

JT60/JT60 All Terrain

Tier 4

Operator's Manual



Overview

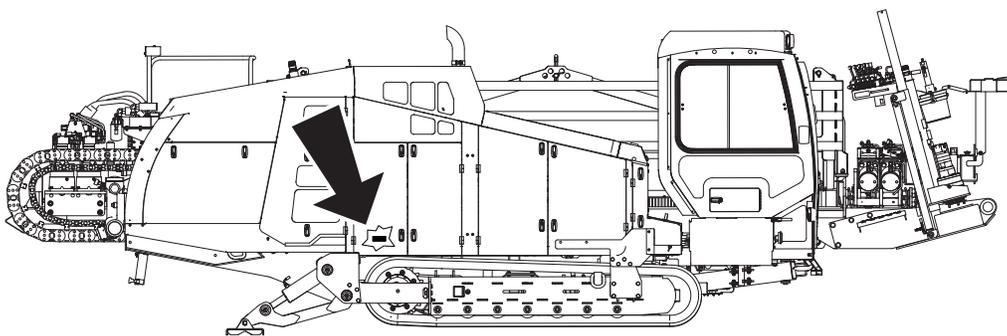


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Serial Number Location

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.

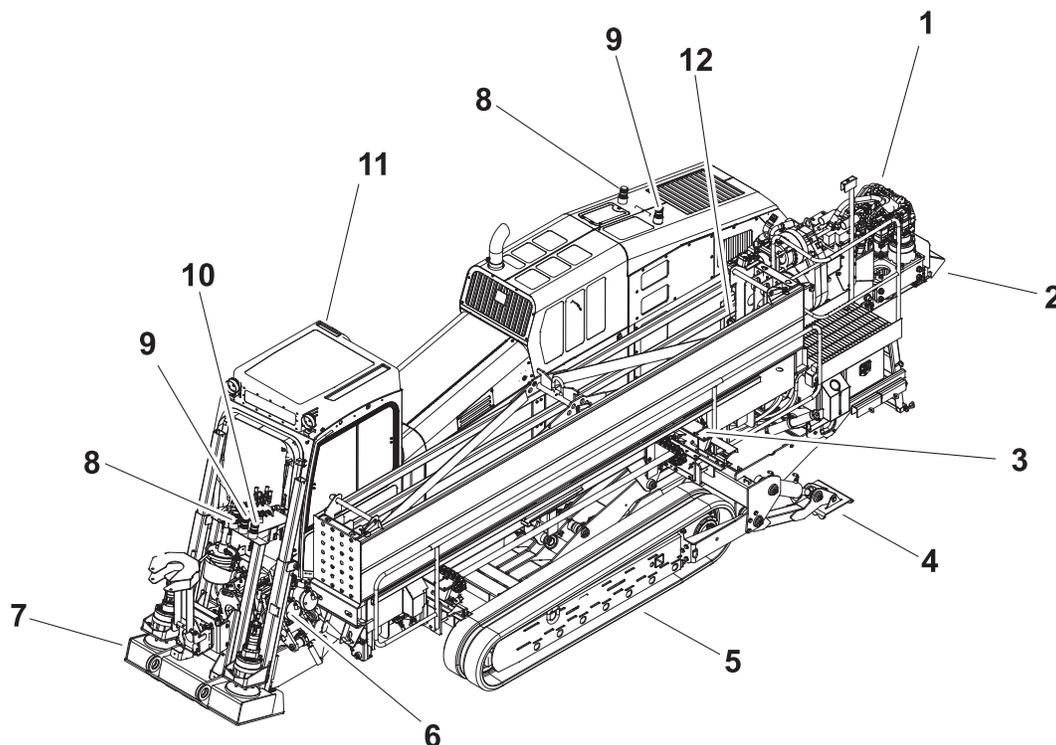
The unit is designed for operation in temperatures typically experienced in earth moving and construction work environments. Provisions may be required to operate in extreme temperatures. Contact your Ditch Witch[®] dealer. Use in any other way is considered contrary to the intended use.

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

Equipment Modification

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

Unit Components



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- | | |
|------------------|--|
| 1. Carriage | 7. Anchoring system |
| 2. Drill frame | 8. Wireless remote control light (clear) |
| 3. Pipelader | 9. ESID strobe light (amber) |
| 4. Stabilizer | 10. DrillLok® light (green) |
| 5. Tracks | 11. Operator's station |
| 6. Vice wrenches | 12. Spindle |



FCC Statement - Internal Transmitter

U.S.

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

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

Contains **FCC ID**: ITQ-TR2 & KWL-RM02410.

Canada

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

Contains **IC**: 3598A-TR2I & 2268C-RM02410.

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

Contient **IC**: 3598A-TR2I & 2268C-RM02410.



N 16819

RF Exposure Statement

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

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

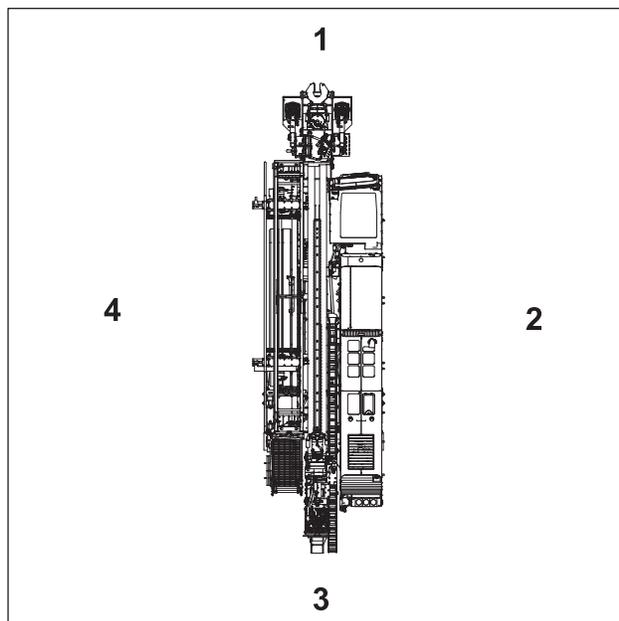
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with Health Canada's Safety Code. The installer of this device should ensure that RF radiation is not emitted in excess of the Health Canada's requirement. Information can be obtained at http://hc-sc.gc.ca/ewh-sem/pub/radiation/radio_guide-lignes_direct-eng.php.

Operator Orientation

IMPORTANT: Top view of unit is shown.

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



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About This Manual

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

Bulleted Lists

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

Numbered Lists

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

Foreword



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

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

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

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

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

Thank you for buying and using Ditch Witch equipment.



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

**Issue number 1.0/OM-10/16
Part number 053-2955**

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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

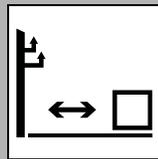
Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.



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.

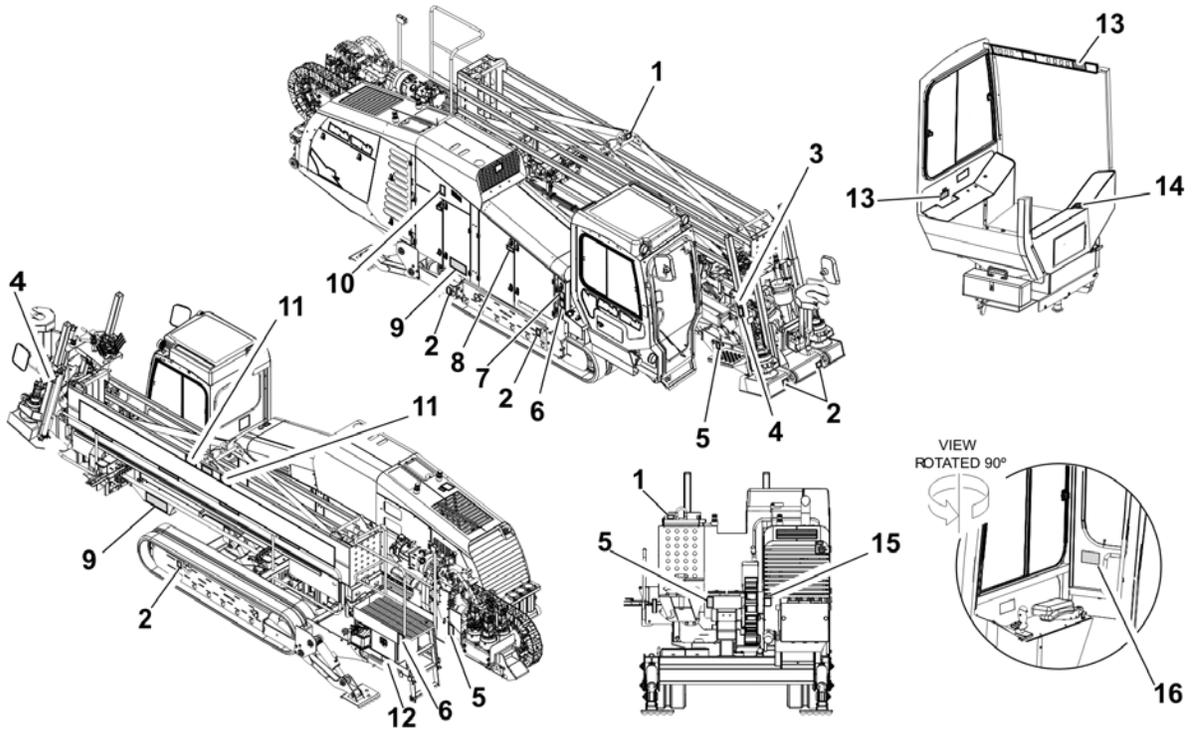
 **CAUTION** indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

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



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1



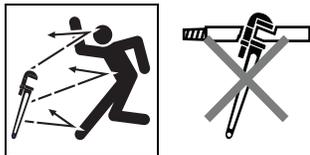
Lift point. See Transport chapter for more information.

2



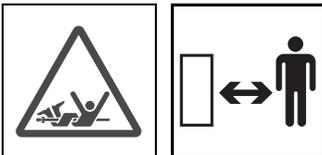
Tiedown location. See Transport chapter for more information.

3

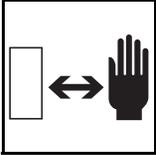
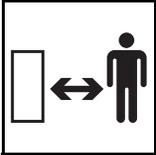
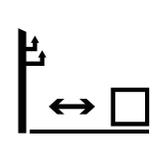
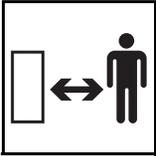
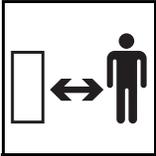


⚠ DANGER Moving tools will kill or injure. Shut off drill string power when anyone can be struck by moving or thrown tools. Never use pipe wrenches on drill string.

4

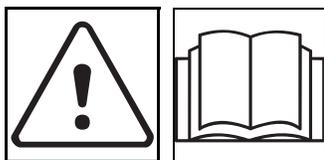


⚠ DANGER Turning shaft will kill you or crush arm or leg. Stay away.

5			⚠ WARNING Moving parts could cut off hand or foot. Stay away.
6			⚠ CAUTION Equipment can be operated by remote control. Stay away.
7			⚠ WARNING Crushing weight could cause death or serious injury. Use proper procedures and equipment or stay away.
8			⚠ WARNING Fire or explosion possible. Do not use starter fluid. 273-459 (2P), 274-206 (2P), 700-206 (2P)
9			⚠ DANGER Electric shock. Contacting electric lines will cause death or serious injury. Know location of lines and stay away.
10			⚠ CAUTION Hot parts may cause burns. Do not touch until cool or wear gloves.
11			⚠ WARNING Crushing weight could cause death or serious injury. Use proper procedures and equipment or stay away.
12			⚠ WARNING Moving parts can crush. Secure extended cylinder with locking device before servicing.



13



⚠ 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.

14



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

15



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

16



Emergency exit. Push window out to exit cab when door is blocked or inoperable.

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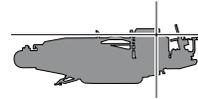
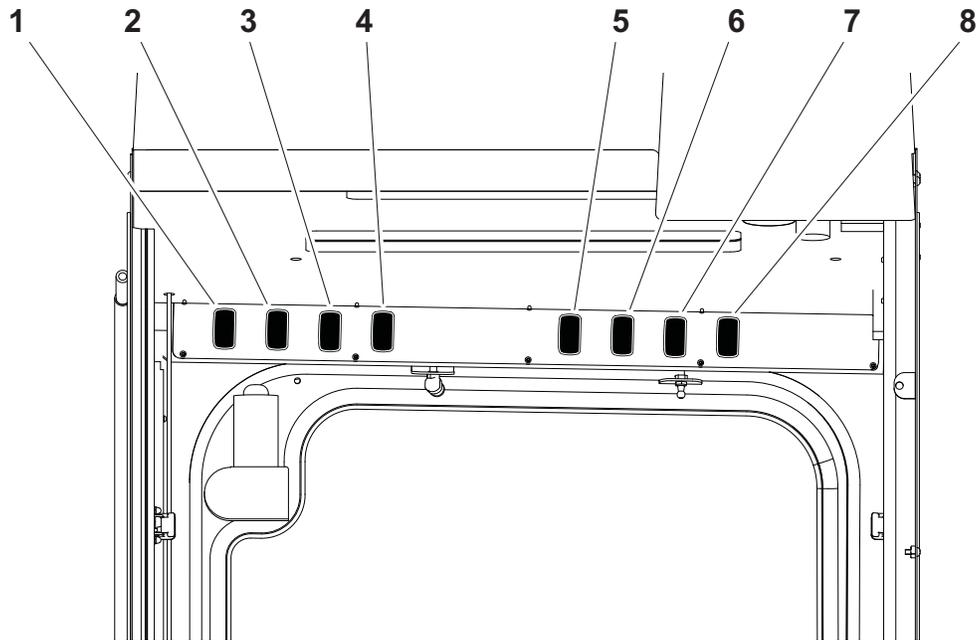
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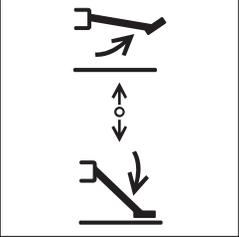
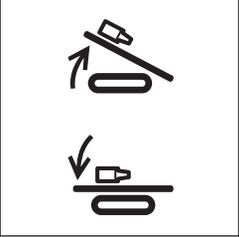
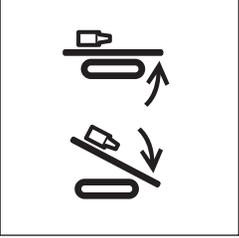
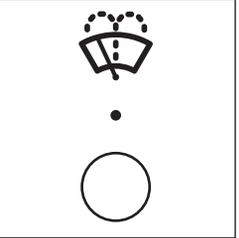
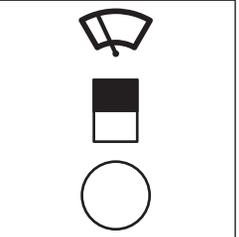
Setup Console



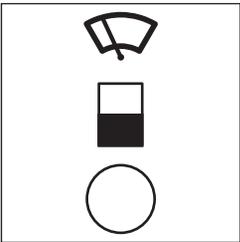
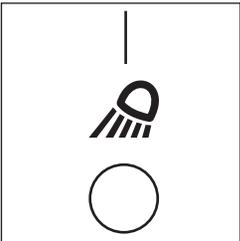
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|--|--|
| <ul style="list-style-type: none"> 1. Left stabilizer control 2. Right stabilizer control 3. Back frame tilt control 4. Front frame tilt control | <ul style="list-style-type: none"> 5. Washer fluid on/off switch 6. Upper wiper switch 7. Lower wiper switch 8. Worklight switch |
|--|--|

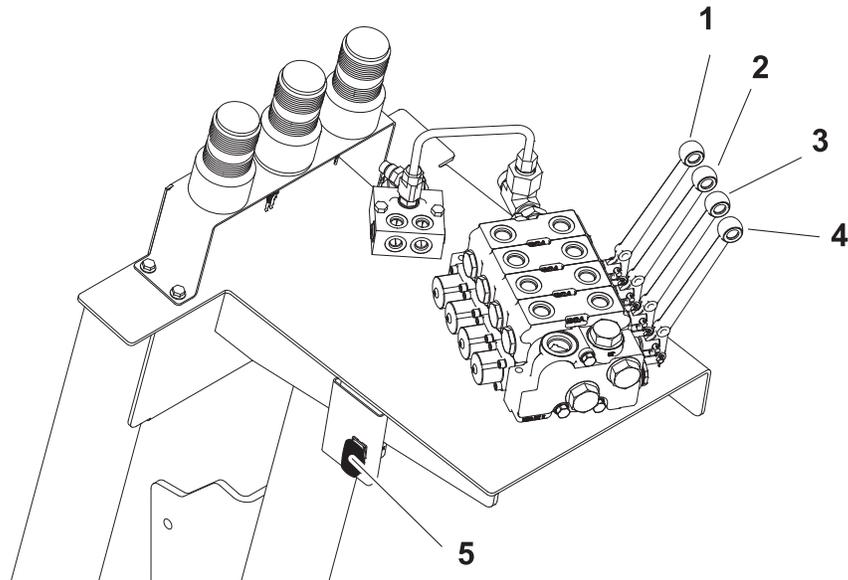
Item	Description	Notes
<p>1. Left stabilizer control</p> <p style="font-size: small;">c00ic030h.eps</p>	<p>To raise, push up.</p> <p>To lower, pull down.</p>	<p>IMPORTANT: Lower right and left stabilizers to the ground together, then adjust individually.</p>

