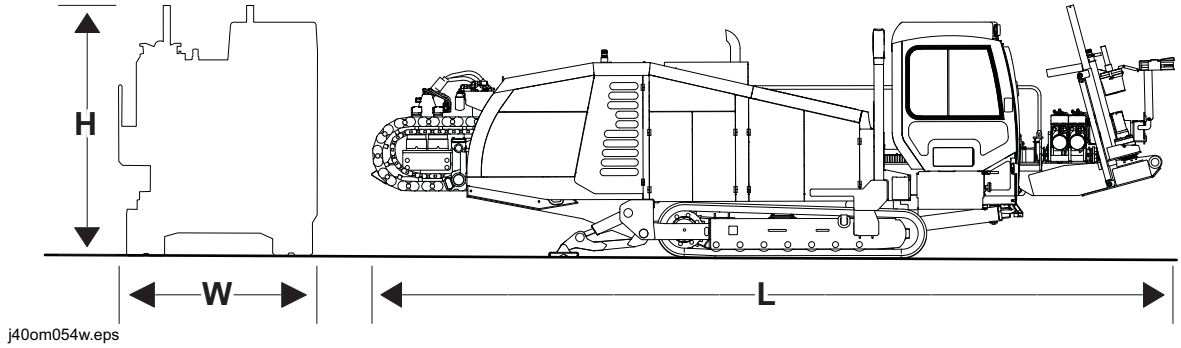
3. Inspect battery in disabled vehicle (B) for signs of cracking, bulging, leaking, or other damage. Connect red positive (+) jumper cable clamp to positive (+) post (2) of battery in disabled vehicle first.

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



Dimensions		U.S.	Metric
L, length (per SAE J2022)		331 in	8.4 m
W, width (per SAE J2022)		87 in	2.2 m
H, height, with cab (per SAE J2022)		99 in	2.5 m
Angle of approach		18°	18°
Angle of departure		13°	13°
Weight (per SAE J2022)			
	JT mode	31,250 lb	14,175 kg
	AT mode	31,250 lb	14,175 kg

Power Pipe®		U.S.	Metric
Length (per SAE J2022)		180 in	4.57 m
Joint diameter (per SAE J2022)		3.5 in	89 mm
Tubing diameter (per SAE J2022)		3.06 in	78 mm
Minimum bend radius		170 ft	52 m
Weight (per SAE J2022)		184 lb	84 kg
Pipe box weight			
	large JT pipe box with 28 pipe	6096 lb	2765 kg
	small JT pipe box with 16 pipe	3612 lb	1638 kg

All Terrain Pipe		U.S.	Metric
Length, without inner pipe (per SAE J2022)		171 in	4.3 m
Joint diameter (per SAE J2022)		4.13 in	105 mm
Tubing diameter (per SAE J2022)		3.63 in	92 mm
Minimum bend radius		205 ft	63 m
Weight, with inner pipe (per SAE J2022)		264 lb	120 kg
Pipe box weight			
	large AT pipe box with 18 pipe	5580 lb	2530 kg
	small AT pipe box with 9 pipe	3150 lb	1430 kg

Power Pipe® Forged		U.S.	Metric
Length (per SAE J2022)		180 in	4.57 m
Joint diameter (per SAE J2022)		3.25 in	83 mm
Tubing diameter (per SAE J2022)		2.88 in	73 mm
Minimum bend radius		169 ft	52 m
Weight (per SAE J2022)		180 lb	82 kg
Pipe box weight			
	large JT pipe box with 28 pipe	5984 lb	2715 kg
	small JT pipe box with 16 pipe	3548 lb	1610 kg

Pipe Box Capacities

Certain pipe box/drill pipe combinations exceed ROPS capacity on Tier 4i units. The factory has installed yellow pipe blocks to limit pipe box capacity in those instances. Do not remove pipe blocks and load more drill pipes into these pipe boxes.

Drilling Unit	DW JT	900 JT	800 JT	AT
JT60 Tier 3	28	28	18	N/A
JT60 AT Tier 3	28	28	18	18
JT60 Tier 4i	**27**	28	18	N/A
JT60 AT Tier 4i	**24**	**24**	18	18

Operational		U.S.	Metric
Spindle speed (per SAE J2022)			
	inner pipe	0-250 rpm	0-250 rpm
	outer pipe	0-240 rpm	0-240 rpm
Spindle torque (per SAE J2022)			
	inner pipe, max	2000 ft•lb	2712 N•m
	outer pipe, max	9000 ft•lb	12202 N•m
Carriage speed (per SAE J2022)		0-100 fpm	0-30.5 m/min
Pullback force (per SAE J2022)		60,000 lb	267 kN
Thrust force (per SAE J2022)			
	actual, All Terrain mode	60,000 lb	267 kN
	actual, JT and AT dirt modes	60,000 lb	267 kN
Minimum bore diameter			
	All Terrain with roller cone bit	6.25 in	159 mm
	JT with soil bit	5 in	127 mm
Backream diameter		variable	variable
Ground drive speed (per SAE J2022)			
	forward	0-2.5 mph	0-4 km/h
	reverse	0-2.5 mph	0-4 km/h



Power		**U.S.**	**Metric**
Engine: Cummins® QSB 6.7			
Engine compliance: EPA Tier 3, EU Stage IIIA; EPA Tier 4i, EU Stage IIIB			
Fuel: diesel			
Cooling medium: liquid			
Cylinders: 6			
Injection: Direct			
Aspiration: turbocharged and charge air cooled			
Displacement		408 in^3	6.7 L
Bore		4.21 in	107 mm
Stroke		4.88 in	124 mm
Power			
	manufacturer's gross power rating (per SAE J1995)	190 hp	142 kW
	rated speed	2200 rpm	2200 rpm
	estimated net power (per SAE 1349)	194 hp	146 kW

Drilling Fluid System	**U.S.**	**Metric**
Maximum drilling fluid flow (per SAE J2022)	150 gpm	560 L/min
Maximum drilling fluid pressure (per SAE J2022)	1300 psi	90 bar

Fluid Capacities	U.S.	Metric
Fuel tank *	55 gal	208 L
Hydraulic reservoir	36 gal	136 L
Engine oil, including filter	20 qt	19 L
Engine cooling system	31 qt	29 L
Antifreeze tank	16 gal	60 L

* Under normal operating conditions, a full tank of fuel will last 10-14 hours.

Battery
SAE reserve capacity 195 min, 12V, negative ground, SAE cold crank @ 0°F (-18°C), 2 batteries @ 950A each.

Vibration Levels
Average vibration transmitted to the operator's hand and whole body during normal operation does not exceed 2.5 and 0.5 m/sec^2 respectively.

Noise Levels
Operator ear sound pressure level is 81 dBA per ISO 6394 Exterior sound power level is 106 dBA per ISO 6393

Specifications are called out according to SAE recommended practices. 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 Ditch Witch factory 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 Ditch Witch Product Support (DWPS) or its authorized dealer. DWPS will provide the location of its inspection facilities or its nearest authorized dealer upon inquiry. DWPS 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 the Ditch Witch factory.

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 the DWPS department, P.O. Box 66, Perry, OK 73077-0066, or contact your local dealer.

First version: 1/91; Latest version: 8/16

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

POSTAGE WILL BE PAID BY

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

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BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO 23 PERRY OKLAHOMA

POSTAGE WILL BE PAID BY

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

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

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

Service Record

Service Performed	Date	Hours

Service Performed	Date	Hours