Item	Description	Notes
<p>2. Right stabilizer control</p>  <p>c00ic029h.eps</p>	<p>To raise, push up.</p> <p>To lower, pull down.</p>	<p>IMPORTANT: Lower left and right stabilizers to the ground together, then adjust individually.</p>
<p>3. Back frame tilt control</p>  <p>c00ic027h.eps</p>	<p>To raise, push up.</p> <p>To lower, push down.</p>	<p>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.</p>
<p>4. Front frame tilt control</p>  <p>c00ic026h.eps</p>	<p>To raise, push up.</p> <p>To lower, push down.</p>	<p>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.</p>
<p>5. Washer on/off switch</p>  <p>c00ic045w.eps</p>	<p>To start windshield washer fluid, press and hold top.</p> <p>To stop washer fluid flow, release.</p>	
<p>6. Upper wiper switch</p>  <p>c00ic046w.eps</p>	<p>To start wiper blade, press top.</p> <p>To stop wiper blade, press bottom.</p>	



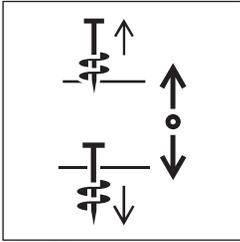
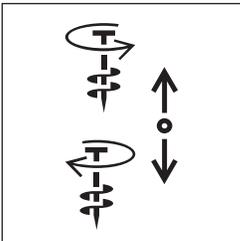
Item	Description	Notes
<p>7. Lower wiper switch</p>  <p>c00ic047w.eps</p>	<p>To start wiper blade, press top.</p> <p>To stop wiper blade, press bottom.</p>	
<p>8. Worklight switch</p>  <p>c00ic048w.eps</p>	<p>To turn on, press top.</p> <p>To turn off, press bottom.</p>	

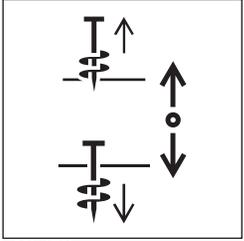
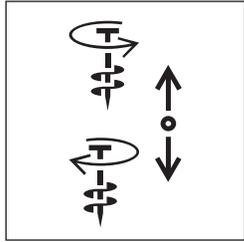
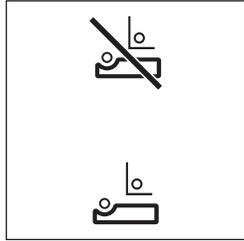
Anchoring System Console



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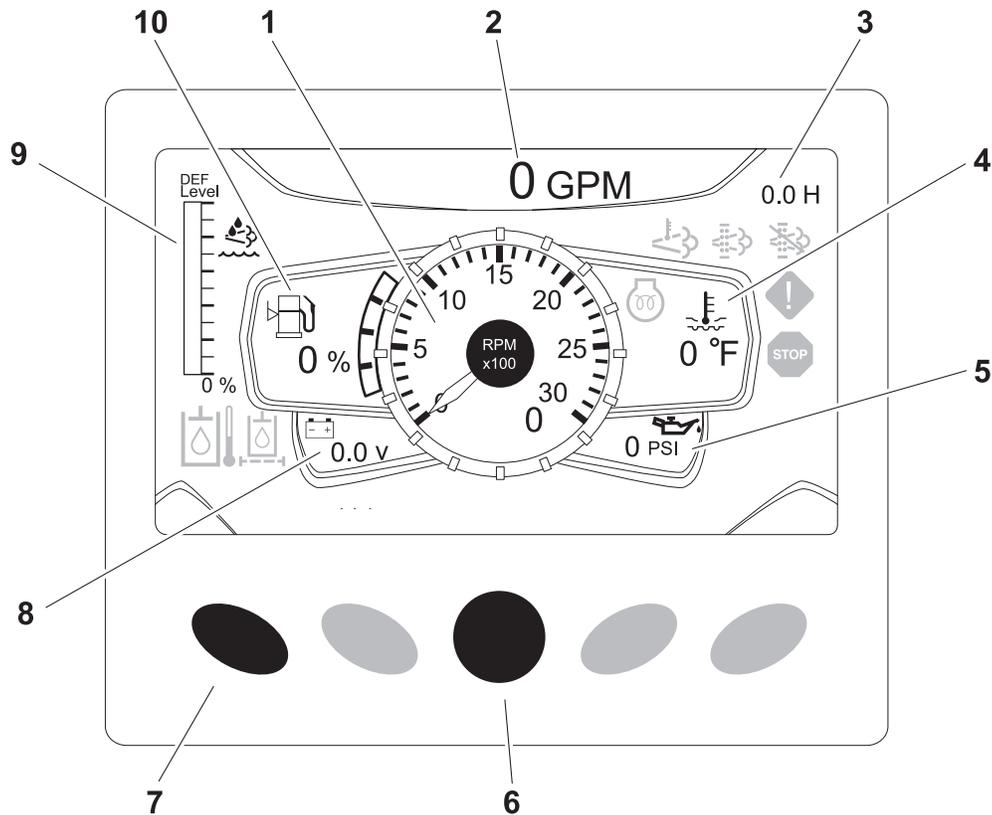
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|---------------------------|--|
| 1. Left rotation control | 4. Right thrust control |
| 2. Left thrust control | 5. Wireline restricted operating mode switch |
| 3. Right rotation control | |

Item	Description	Notes
1. Right thrust control  <small>c00ic170h.eps</small>	To move anchor up, pull. To move anchor down, push.	See "Anchor System" on page 131.
2. Right rotation control  <small>c00ic169h.eps</small>	To remove anchor, pull. To drive anchor, push.	See "Anchor System" on page 131.

Item	Description	Notes
<p>3. Left thrust control</p>  <p>c00ic170h.eps</p>	<p>To move anchor up, pull.</p> <p>To move anchor down, push.</p>	<p>See "Anchor System" on page 131.</p>
<p>4. Left rotation control</p>  <p>c00ic169h.eps</p>	<p>To remove anchor, pull.</p> <p>To drive anchor, push.</p>	<p>See "Anchor System" on page 131.</p>
<p>5. Shuttle lockout switch</p>  <p>c00ic709h.eps</p>	<p>To prevent shuttle operation, press top.</p> <p>To allow shuttle operation, press bottom</p>	<p>Use when loading and unloading extra drill pipe with auxiliary loaders.</p>

Left Control Console

Engine Display



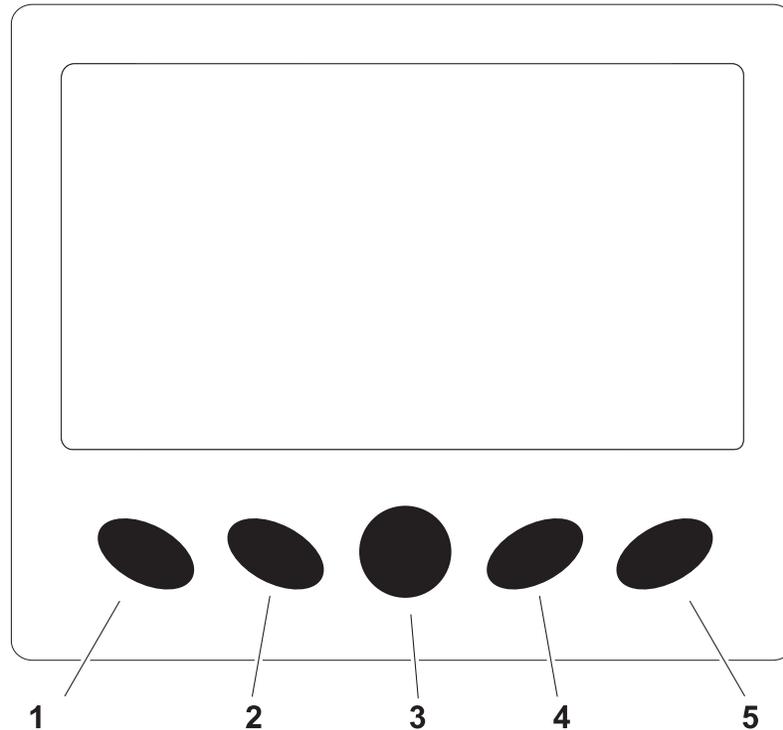
- | | |
|-------------------------------------|---|
| 1. Tachometer | 7. Day/Night mode key |
| 2. Drilling fluid flow display | 8. Voltmeter display |
| 3. Hourmeter | 9. Diesel exhaust fluid (DEF) gauge and indicator |
| 4. Engine coolant temperature gauge | 10. Fuel gauge |
| 5. Engine oil pressure gauge | |
| 6. Main menu key | |

Item	Description	Notes
1. Tachometer	Displays engine speed.	
2. Drilling fluid flow display	Displays the estimated GPM or LPM of drilling fluid being pumped.	
3. Hourmeter	Displays number of hours engine has been running.	

Item	Description	Notes
4. Engine coolant temperature gauge	Displays engine coolant temperature.	Normal coolant temperature is 160°-225° F (71°-107° C).
5. Engine oil pressure gauge	Displays engine oil pressure.	Full load reading should be 60-80 psi (4.1-5.5 bar).
6. Main menu key	Press from main screen (gauges) to select main menu.	
7. Day/Night mode key	Press from main screen (gauges) to toggle between day and night modes.	
8. Voltmeter display	Shows system voltage.	Normal voltage is 13-14V with engine running.
9. Diesel exhaust fluid (DEF) gauge and indicator	Displays amount of diesel exhaust fluid (DEF) remaining in tank.	<ul style="list-style-type: none"> • Indicator appears when level reaches 10%. • Indicator flashes yellow when level reaches 5%. • When level falls below 2.5%, engine derates. • When level reaches 0%, engine begins secondary derate and locks machine to low throttle after 30 minutes. <p>See "Diesel Exhaust Fluid (DEF)" on page 194.</p>
10. Fuel gauge	Displays amount of fuel remaining in tank.	See "Approved Fuel" on page 193.

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

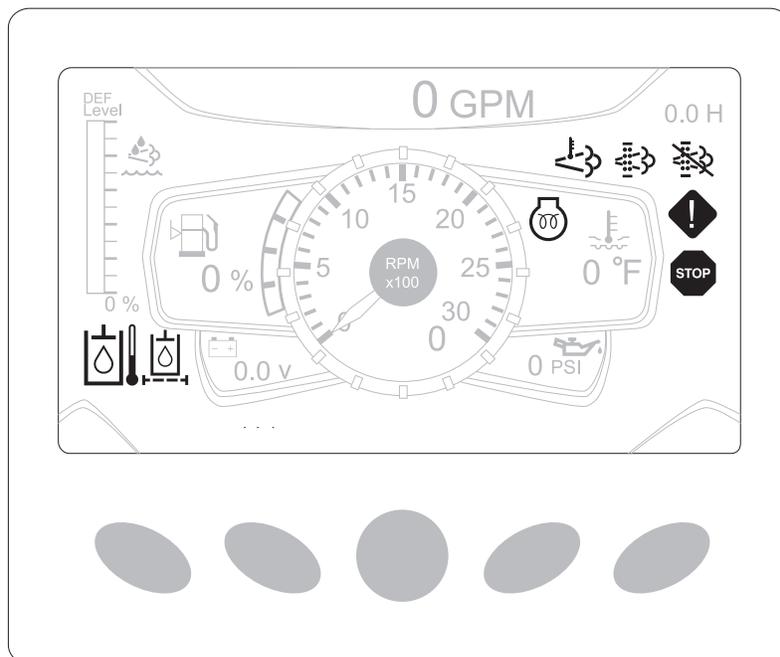
Main Menu



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

Item	Description	Notes
1. System settings key	Press to select system settings menu.	System settings menu displays information about the system, including exhaust cleaning options (under Tier 4 menu). Diagnostic information is only available to dealer technicians.
2. User settings key	Press to select user settings menu.	User settings menu allows user to change the language and unit settings, brightness settings for daylight and nighttime displays, and to set the time and date.
3. Main screen key	Press to return to main screen (gauges).	
4. Engine diagnostics key	Press to select engine diagnostics menu.	For dealer technician use only.
5. System operating info	Press to show combined system information screen.	For dealer technician use only.

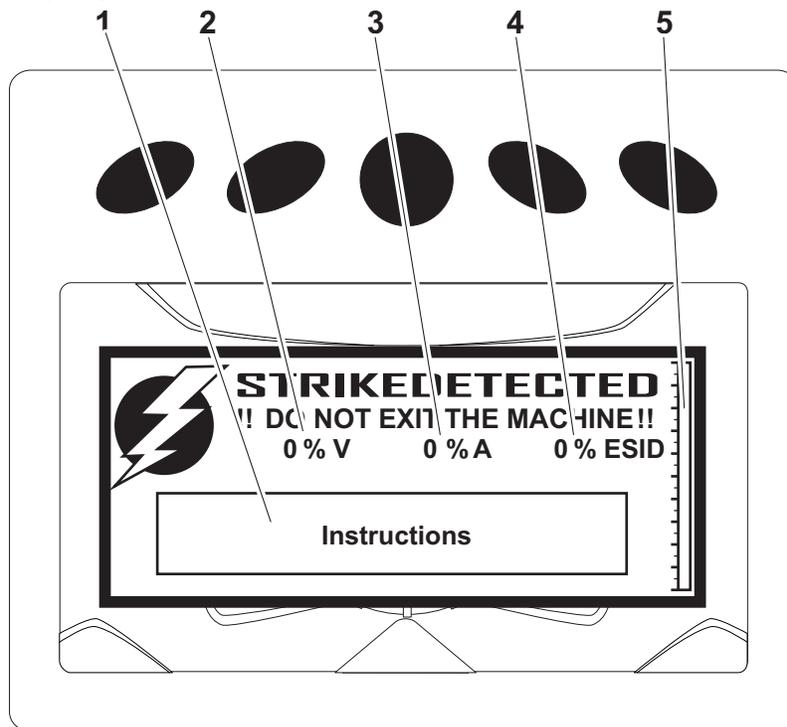
Status Indicators



Indicators

	Exhaust cleaning inhibited		High hydraulic temperature		Engine stop
	Exhaust cleaning		Hydraulic filter restriction		Engine caution
	High exhaust temperature		Wait-to-start lamp		

ESID Strike Display



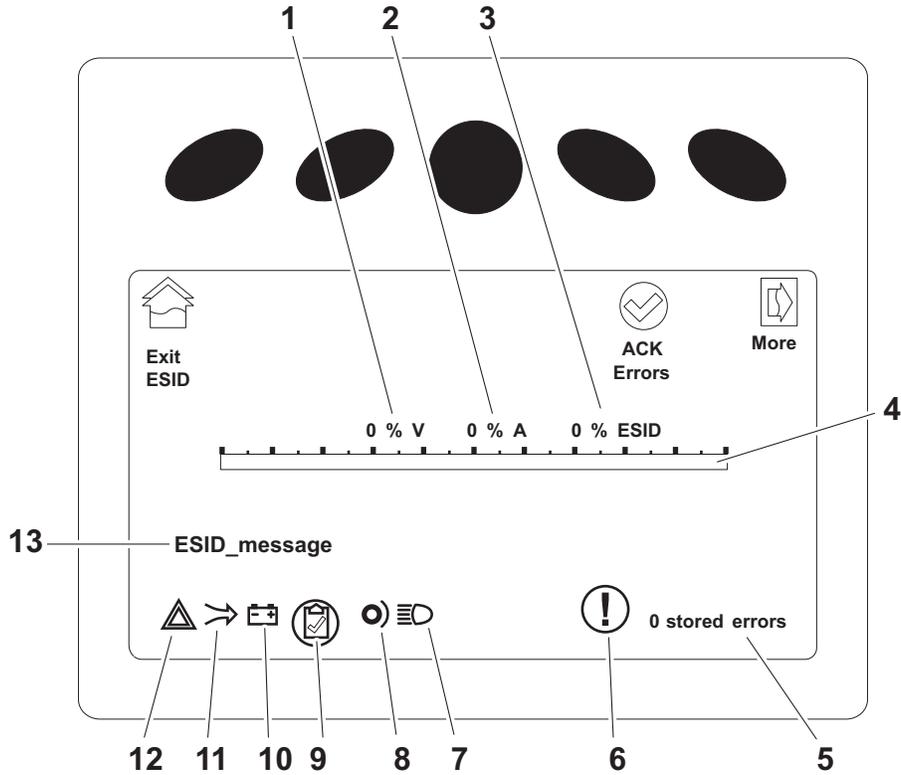
j40om013w.eps

- | | |
|------------------------|-----------------------------------|
| 1. Instruction display | 4. Strike condition |
| 2. Voltage indicator | 5. Percentage of strike indicator |
| 3. Current 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 135.

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.

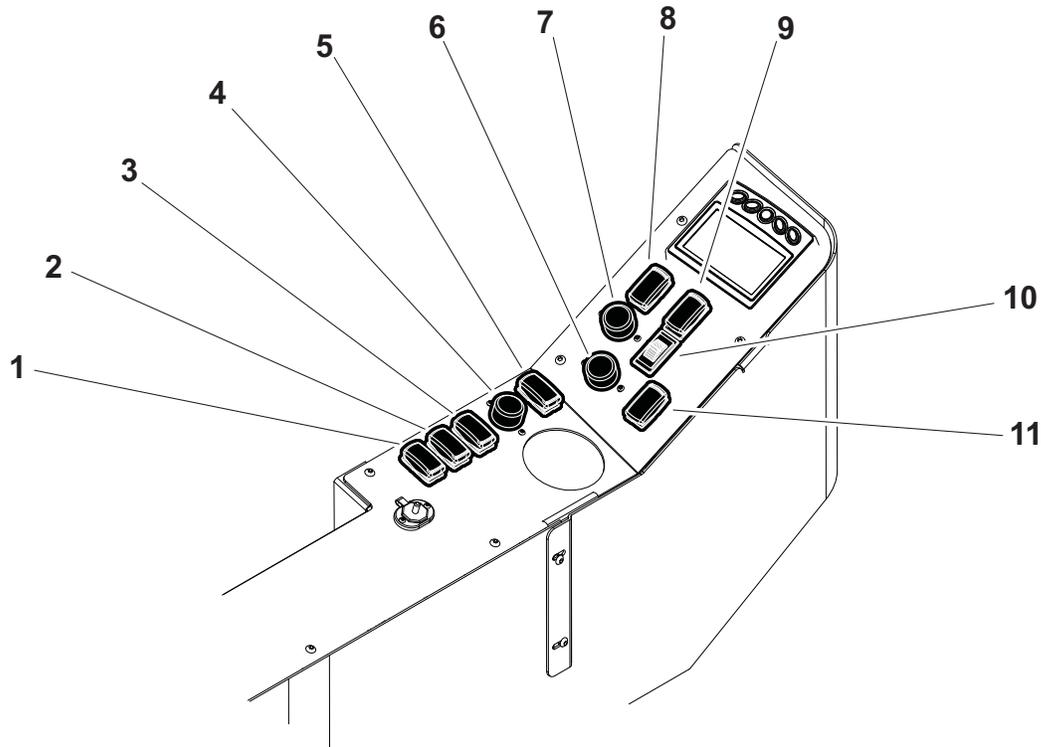
ESID Application Display



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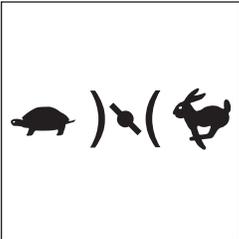
Item Description	Notes
1. Voltage % of strike threshold	
2. Amperage % of strike threshold	
3. Combined % of strike threshold	
4. Graphical display of electrical strike percentage	
5. ESID stored error count	
6. ESID error code indicator	
7. ESID strobe active indicator	
8. ESID horn active indicator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

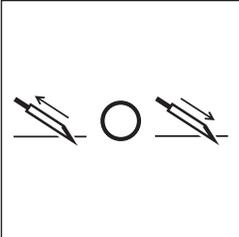
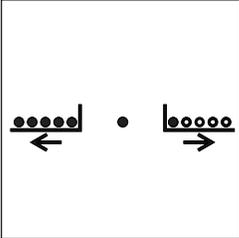
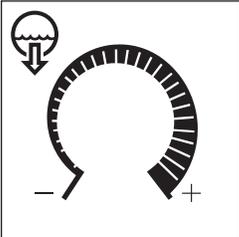
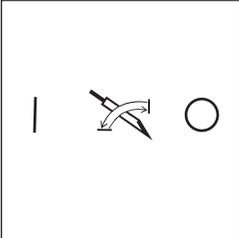
Drilling Controls

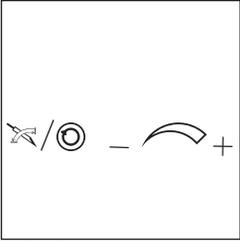
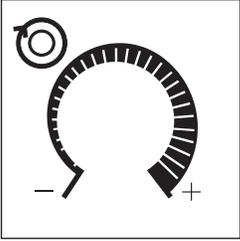
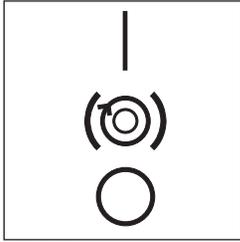
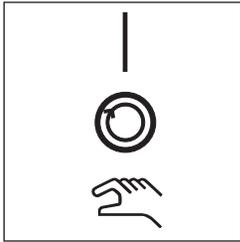


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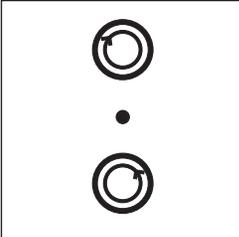
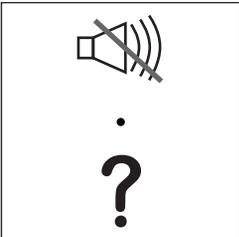
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|--|--|
| 1. Engine throttle switch | 7. Outer rotation speed control |
| 2. Add pipe/manual/remove pipe switch | 8. Spindle brake switch |
| 3. Pipe shuttle stop switch | 9. Inner spindle switch |
| 4. Drilling fluid flow control | 10. Manual inner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

Item	Description	Notes
<p>1. Engine throttle switch</p>  <p>c00ic059w.eps</p>	<p>To increase speed, press right.</p> <p>To decrease speed, press left.</p> <p>To further increase or decrease speed, press additional times.</p>	<p>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.</p>

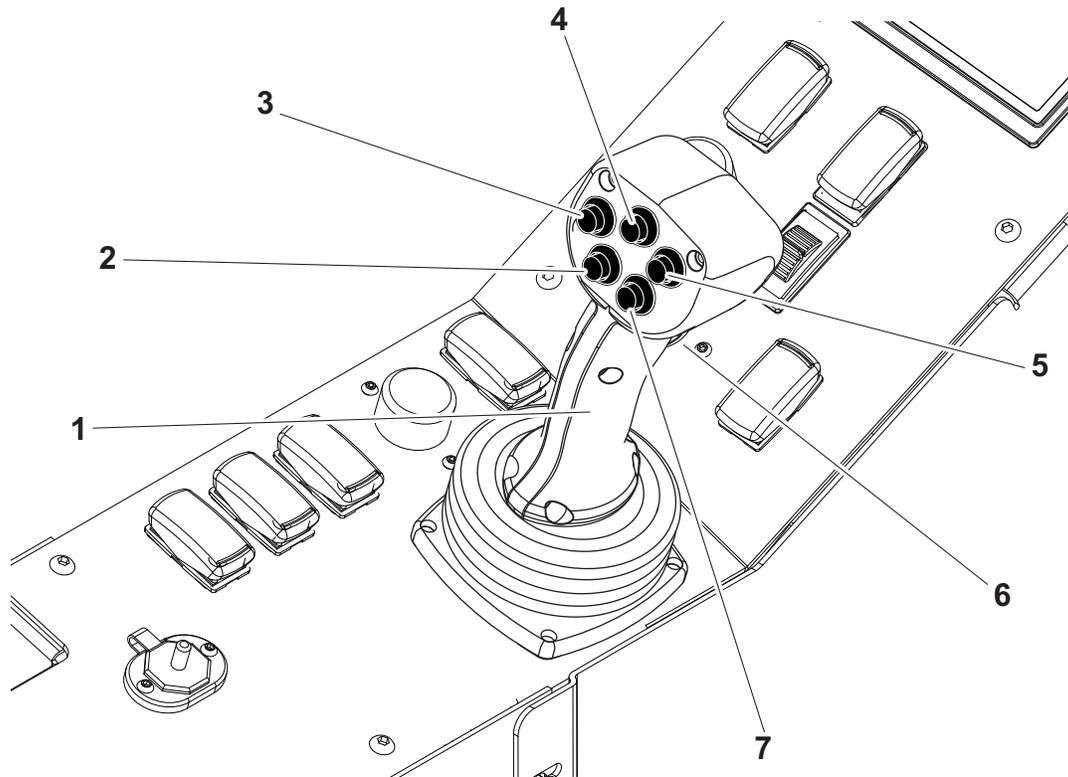
Item	Description	Notes
<p>2. Add pipe/manual/ remove pipe switch</p>  <p>c00ic058w.eps</p>	<p>To select "add pipe" automated pipeloader function, press right.</p> <p>To use manual pipeloader controls, move to center.</p> <p>To select "remove pipe" automated pipeloader function, press left.</p>	<p>See "Add Pipe" on page 116.</p> <p>See "Remove Pipe" on page 126.</p>
<p>3. Pipe shuttle stop switch</p>  <p>c00ic057w.eps</p>	<p>To lower shuttle stop, press right.</p> <p>To raise shuttle stop, press left.</p>	<p>IMPORTANT: Look at pipe row indicator on drill frame to see which row shuttles will stop under.</p>
<p>4. Drilling fluid flow control</p>  <p>c00ic056w.eps</p>	<p>To increase flow, turn clockwise.</p> <p>To decrease flow, turn counterclockwise.</p>	
<p>5. AutoCarve switch</p>  <p>c00ic055w.eps</p>	<p>To enable autocarve, press left.</p> <p>To deactivate autocarve, press right.</p>	<p>Two-speed thrust is not allowed in autocarve mode.</p>

Item	Description	Notes
<p>6. Carve window / inner rotation speed control</p>  <p>c00ic053w.eps</p>	<p>To increase, turn clockwise.</p> <p>To decrease, turn counterclockwise.</p>	<p>See "Use AutoCarve" on page 120.</p>
<p>7. Outer rotation speed control</p>  <p>c00ic052w.eps</p>	<p>To increase outer rotation maximum speed above 75 rpm, turn clockwise.</p> <p>To decrease outer rotation maximum speed toward 75 rpm, turn counterclockwise.</p>	<p>IMPORTANT: Unless outer rotation speeds greater than 75 rpm are needed, keep knob turned fully counterclockwise to maintain full torque.</p>
<p>8. Spindle brake switch</p>  <p>c00ic049w.eps</p>	<p>To engage, press top.</p> <p>To disengage, press bottom.</p>	<p>IMPORTANT: Use when steering in rock.</p>
<p>9. Inner spindle switch</p>  <p>c00ic050w.eps</p>	<p>To turn on, press top.</p> <p>To turn off, move to center.</p> <p>To manually dither, press bottom and control dither with the manual inner rotation switch.</p>	<p>IMPORTANT: To restart inner rotation after operator has left seat, turn inner rotation off and then on.</p>



Item	Description	Notes
<p>10. Manual inner rotation control</p>  <p>c00ic051w.eps</p>	<p>To rotate clockwise, move to top.</p> <p>To rotate counterclockwise, move to bottom.</p> <p>To stop inner rotation, release.</p>	<p>IMPORTANT:</p> <ul style="list-style-type: none"> • 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.
<p>11. ESID Alarm interrupt / self test button</p>  <p>c00ic054w.eps</p>	<p>To turn off strike alarm at drilling unit, press top.</p> <p>To start manual self test, press bottom.</p> <p>To reset system after a strike has been detected, press bottom.</p>	<p>Self test checks all systems and circuits except voltage limiter.</p> <p>IMPORTANT: See "If an Electric Line is Damaged" on page 14.</p>

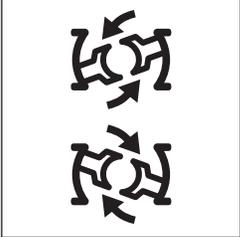
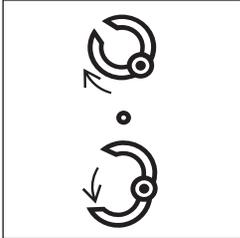
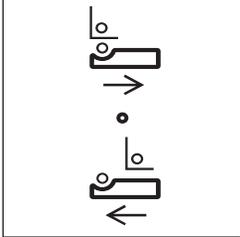
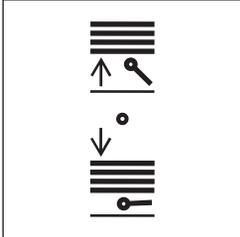
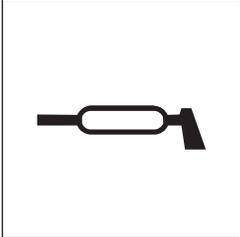
Wrench Control



j40om005w.eps

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

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

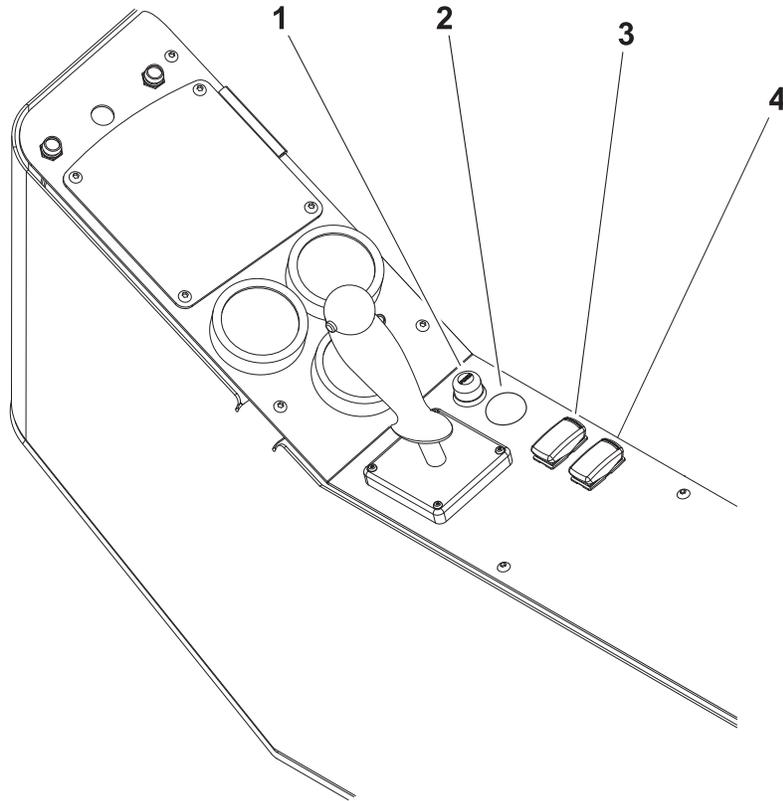
Item	Description	Notes
<p>2. Rear wrench rotation switch</p>  <p>c00ic038h.eps</p>	<p>To rotate counterclockwise, press top.</p> <p>To rotate clockwise, press bottom.</p> <p>To stop rotation, release.</p>	
<p>3. Pipe gripper switch</p>  <p>c00ic613h.eps</p>	<p>To close, press top.</p> <p>To open, press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

Item	Description	Notes
<p>7. Set/Resume switch</p> <div data-bbox="254 312 493 554" style="border: 1px solid black; padding: 10px; text-align: center;"><p>RES/+</p><p>•</p><p>SET/—</p></div> <p><small>c00ic631h.eps</small></p>	<p>To resume operation or increase operation levels, press top.</p> <p>To set operating conditions or reduce operation levels, press bottom.</p>	<p>See "Wireless Ground Drive Controller" on page 166.</p> <p>See "Use AutoCarve" on page 120.</p>



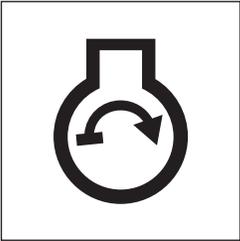
Right Control Console

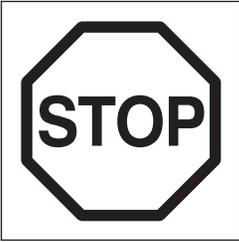
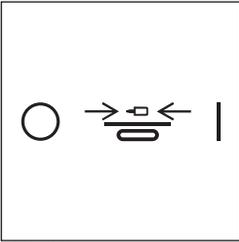
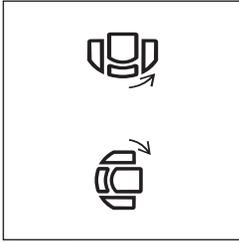
Operation Controls



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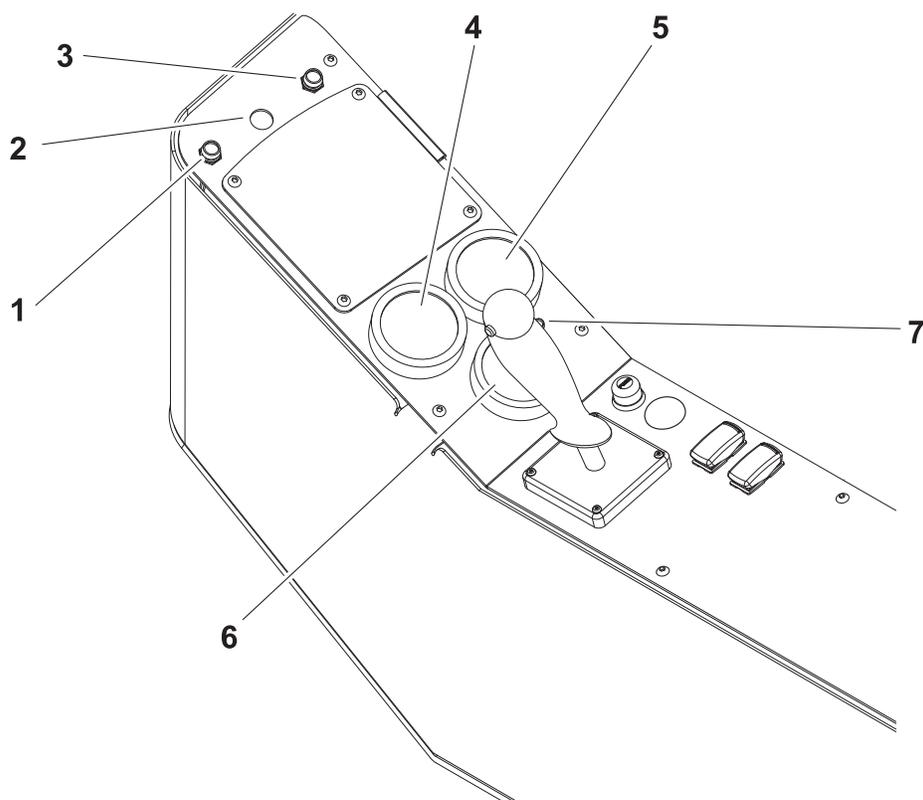
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|-------------------------------|-----------------------------|
| 1. Remote engine start switch | 3. Transport mode switch |
| 2. Remote engine stop switch | 4. Cab pivot control switch |

Item	Description	Notes
<p>1. Remote engine start switch</p>  <p>c00ic152h.eps</p>	<p>To start engine from operator's station, push button.</p> <p>Release when engine starts.</p>	<p>IMPORTANT: This button works only when key in set-up console is on, operator is in seat, and battery disconnect switch is closed.</p>

Item	Description	Notes
<p>2. Remote engine stop switch</p>  <p>c00ic062h.eps</p>	<p>To stop engine, press.</p> <p>To restart engine, press remote engine start switch (page 40).</p>	<p>IMPORTANT:</p> <ul style="list-style-type: none"> If this switch is used to stop drilling unit, be sure to turn ignition switch off if machine will be left unattended for long periods of time. Battery discharge can occur. If wrenches are engaged when remote stop is pressed, wrenches will remain engaged but could gradually open.
<p>3. Transport mode switch</p>  <p>c00ic736h.eps</p>	<p>To enter transport mode and see instructions in the display, press right.</p> <p>To exit transport mode, press left.</p>	<p>IMPORTANT: During transport follow on-screen instructions.</p>
<p>4. Cab pivot control switch</p>  <p>c00ic624h.eps</p>	<p>To move cab into drilling position, press </p> <p>To move cab into driving position, press </p>	<p>IMPORTANT: Lift the yellow cab latch handle behind the operators fee to swing the cab out to drill position.</p>

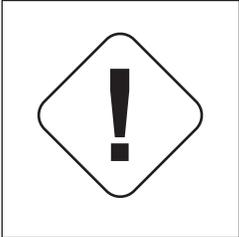
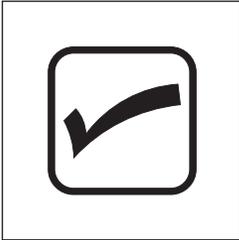
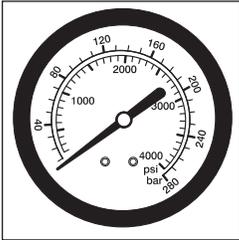


Gauges and Indicators

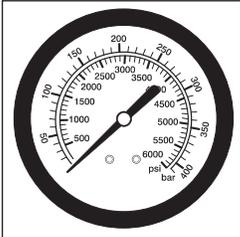
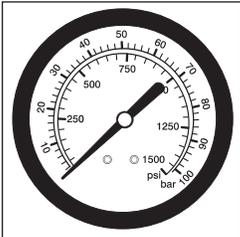


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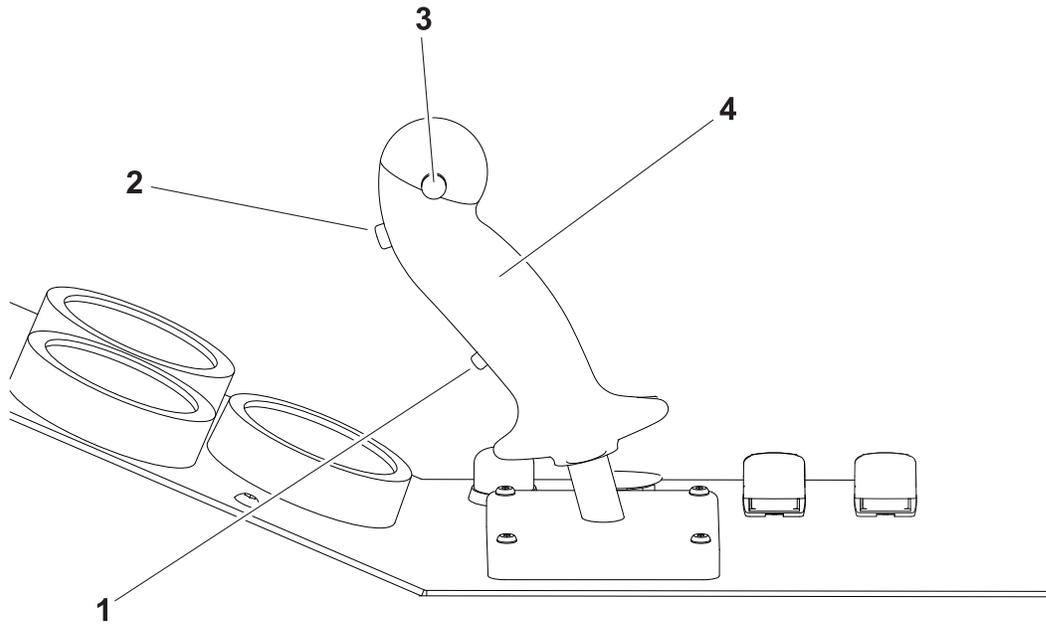
- | | |
|------------------------------------|---|
| 1. Diagnostic indicator (red) | 5. Rotation pressure gauge |
| 2. EDT Port | 6. Drilling fluid pressure gauge |
| 3. Control cycle indicator (green) | 7. Drilling fluid pump status indicator (red) |
| 4. Thrust pressure gauge | |

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



Item	Description	Notes
<p>5. Rotation pressure gauge</p>  <p>c00ic049h.eps</p>	<p>Displays hydraulic fluid pressure to rotation motor when spindle is turned clockwise.</p>	<p>Inner rotation pressure is displayed when inner rotation is on and front wrench is open.</p> <p>Outer rotation pressure is displayed when front wrench is closed and during backreaming.</p>
<p>6. Drilling fluid pressure gauge</p>  <p>c00ic048h.eps</p>	<p>Displays drilling fluid pressure in the drilling fluid hard line.</p>	<p>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.</p>
<p>7. Drilling fluid pump status indicator (red)</p>	<p>Lights when pump is on.</p>	

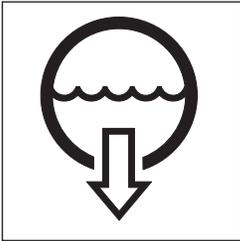
Drill/Drive Control

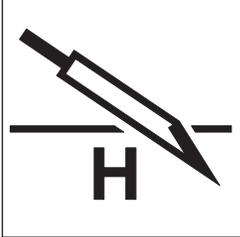
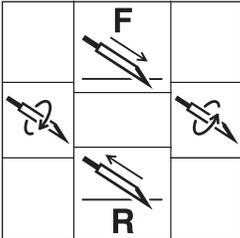


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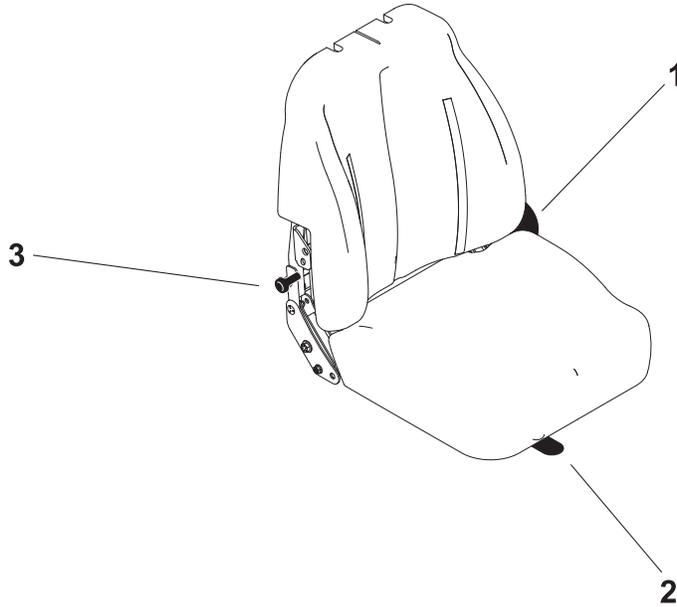
- | | |
|---|-------------------------------------|
| 1. Drilling fluid pump switch | 3. Drilling fluid quick fill switch |
| 2. Dual speed carriage/Two-speed ground drive control | 4. Track and carriage control |



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

Item	Description	Notes
<p>2. Dual speed carriage/ Two-speed ground drive control</p>  <p><small>c00ic058h.eps</small></p>	<p>Carriage travel speed:</p> <ul style="list-style-type: none"> To increase, push and hold. To return to normal carriage speed, release. <p>Ground drive speed:</p> <ul style="list-style-type: none"> For high ground drive speed, push once. To return to low ground drive speed, push once. 	<p>Use during bore or pullback when no pipe is in spindle to save time.</p> <p>IMPORTANT: Drill/Park/Drive switch must be in drill position.</p> <p>Use when driving straight.</p> <p>IMPORTANT: Drill/Park/Drive switch must be in drive position.</p> <p>Unit will be in low speed each time unit is started.</p>
<p>3. Drilling fluid quick fill switch</p>  <p><small>c00ic059h.eps</small></p>	<p>For full pump flow to fill pipe with fluid, press and hold.</p> <p>To return fluid flow to flow control setting, release.</p>	
<p>4. Carriage control</p>  <p><small>c00ic061h.eps</small></p>	<p>Carriage control:</p> <ul style="list-style-type: none"> To move carriage forward, push. To move carriage backward, pull. To rotate spindle counterclockwise (breakout), move right. To rotate spindle clockwise (makeup), move left. 	<p>IMPORTANT: Drill/Park/Drive switch must be in drill position. See "Operate Carriage Control" on page 109 for more information.</p>

Seat



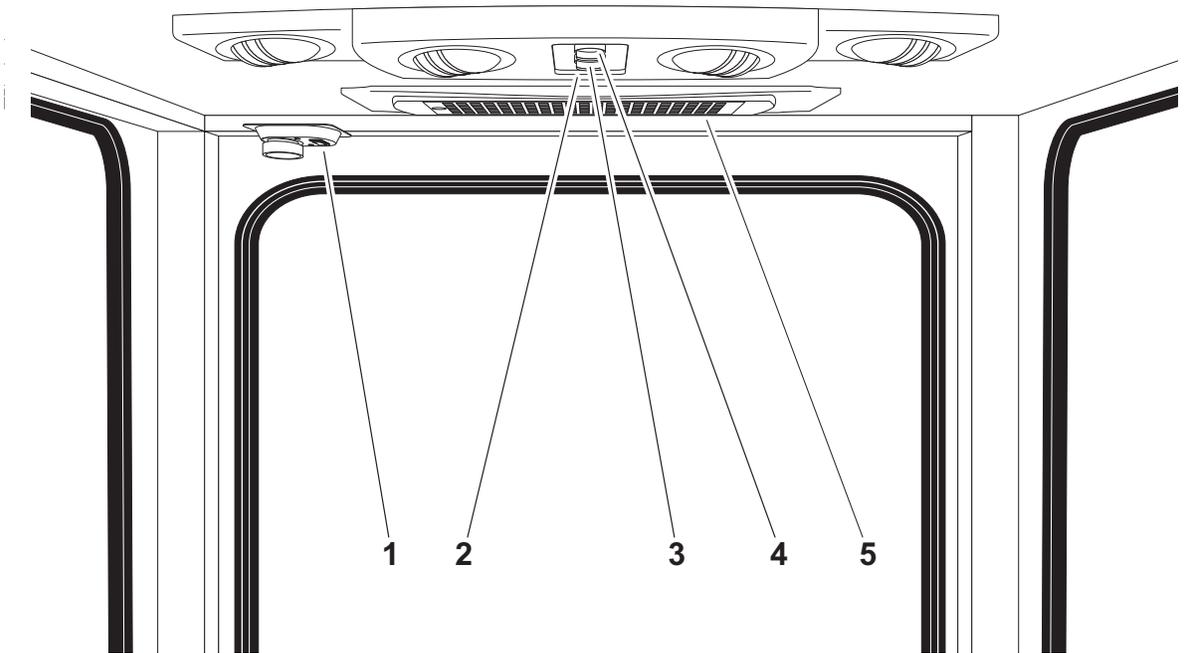
- 1. Seat recline control
- 2. Seat slide control
- 3. Seat lumbar control

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.	

Cab Controls

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

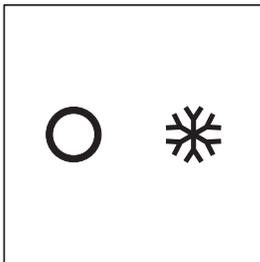
Top/Rear



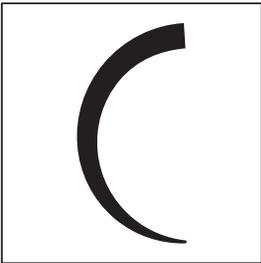
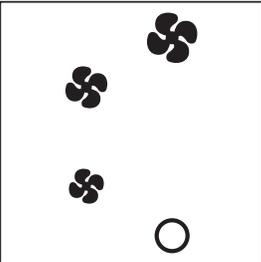
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|---|--|
| <ul style="list-style-type: none"> 1. Dome light switch 2. Air conditioner on/off switch 3. Air conditioner temperature dial | <ul style="list-style-type: none"> 4. Air conditioner fan speed dial 5. Air conditioner filter |
|---|--|

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

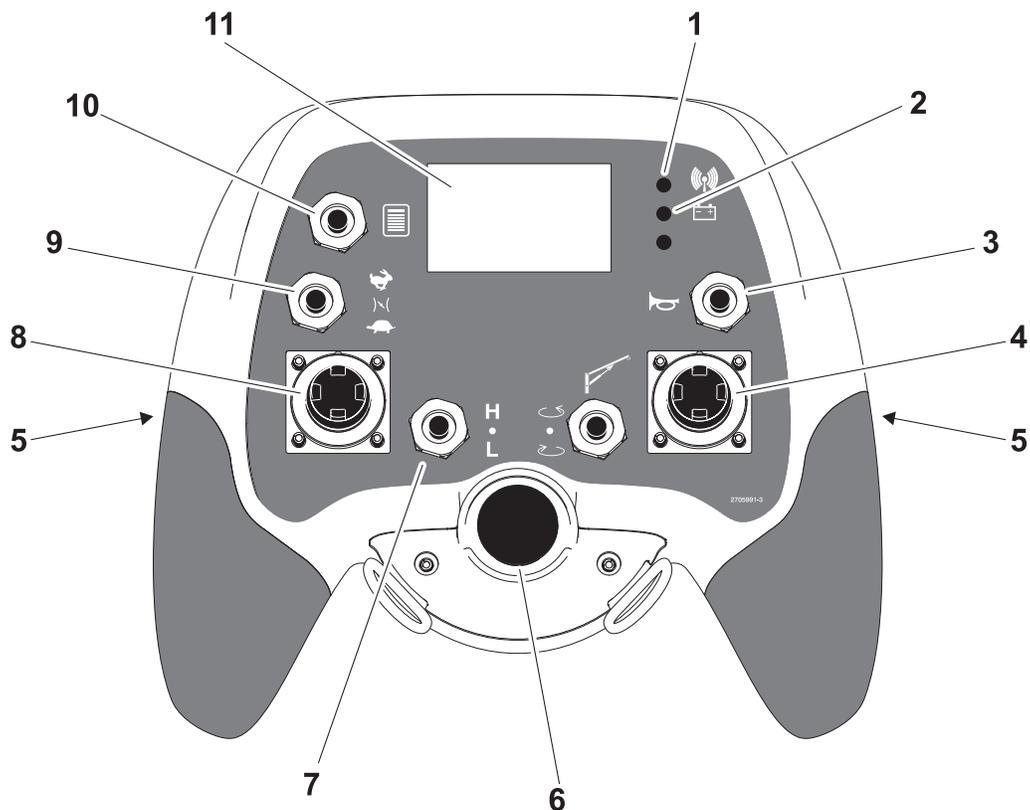


c00ic157a.eps

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



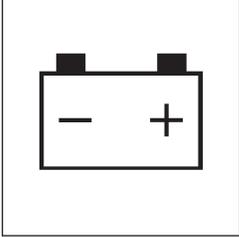
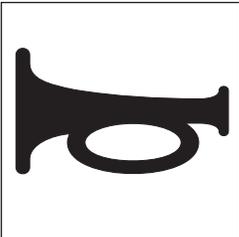
Wireless Ground Drive Controller



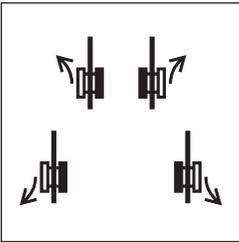
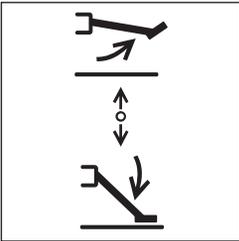
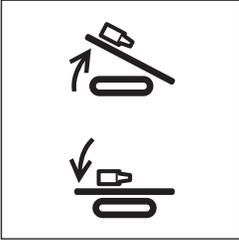
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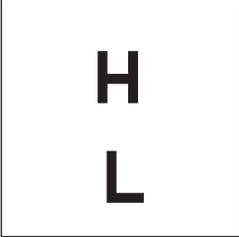
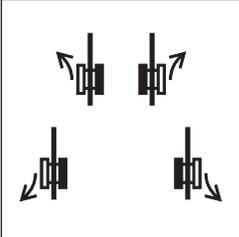
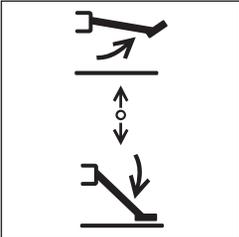
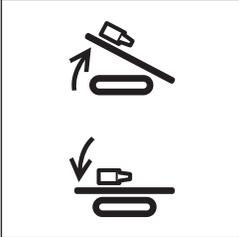
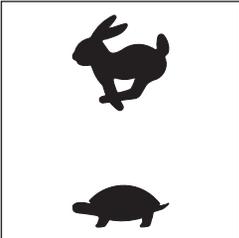
- | | |
|---------------------------------|---------------------------|
| 1. Communication link indicator | 7. Drive mode switch |
| 2. Power status indicator | 8. Multifunction joystick |
| 3. Power/start/horn switch | 9. Throttle switch |
| 4. Multifunction joystick | 10. Menu select switch |
| 5. Operator presence switches | 11. LCD display |
| 6. Engine stop | |

IMPORTANT: Operator station must be empty to operate wireless ground drive control.

Item	Description	Notes
<p>1. Communication link indicator</p>  <p>c00ic713h.eps</p>	<p>Indicates the status of the transmitter and receiver link.</p> <ul style="list-style-type: none"> • Blinking yellow indicates no communication link. • Blinking green indicates good communication link. • Steady red indicates an internal problem. Contact your Ditch Witch® dealer. 	<p>An active communication link is required for wireless control.</p>
<p>2. Power status indicator</p>  <p>c00ic008w.eps</p>	<p>Indicates battery status and cable connection.</p> <ul style="list-style-type: none"> • Off indicates good battery level. • Blinking red indicates low battery level. • Solid green indicates transmitter is connected to machine. 	
<p>3. Power/start/horn switch</p>  <p>c00ic044h.eps</p>	<p>To turn power on, hold switch up until yellow LED indicator comes on and then blinks green. Release switch. Wireless remote control light (page 4) will shine.</p> <p>To start operation, hold switch up with speed/direction control in neutral position until horn sounds. Release switch.</p> <p>To use horn, move switch up. Release switch to stop horn.</p> <p>To turn power off, hold switch down until LED indicators go off.</p>	<ul style="list-style-type: none"> • Transmitter shuts off and yellow LED indicator blinks after 1 minute of inactivity. Hold switch up twice to restart. • Must be pushed to initialize the transmitter each time the menu selection changes.



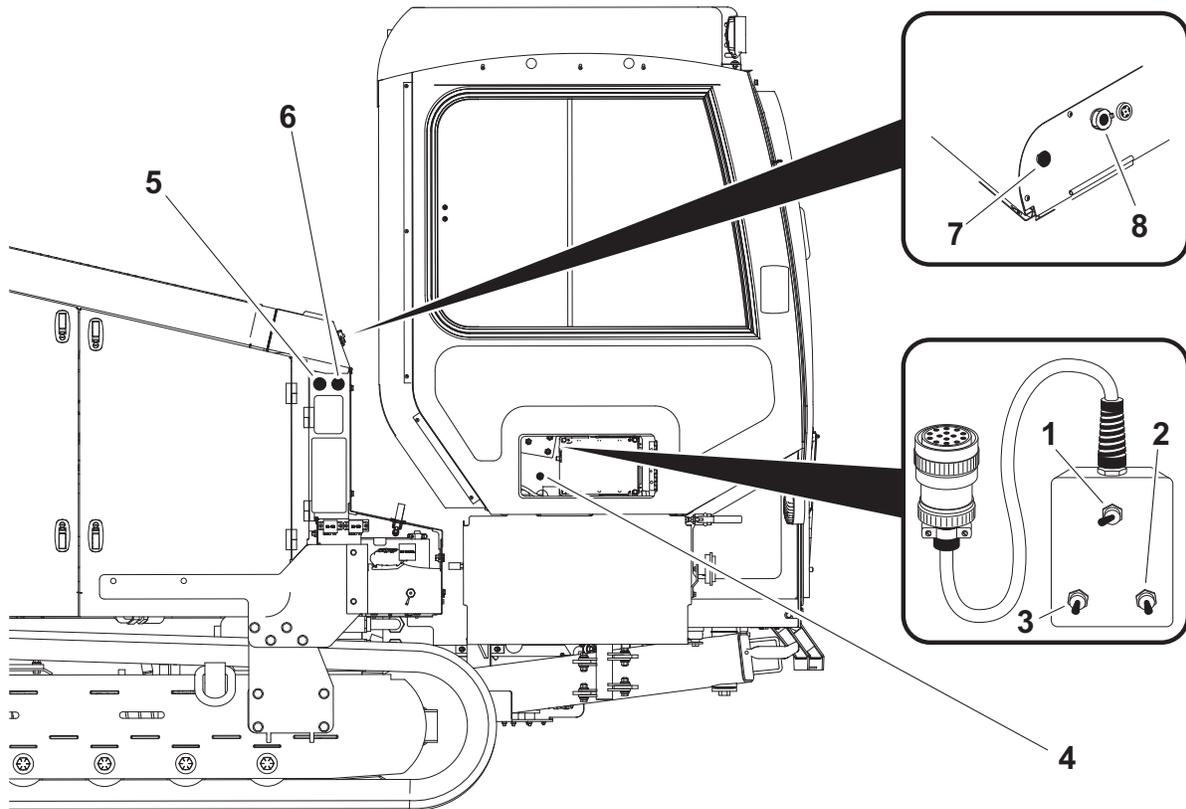
Item	Description	Notes
<p>4. Multifunction joystick</p>  <p>c00ic145h.eps</p>  <p>c00ic029h.eps</p>  <p>c00ic027h.eps</p>	<p>Single joystick ground drive:</p> <p>To move forward, move up.</p> <p>To move backward, move down.</p> <p>To steer, move left or right while moving forward or backward.</p> <p>Dual joystick ground drive:</p> <p>To move right track forward, move lever forward.</p> <p>To move right track backward, move lever back.</p> <p>Right stabilizer control:</p> <p>To raise, push up.</p> <p>To lower, pull down.</p> <p>Back drill frame tilt</p> <p>To raise, push up.</p> <p>To lower, push down.</p>	<ul style="list-style-type: none"> Operator presence switch must be pressed and operator seat must be empty for control to work. See "Steer Unit" on page 90 for more information. <p>IMPORTANT: Lower left and right stabilizers to the ground together, then adjust individually.</p> <p>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.</p>
<p>5. Operator presence switches</p>	<p>To operate wireless controller, press one or both switches.</p> <p>To disable controller, release.</p>	
<p>6. Engine stop</p>	<p>To stop engine, press red button.</p>	<p>IMPORTANT: To restart engine, turn ignition switch off and then back on.</p>

Item	Description	Notes
<p>7. Drive mode switch</p>  <p>c00ic146h.eps</p>	<p>To select normal driving mode (high), move up.</p> <p>To select loading and unloading mode (low), move down.</p>	
<p>8. Multifunction joystick</p>  <p>c00ic145h.eps</p>  <p>c00ic029h.eps</p>  <p>c00ic027h.eps</p>	<p>Dual joystick ground drive:</p> <p>To move left track forward, move lever forward.</p> <p>To move left track backward, move lever back.</p> <p>Left stabilizer control:</p> <p>To raise, push up.</p> <p>To lower, pull down.</p> <p>Front drill frame tilt</p> <p>To raise, push up.</p> <p>To lower, push down.</p>	<ul style="list-style-type: none"> Operator presence switch must be pressed and operator seat must be empty for control to work. See "Steer Unit" on page 90 for more information. <p>IMPORTANT: Lower left and right stabilizers to the ground together, then adjust individually.</p> <p>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.</p>
<p>9. Throttle switch</p>  <p>c00ic042h.eps</p>	<p>To increase engine speed, move up.</p> <p>To decrease engine speed, move down.</p> <p>Release switch to stop speed adjustment.</p>	<p>IMPORTANT: Switch only works when controller is in the ready mode (green LED blinking) and at least one operator presence switch is pressed.</p>



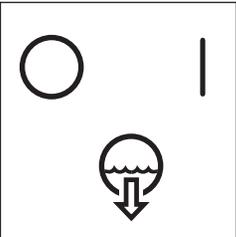
Item	Description	Notes
10. Menu select switch	To move up through the modes on the transmitter move up. To move down through the modes on the transmitter move down. Release switch to stop moving through modes.	Menu display order: <ul style="list-style-type: none">• Dual joystick ground drive• Single joystick ground drive• Stabilizers up/down• Drill frame tilt front/back
11. LCD display	Indicate the selected mode of operation.	

Override Box

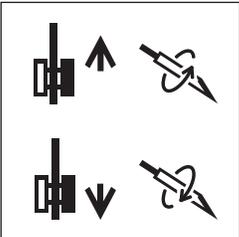
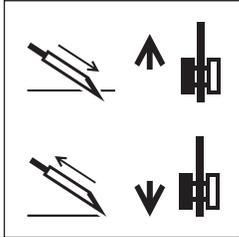
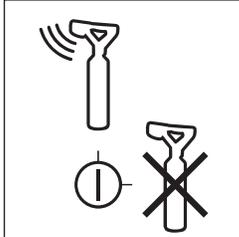
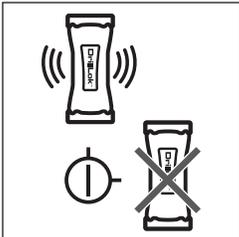


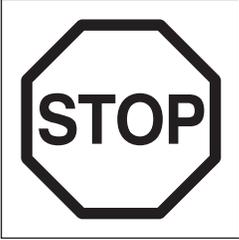
j52om065h.eps

- | | |
|--|--------------------------------------|
| 1. Drilling fluid flow override switch | 5. Drive override port |
| 2. Rotation or right track override switch | 6. Drill override port |
| 3. Thrust/pullback or left track override switch | 7. Remote engine stop switch |
| 4. DrillLok® key | 8. J1939 CAN diagnostic port, engine |

Item	Description	Notes
1. Drilling fluid flow override switch 	To turn fluid on, move right. To turn fluid off, move left.	Connect to drill connector (B) to control fluid flow.

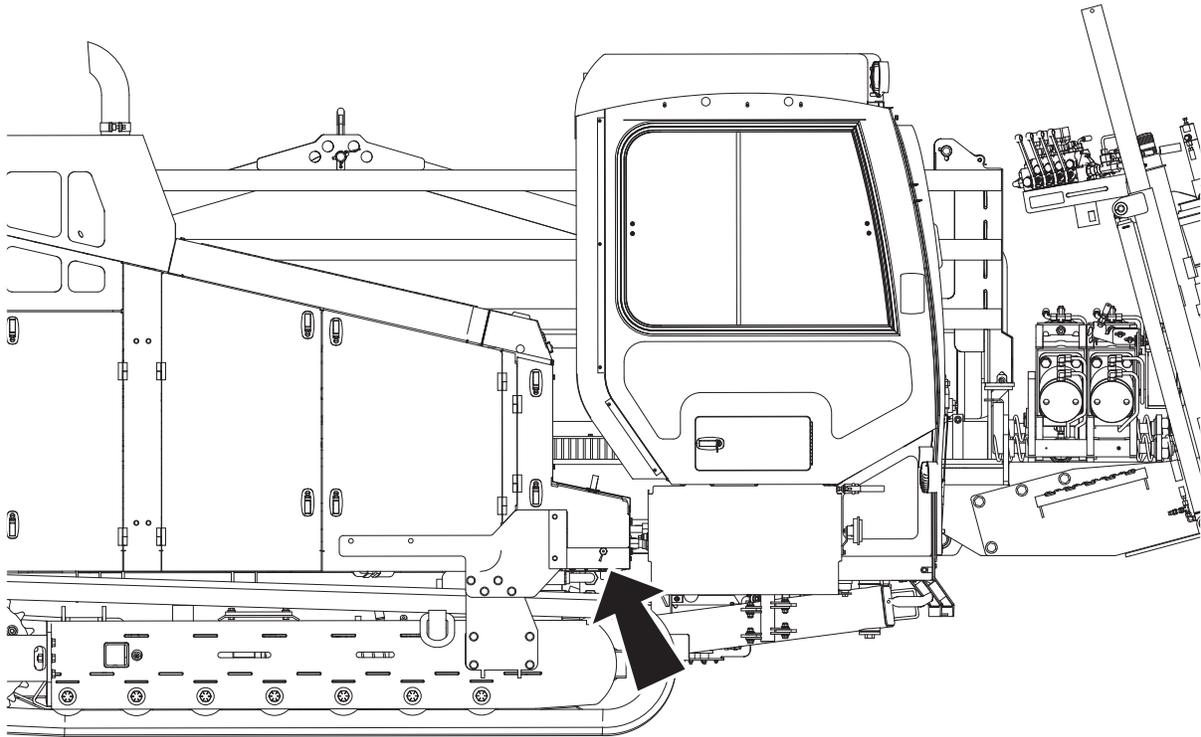
c00ic068h.eps

Item	Description	Notes
<p>2. Rotation or right track override switch</p>  <p>c00ic070h.eps</p>	<p>For counterclockwise rotation or to move track forward, move up.</p> <p>For clockwise rotation or to move track backward, move down.</p>	<p>Connect to drill connector (B) to control rotation.</p> <p>Connect to drive connector (A) to control right track.</p> <p>IMPORTANT: When connected to connector (A), drill fluid switch functions as an operator presence switch.</p>
<p>3. Thrust/pullback or left track override switch</p>  <p>c00ic069h.eps</p>	<p>For thrust or to move track forward, move up.</p> <p>For pullback or to move track backward, move down.</p>	<p>Connect to drill connector (B) to control thrust/pullback.</p> <p>Connect to drive connector (A) to control left track.</p> <p>IMPORTANT: When connected to connector (A), drill fluid switch functions as an operator presence switch.</p>
<p>4. DrillLok® key</p>  <p>c00ic063h.eps</p>  <p>c00ic122w.eps</p>	<p>To allow tracker operator to stop thrust and rotation, move key to enable position (up).</p> <p>To override DrillLok mode, move key to override position (right).</p>	<p>IMPORTANT: Remove key and keep in tracker operator's possession.</p> <ul style="list-style-type: none"> • Top icon is shown when operating with Subsite® Electronics tracker. • Bottom icon is shown when operating without Subsite Electronics tracker.
<p>5. Drive override port</p>	<p>Connect tether to this port to override drive functions.</p>	
<p>6. Drill override port</p>	<p>Connect tether to this port to override drill functions.</p>	

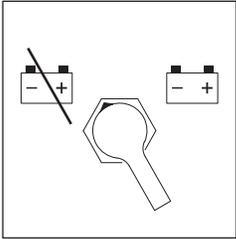
Item	Description	Notes
<p>7. Remote engine stop switch</p>  <p><small>c00ic062h.eps</small></p>	<p>To stop engine, press.</p> <p>To restart engine, press remote engine start switch (page 40).</p>	<p>IMPORTANT:</p> <ul style="list-style-type: none"> • If this switch is used to stop drilling unit, be sure to turn ignition switch off if machine will be left unattended for long periods of time. Battery discharge can occur. • If wrenches are engaged when remote stop is pressed, wrenches will remain engaged but could gradually open.
<p>8. J1939 CAN diagnostic port, engine</p>	<p>For use only by qualified Ditch Witch® technicians.</p>	



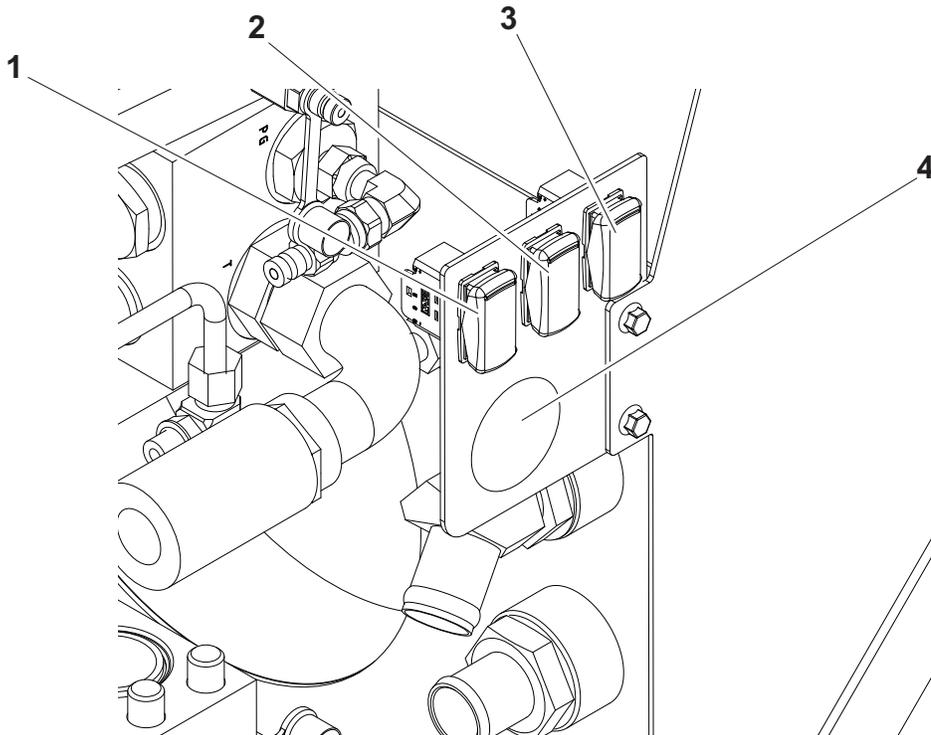
Battery Disconnect



j52om062h.eps

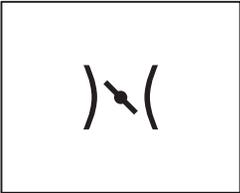
Item	Description	Notes
<p data-bbox="204 1182 493 1241">1. Battery disconnect switch</p>  <p data-bbox="256 1486 362 1503">c00ic097h.eps</p>	<p data-bbox="586 1182 914 1241">To connect, move switch so that indicator points right.</p> <p data-bbox="586 1276 914 1335">To disconnect, move switch so that indicator points left.</p>	<p data-bbox="969 1182 1386 1241">Use when servicing unit and during long-term storage.</p> <p data-bbox="969 1276 1409 1398">IMPORTANT: Wait 2 minutes before switching after turning off engine. Engine ECU has to shut down before power is disconnected.</p>

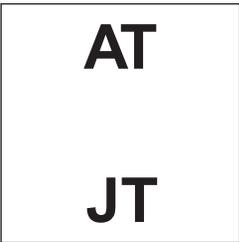
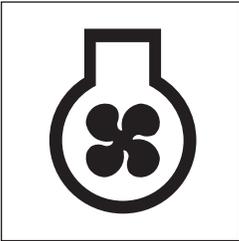
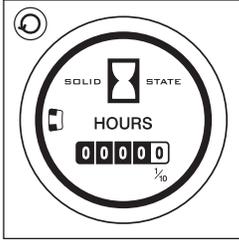
Engine Compartment



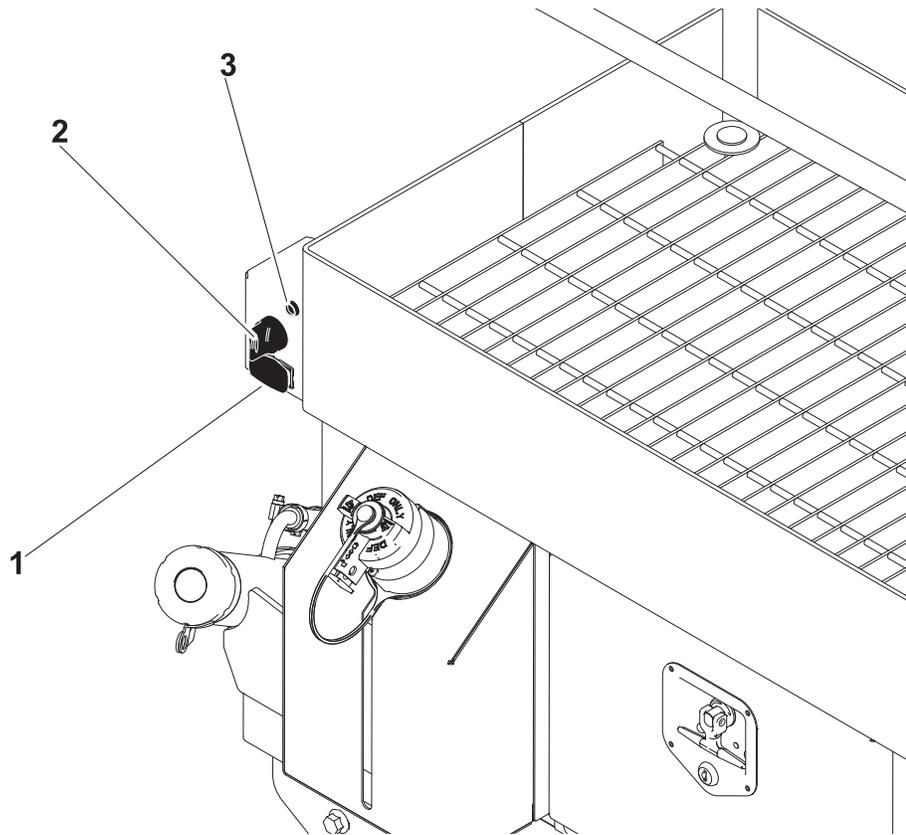
j40om009w.eps

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

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

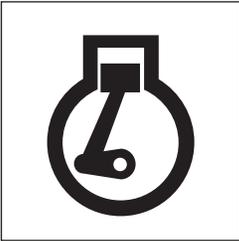
Item	Description	Notes
<p>2. Drill mode switch</p>  <p>c00ic468h.eps</p>	<p>To select AT Rock mode, press top.</p> <p>To select AT Dirt mode, move to middle.</p> <p>To select JT mode, press bottom.</p>	<p>Use AT Rock mode when using AT pipe with inner rod and rock drilling bits.</p> <p>Use AT Dirt mode when using AT pipe with inner rod and adapter to use dirt tool head.</p> <p>Use JT drilling mode when using JT pipe without inner rod.</p> <p>IMPORTANT: See “Prepare Drilling Unit” on page 90 for how to set up unit for each drilling mode.</p>
<p>3. Fan speed switch</p>  <p>c00ic063w.eps</p>	<p>For high speed, press top.</p> <p>For automatic speed, press bottom.</p>	<p>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.</p>
<p>4. Inner rotation hour meter</p>  <p>c00ic090h.eps</p>	<p>Displays inner rotation operating time.</p>	<p>Use these times to schedule service for downhole tool and inner shaft. See “Service” on page 189.</p>

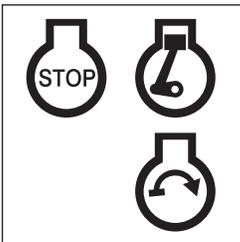
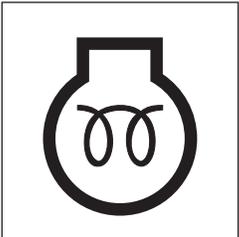
Rear Console



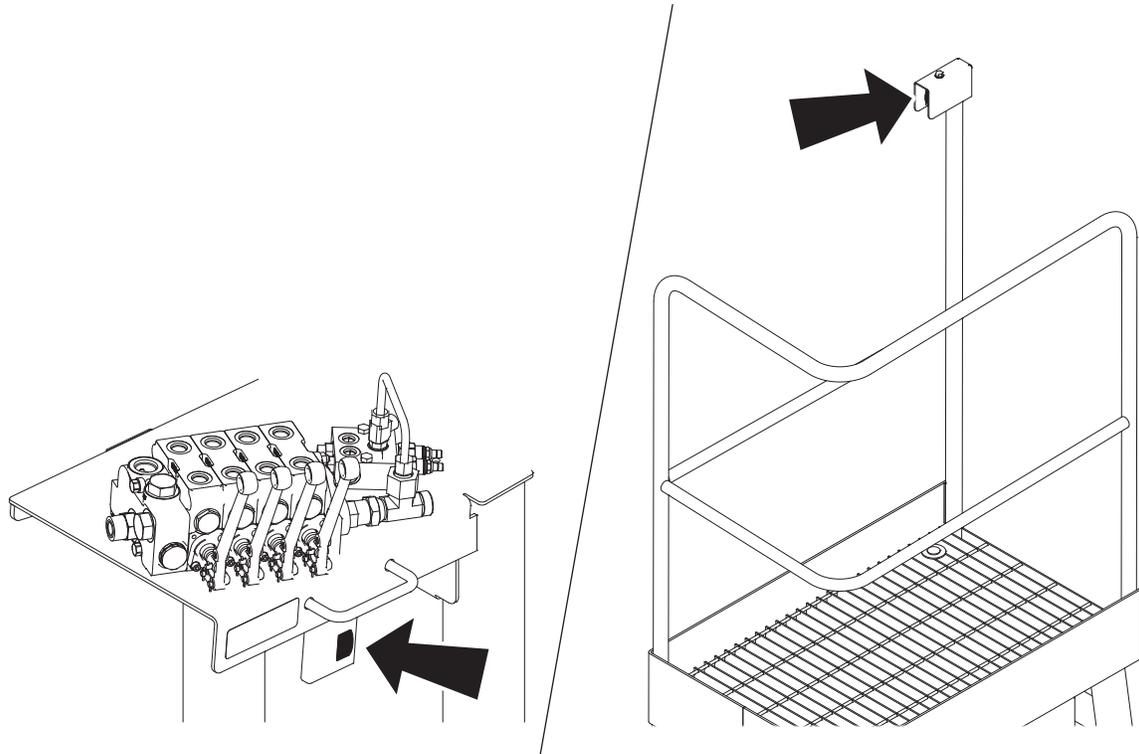
j52om066h.eps

- 1. Engine shutdown override switch
- 2. Ignition Switch
- 3. Cold start wait indicator

Item	Description	Notes
<p>1. Engine shutdown override switch</p>  <p>c00ic178h.eps</p>	<p>If engine shutdown indicator comes on, press to delay engine shutdown for 30 seconds.</p>	<p>This control allows a temporary override of engine shutdown.</p> <p>NOTICE: After 30 seconds, engine will again shut down unless fault condition has been corrected.</p> <p>IMPORTANT: See “Electronic Controlled Engine Overview” on page 173.</p>

Item	Description	Notes
<p>2. Ignition switch</p>  <p>c00ic065h.eps</p>	<p>To start engine, insert key and turn clockwise.</p> <p>To stop engine, turn key counterclockwise.</p>	
<p>3. Cold start wait indicator</p>  <p>c00ic180h.eps</p>	<p>Lights when intake air pre-heater is operating.</p>	<p>NOTICE: If indicator is on, wait until it goes out before starting engine.</p>

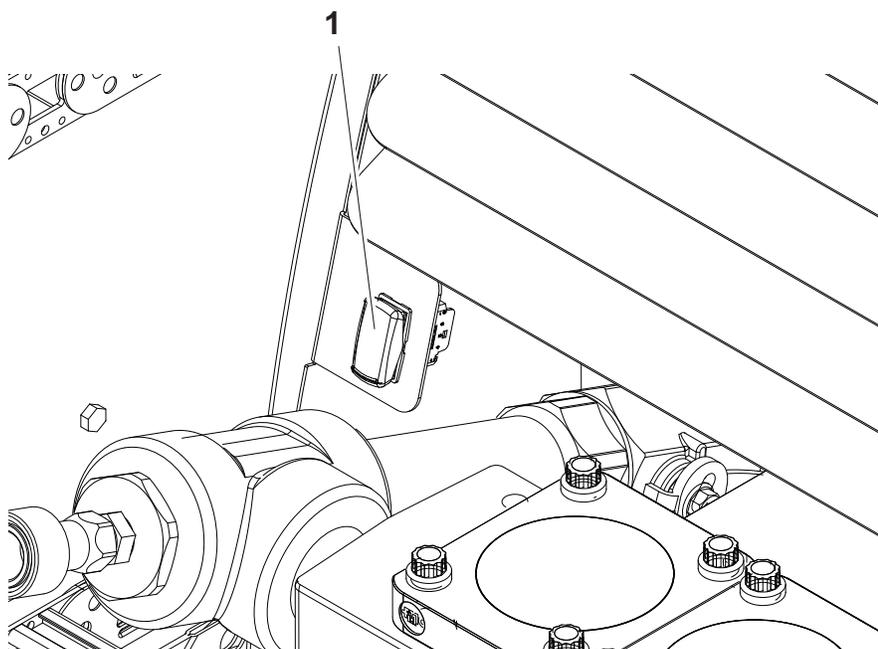
Wireline Controls



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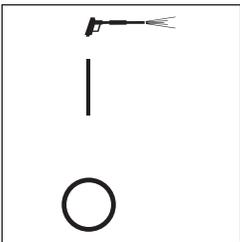
Item	Description	Notes
<p>Wireline restricted operating mode switch</p>  <p>c00ic133w.eps</p>	<p>To slow rotation and thrust, press top.</p> <p>To allow normal rotation and thrust, press bottom.</p>	<p>Used when adding pipe and when making wireline connections.</p> <p>A display indicator is shown in the Engine Display when the wireline restricted operating mode is on.</p>

Miscellaneous Controls



j40m010w.eps

1. Pressure wand on/off switch

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

Operation Overview

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Drilling	67
Backreaming	68
Leaving Jobsite	68
Storing Equipment	68



Planning

1. Gather information about jobsite. See page 71.
2. Inspect jobsite. See page 72.
3. Classify jobsite. See page 74.
4. Plan bore path. See page 77.
5. Select drilling mode based on jobsite conditions. See page 89.
6. Check supplies and prepare equipment. See page 87.
7. Load equipment. See page 101.

Setting Up at Jobsite

1. Prepare jobsite. See page 86.
2. Unload drilling unit from trailer. See page 103.
3. Assemble drill string. See page 111.
4. Position drilling unit and frame. See page 107.
5. Assemble strike system. See page 135.
6. Anchor drilling unit. See page 131.
7. Connect fluid system. See page 107.
8. Calibrate tracker with beacon that will be installed in beacon housing. See tracker operator's manual.

Drilling

1. Start system. See page 108.
2. Engage DrillLok[®] if desired. See page 146.
3. Drill first pipe. See page 114.
 - JT mode
 - AT dirt mode
 - AT mode
4. Swab the hole to remove cuttings (AT mode only). See page 115.
5. Record bore path. See page 122.
6. Add pipe. See page 116.
7. Drill remaining pipes in pipe box.
 - Correct direction. See page 118.
 - Engage cruise control. See page 169.
8. Remove empty pipe box and add full box (see page 160) or add up to a single row of drill pipe to empty box (see page 161) to complete bore.
9. Surface drill head. See page 123.
 - Remove drill head.
 - Grease downhole tool (AT mode).



Backreaming

1. Assemble backream string. See page 124.
2. Start drilling unit and adjust throttle.
3. Set drilling fluid flow. Check that fluid flows through all nozzles. See page 147.
4. Remove pipe from bore. See page 126.
5. Remove full pipe box and add empty box (see page 159) or remove up to a single row of drill pipe from full box (see page 161) to complete backream.
6. Remove pullback device. See page 128.

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 133.
3. Rinse unit and downhole tools. See page 186.
4. Disassemble strike system and disconnect from fluid system. See page 135.
5. Stow tools. See page 187.
6. Load unit onto trailer. See page 101.

Storing Equipment

1. For cold weather storage, antifreeze drilling unit. See page 184.
2. For long-term storage, disconnect battery disconnect switch.

Prepare

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- Arrange for Traffic Control.....71
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- Prepare Drilling Unit90
- Assemble Accessories92

Gather Information

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

Review Job Plan

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

Notify One-Call Services

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

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



Examine Pullback Material

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

Arrange for Traffic Control

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

Plan for Emergency Services

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

Inspect Site

Identify Hazards

Inspect jobsite before transporting equipment. Check for the following:

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

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

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

Select Start and End Points

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

Slope

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. Assess the risks on each slope to determine if factors affecting risks create an unsafe condition for drilling.

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 82.

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

Comfort

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

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



Classify Jobsite



WARNING

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

To help avoid injury:

- Wear personal protective equipment including hard hat, safety eye wear, and hearing protection.
- Do not wear jewelry or loose clothing.
- Mark proposed path with white paint and have underground utilities located before working.
- Comply with all utility notification regulations before digging or drilling.
- Verify location of previously marked underground hazards.
- Mark jobsite clearly and keep spectators away.

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

Select a Classification

Jobsites are classified according to underground hazards present.

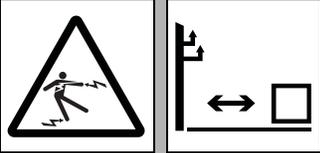
If working . . .	then classify jobsite as . . .
within 10' (3 m) of a buried electric line	electric
within 10' (3 m) of a natural gas line	natural gas
in sand, granite, or concrete which is capable of producing crystalline silica (quartz) dust	crystalline silica (quartz) dust
within 10' (3 m) of any 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. Follow U.S. Department of Labor regulations on excavating and trenching (Part 1926, Subpart P) and other similar regulations.

Electric Jobsite Precautions



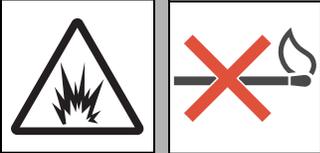
⚠ DANGER Electric shock will cause death or serious injury. Stay away. 274-049

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

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



Natural Gas Jobsite Precautions

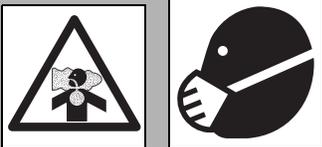


⚠ WARNING Fire or explosion possible. Fumes could ignite and cause burns. No smoking, no flame, no spark. 275-419 (2P)

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. If utility must be crossed, tracker operator must watch the drill head during drilling and backreaming. The tracker operator must have communication with the drill operator or DrillLok must be enabled with the DrillLok key in the tracker operator's possession.
- 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

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

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

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 Subsite[®] Electronics bore planning software is available for planning your bore path. This special software can be run in the field using a laptop computer. See your Ditch Witch[®] dealer for details.

If not using bore planning software, 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 bore planning software, see “Bore Path Calculator” on page 83 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.

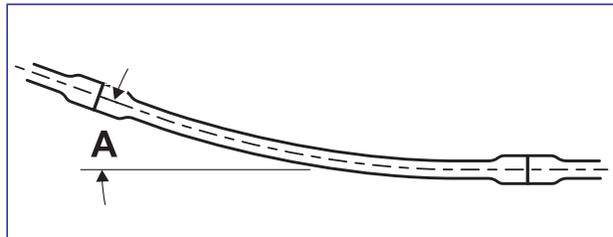
Ditch Witch® drill pipes are designed to bend slightly during operation. Slight bending allows for steering and correcting direction. Bending beyond recommended limits will cause damage that might not be visible. This damage adds up and will later lead to sudden drill pipe failure.

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.

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



j07om003c.eps

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

Monitor the pitch of each pipe with the remote display on the operator's console. (See tracking system operation instructions.)

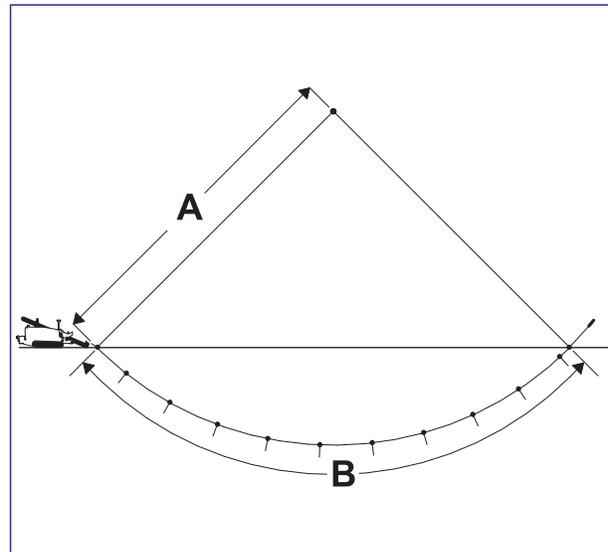
Bend Radius

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).



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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:

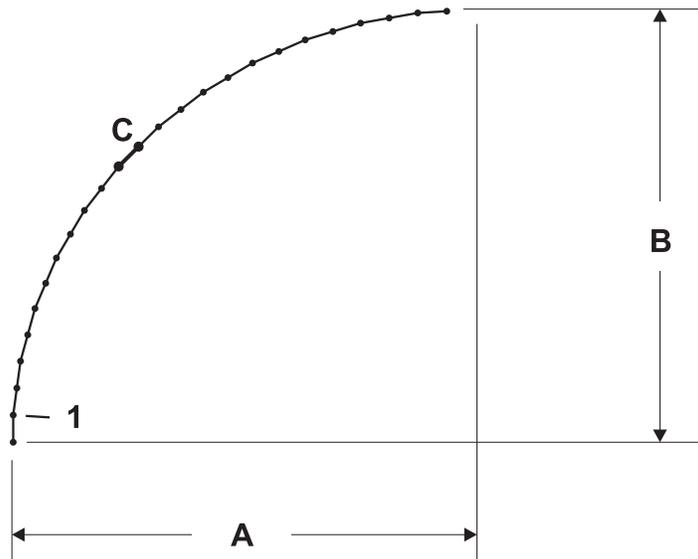
- has a radius (A) of 205' (63 m)
- requires approximately 471' (143.6 m) of drill pipe (B).



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.

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



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" (34.91 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

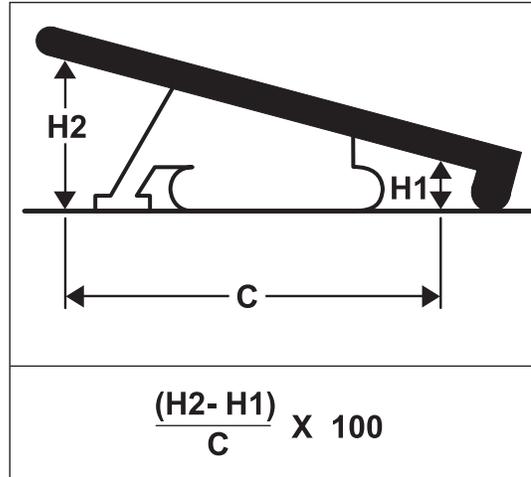
Entry pitch is the slope of the drill frame compared with the slope of the ground. Determine entry pitch one of two ways:

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.

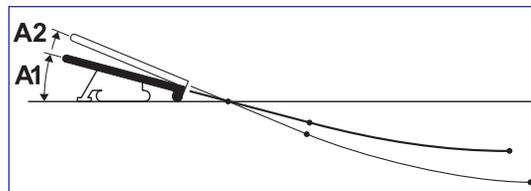
2. With Measurements

- 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.

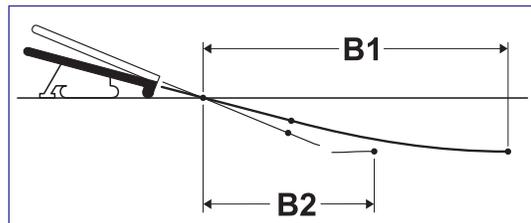


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Minimum Setback

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

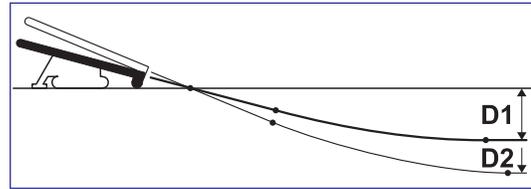
NOTICE: If setback is too small (B2), you will exceed bend limits and damage the pipe.



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Minimum Depth

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**.



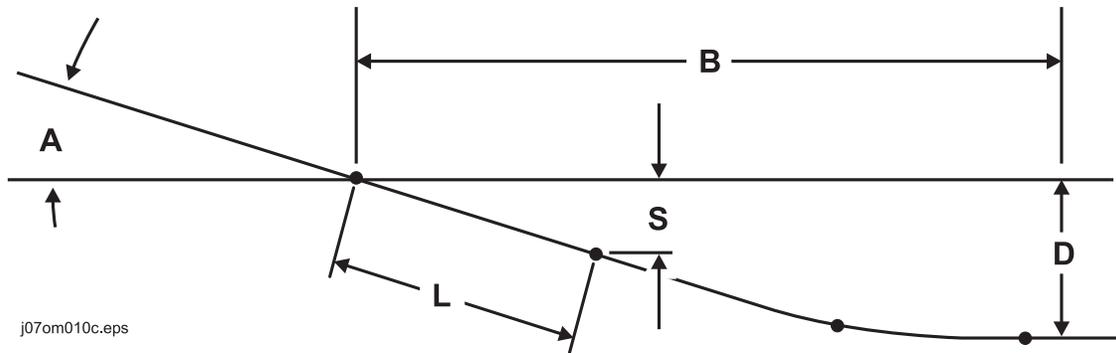
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- To reduce minimum depth (D1), reduce entry pitch. This also decreases setback.
- To increase minimum depth (D2), increase entry pitch. This also increases setback.

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



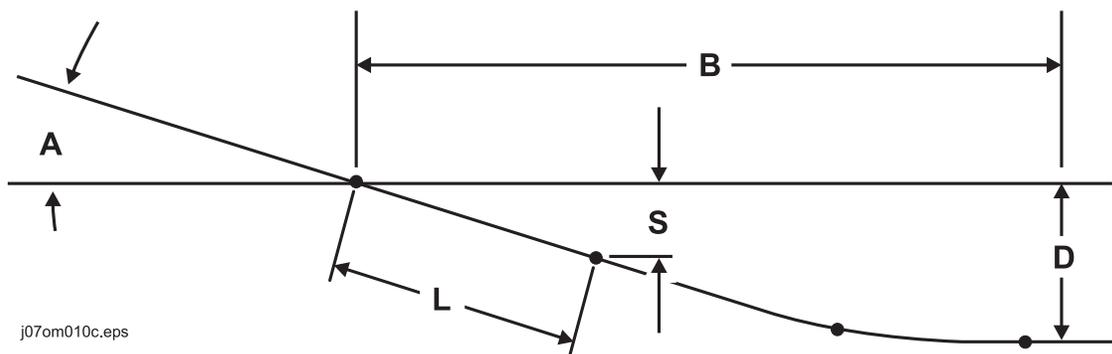
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Minimum depth (D)	Entry pitch (A)	Setback (B)	Depth to begin steering (S)
4' 10" (1.47 m)	18%/10.0°	42' 2" (12.85 m)	2' 3" (0.69 m)
5' 7" (1.70 m)	19%/11.0°	45' 1" (13.74 m)	2' 6" (.076 m)
6' 5" (1.96 m)	21%/12.0°	47' 11" (14.61 m)	2' 8" (0.81 m)
7' 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.



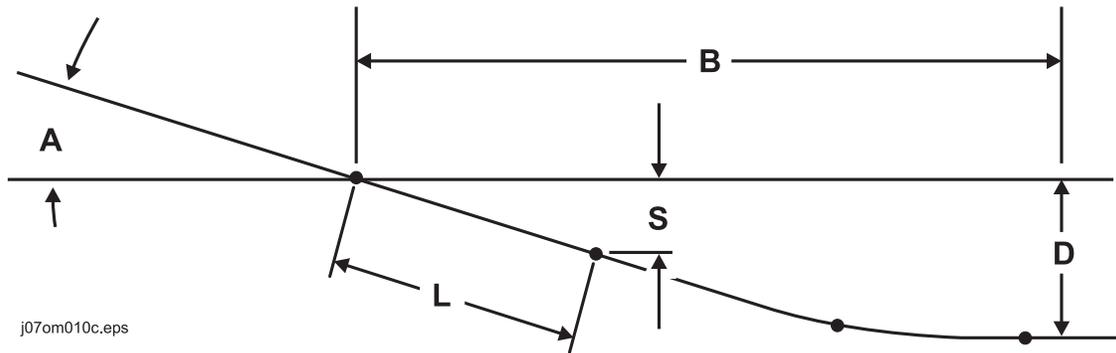
JT60 Power Pipe® Forged



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



j07om010c.eps

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. 274-050; 274-724 (2P)

To help avoid injury:

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

Mark Bore Path

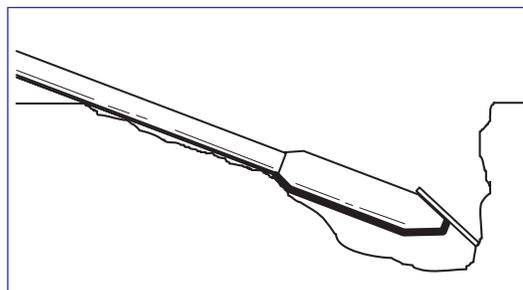
Mark your planned bore path and all located utility lines with flags or paint.

Prepare Entry Point

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

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

To prevent bending or straining pipe, position drilling unit for straight entry.



j07om011c.eps

Check Supplies and Prepare Equipment

Check Supplies

- receiver/transmitter or tracker with spare batteries
- extra batteries for DrillLok[®] remote, if needed
- extra batteries for wireless ground drive controller
- beacons with new and spare batteries
- extra Hydratong battery and charger (see "Hydratong Wrenches" on page 152)
- two-way radios with new and spare batteries
- hydraulic wrench (see "Hydratong Wrenches" on page 152)
- transition sub
- anchoring equipment and accessories
- bits, screens, nozzles (see "Downhole Tools" on page 147)
- adapters, pipe, beacon housings
- marking flags or paint
- water and additional hoses
- fuel
- drilling fluid additives (see "Drilling Fluid" on page 141)
- spare fuses
- keys
- backreamers, swivels, pulling devices (see "Backreamers" on page 149)
- wash down hose and spray gun
- duct tape
- spray lubricant
- tool joint compound (see "Recommended Lubricants/Service Key" on page 192)
- 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



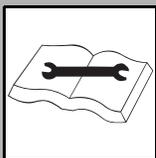
Prepare Equipment

Fluid Levels

- fuel
- diesel exhaust fluid (DEF)
- hydraulic fluid
- engine coolant
- battery charge
- engine oil

Condition and Function

- all controls



⚠ WARNING Improper control function could cause death or serious injury. If control does not work as described in instructions, stop machine and have it serviced.

- 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.	<ul style="list-style-type: none"> • All Terrain drill pipe • Rockmaster™ tool 	<ul style="list-style-type: none"> • 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.	<ul style="list-style-type: none"> • All Terrain drill pipe • beacon housing • transition sub • standard JT tools 	<ul style="list-style-type: none"> • 60,000 lb (266 kN) of thrust • dither • no inner rotation
JT	Soft or intermittent soft rock or other compressible soils.	<ul style="list-style-type: none"> • JT drill pipe • standard JT tools 	<ul style="list-style-type: none"> • 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.

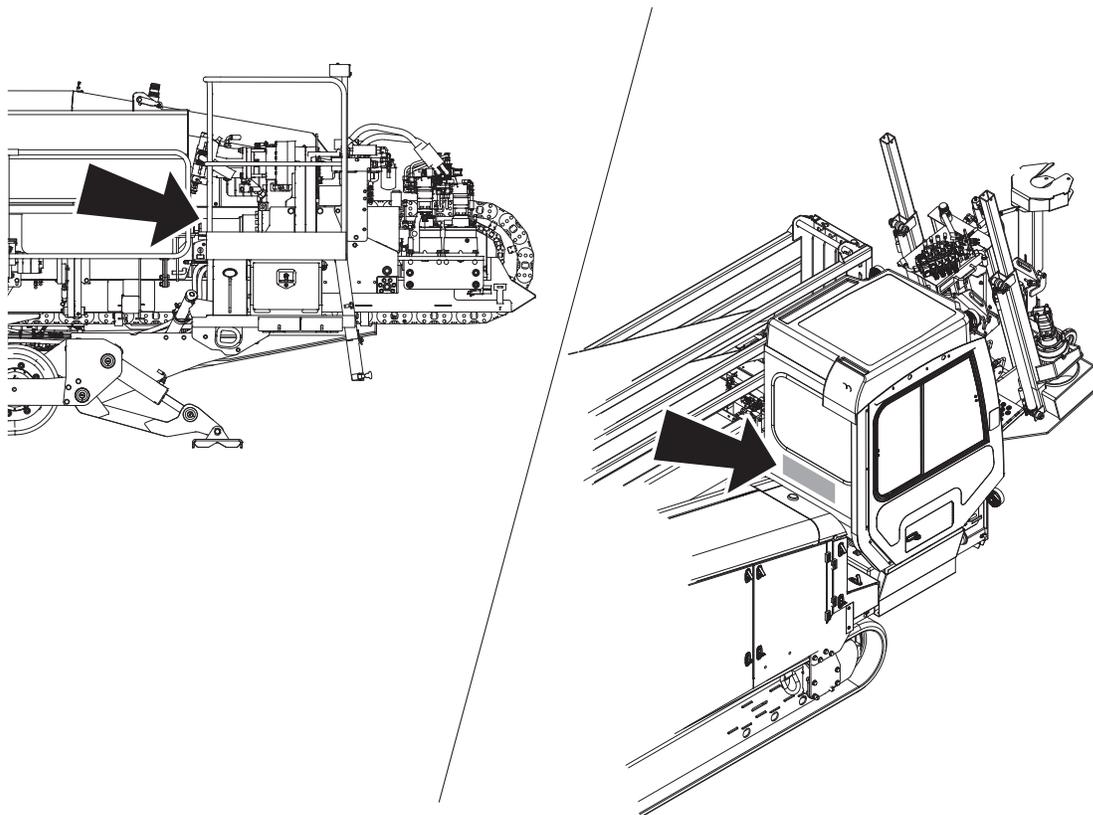
- Move mode selector switch to JT position.



Assemble Accessories

Fire Extinguisher

Identify location (shown) for fire extinguisher. 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.



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IMPORTANT:

- Ensure cab mounted fire extinguisher is mounted horizontally to allow access to the emergency stop button port. See "Override Box" on page 55..
- Ensure back mounted fire extinguisher allows movement of the shuttle guard.

Drive

Chapter Contents

Start Unit 94

Steer Unit 94

- Single Joystick Ground Drive 94
- Dual Joystick Ground Drive. 94
- Tips to Reduce Track Wear. 95
- Safe Slope Operation 96

Shut Down Unit 97



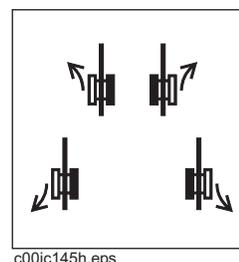
Start Unit

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

To steer drilling unit, follow instructions for type of steering desired. See “Wireless Ground Drive Controller” on page 166.

IMPORTANT: Operator station must be empty to operate wireless ground drive control.



Single Joystick Ground Drive

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

Dual Joystick Ground Drive

To steer while moving forward, move one control slightly more than the other to turn in the desired direction. Drilling unit will gradually turn to left or right.

To steer while moving backward, move one control slightly more than the other to turn in the desired direction. Drilling unit will gradually turn to left or right.

For tight steering at low speed, one control to reverse and one control to forward to turn in the desired direction. Drilling will counter-rotate and turn winch unit in a tight circle.

Tips to Reduce Track Wear

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

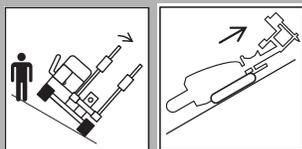
Wash tracks daily to remove foreign objects and abrasive soil from sprockets and idler rollers. Drive slowly and make wide turns when possible. Regularly check undercarriage components (sprocket, rollers, idler) for wear and damage. Maintain proper track tension. (See "Check Track Tension and Condition" on page 229.)

To prevent premature wear, avoid the following:

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



Safe Slope Operation

**WARNING**

Tipover possible. Machine can tip over and crush you.

To help avoid injury:

- Always operate from the uphill side of the unit.
- 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 break.

Operating safely on a slope depends upon many factors including:

- Distribution of machine weight (weight of machine may change due to configuration)
- 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
- 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. Run engine at low throttle for 3 minutes to cool.
3. Turn ignition switch to STOP.
4. Remove key.



Transport

Chapter Contents

Lift **100**

- Pipe box lifting procedure100

Haul **101**

- Load101
- Tie Down102
- Unload103

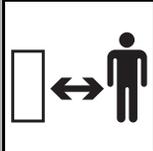
Retrieve **103**



Lift

This machine is not configured for lifting. If the machine must be lifted, load machine into a container or onto a platform appropriate for lifting. See "Specifications" on page 235 for weight of machine.

Pipe Box Lifting Procedure

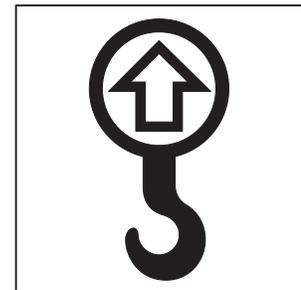



WARNING

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.

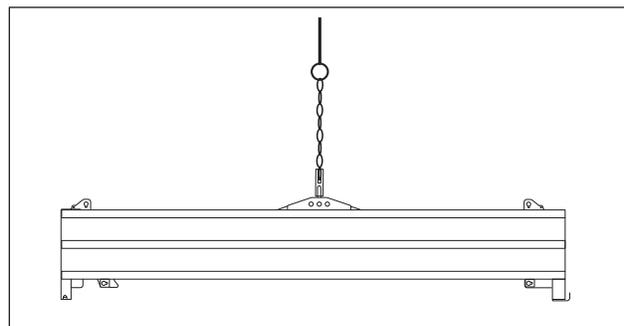
Ensure that proper remove/install procedure is followed. See "Remove/Install Pipe Box" on page 159.



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Use crane capable of supporting the equipment's size and weight. See "Specifications" on page 235 or measure and weigh equipment before lifting.

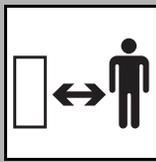
IMPORTANT: Lift only one box of pipe at a time.



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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.

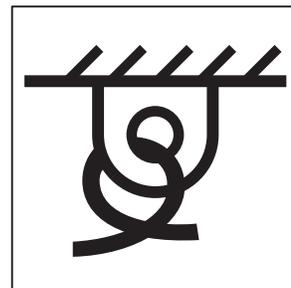
1. Start drilling unit engine.
2. Engage transport mode. See "Transport mode switch" on page 41.
3. Move drilling unit to rear of trailer and align with ramps or center of trailer bed.
4. Ensure shuttle guard is up.
5. Move shuttles in.
6. Move carriage forward as far as the shuttles will allow.
7. Keep anchor low to the ground.
8. Slow engine to low throttle and slowly drive unit onto trailer.
9. Lower stabilizers to trailer floor.
10. Lower drill frame to trailer floor.
11. Stop engine when unit is safely positioned on trailer bed.
12. 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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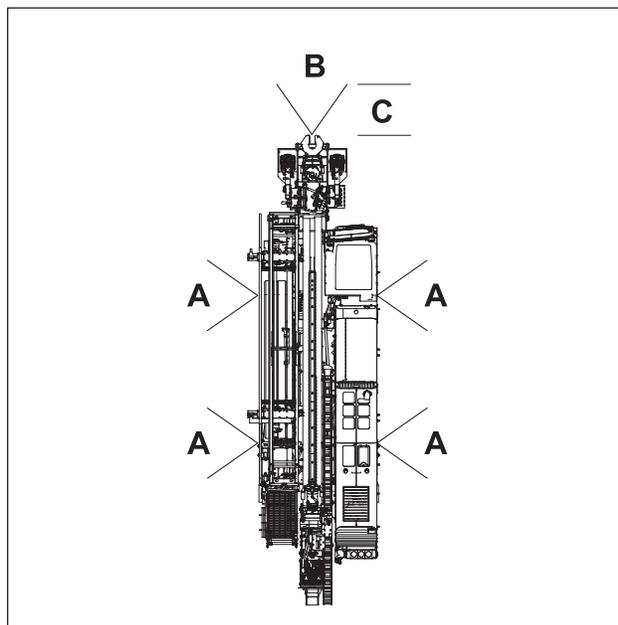
Procedure

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.

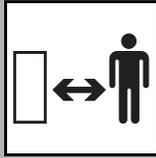
Loop a transport chain around each tie down point. See chart below for correct distances between tiedown ends. Make sure tiedowns are tight before transporting.

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.

Retrieve

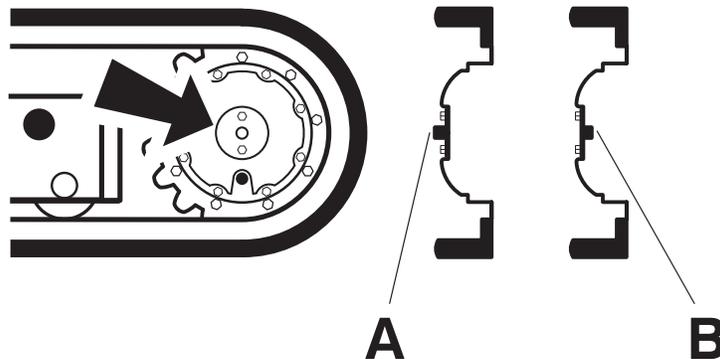


Under normal conditions, drilling unit should not be towed. If unit breaks down and towing is necessary:

- 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 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.

Conduct a Bore



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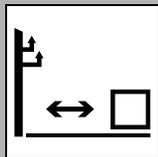
Remove Pullback Device 128



Position Equipment

1. Review bore plan and select drilling unit position and fluid unit position. See “Select Start and End Points” on page 73.
2. Move equipment into selected positions.
3. Drive anchors. (See “Anchor System” on page 131.)
4. Connect and test electric strike system. (See “Electric Strike System” on page 135.)

Connect Fluid System



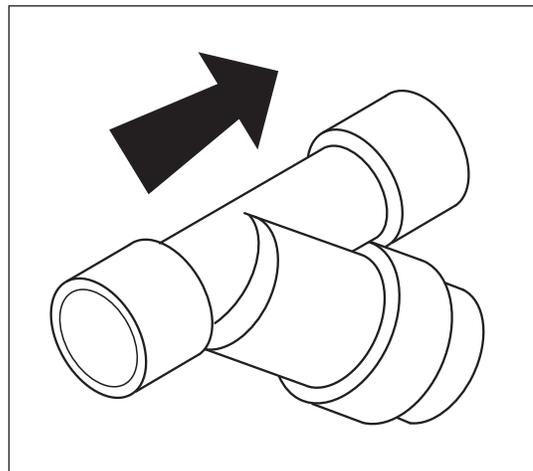
⚠ DANGER

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

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

1. Connect fluid hose from mixing system to drilling fluid pump. A 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. See page 203.



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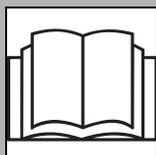
Start System

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

IMPORTANT: Ensure that mixture of drilling fluid matches drilling conditions. See "Drilling Fluid" on page 141.

2. Enable DrillLok[®] mode if desired. See "DrillLok[®] System" on page 146.
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

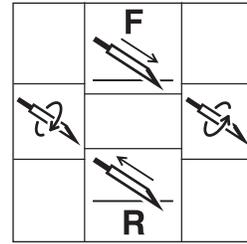
Prime drilling fluid pump each time the tank is changed. To prime the pump:

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.

IMPORTANT: If using drilling fluid recycling equipment, check mud weight before using it during bore. Using drilling fluid with a mud weight higher than 9.2 lb/gal (1.1 kg/L) will decrease fluid pump life.

Operate Carriage Control

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.

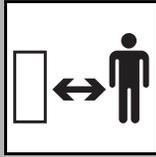


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Carriage Movement	Rotation Direction	
forward	clockwise	 ic1102a.eps
backward	counterclockwise	 ic1104a.eps

Clamp Pipe



DANGER

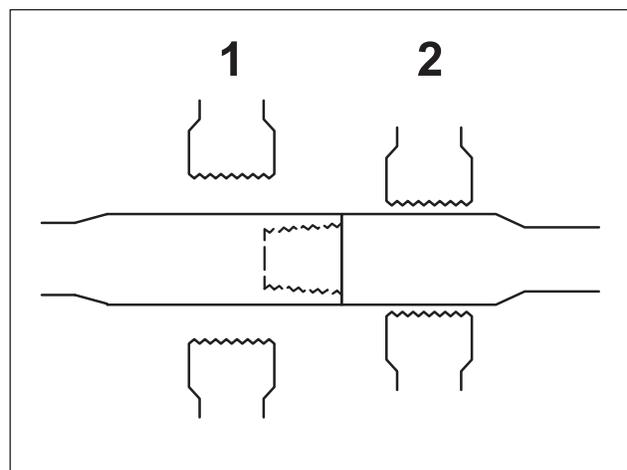
Turning shaft will kill you or crush arm or leg. Stay away.

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

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

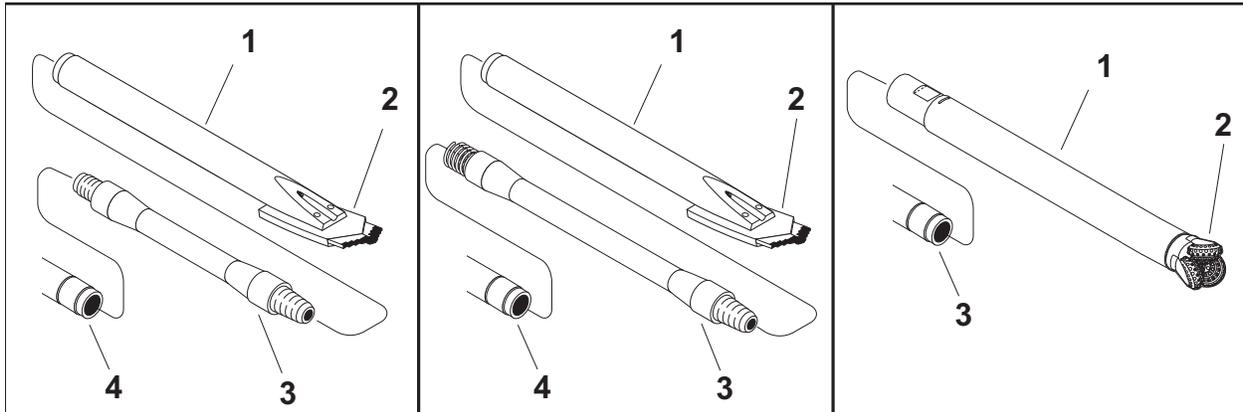
Clamp on pipe when joint is centered between wrenches (1 and 2). Always clamp on the larger diameter areas on either side of the tool joint face.

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



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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

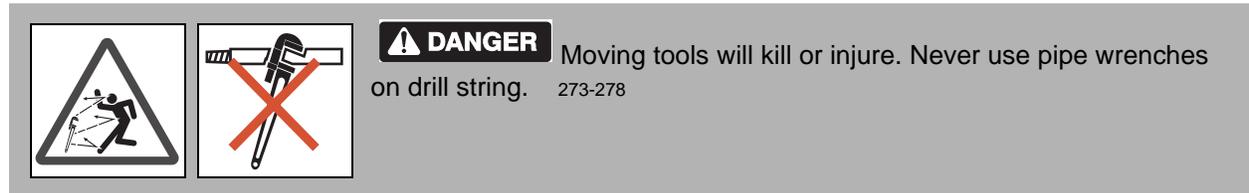
1. Select nozzles (JT and AT Dirt modes only) and bit.

IMPORTANT: A variety of nozzles and bits are available to suit your particular job conditions. See "Downhole Tools" on page 147 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 148.
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 152.

Attach Beacon Housing

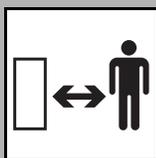
1. Attach downhole tool to transition sub and hand tighten.
2. Attach Hydratong to the joint in the join position and tighten joint. See “Hydratong Wrenches” on page 152.

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 110.
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 86.
4. Slowly move carriage forward. Drill in 13' (4 m) before steering.
5. Monitor gauges.

AT Rock Mode

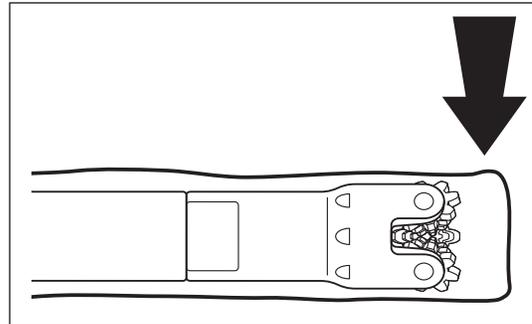
1. Turn on drilling fluid.
2. Visually check for drilling fluid flow.
3. Choose clock position and set spindle brake.
4. Rotate inner spindle clockwise.
5. Slowly move carriage forward. Drill first pipe as straight as possible.
6. Monitor gauges.
 - If inner rotation pressure approaches 1600 psi (110 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
<ol style="list-style-type: none">1. Open front wrench and retract shuttles for add pipe function to work.2. Press top 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.	<ol style="list-style-type: none">1. Open front wrench and retract shuttles for remove pipe function to work.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 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 pipelader system (automated pipelader control only). See "Enable Automated Pipelader System" on page 115.
3. Break joint at SaverLok[®] body.

Manual Pipelader Controls	Automated Pipelader Control
<ul style="list-style-type: none"> • Clamp pipe joint. See "Clamp Pipe" on page 110. • 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. 	<ul style="list-style-type: none"> • Clamp pipe joint. See "Clamp Pipe" on page 110. • 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 Pipelader Controls	Automated Pipelader Control
<ul style="list-style-type: none"> • Make sure shuttle stop is properly positioned on pipelader and lift arms are completely lowered. • Close grippers. • Move pipe to spindle and lube lower threads. • Raise pipe in box. 	<ul style="list-style-type: none"> • Make sure shuttle stop is properly positioned on pipelader. • 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.

IMPORTANT: Always rotate clockwise unless breaking pipe joint. Rotating counterclockwise will unscrew joints.

Manual Pipeloader Controls	Automated Pipeloader Control
<ul style="list-style-type: none"> • Move carriage forward until SaverLok body meets pipe. • Continue to slowly advance carriage and rotate spindle until pipe threads tighten. • Relax grippers. 	<ul style="list-style-type: none"> • 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
<ul style="list-style-type: none"> • 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. 	<ul style="list-style-type: none"> • 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 “Wireless Ground Drive Controller” on page 166.
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 78.
- 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.

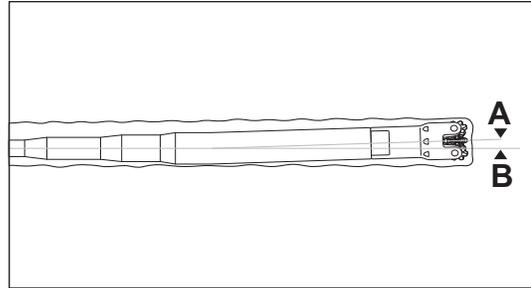


Procedure

1. Locate drill head. Take readings available with your beacon and locating equipment such as:

- depth

IMPORTANT: In AT mode, depth estimate improves if drill head is at 3 o'clock position (A) rather than horizontal (B).



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- pitch
- left/right information
- temperature
- beacon roll

2. Compare position to bore plan. Determine direction drilling should go.

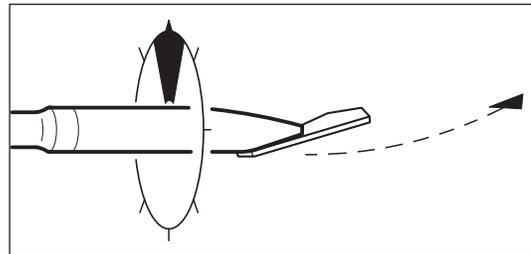
3. Position drill head.

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
<ol style="list-style-type: none"> 1. Rotate pipe to clock position you intend to travel. 2. Push pipe into ground. 	<ol style="list-style-type: none"> 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
<ol style="list-style-type: none"> 1. Rotate pipe. 2. Push pipe into ground. 	<ol style="list-style-type: none"> 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 move 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

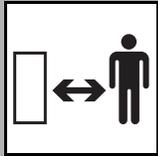
Locate drill head every half-length of pipe. As the job is completed, record the actual data for each drill pipe. List pitch and depth of each joint and a brief description of the procedure. In addition, draw a simple sketch of the site and record depth and rough location of pullback.

Subsite[®] Electronics bore tracking software is also available for plotting and tracking your bore path. It utilizes a Subsite Electronics tracking system, including a tracker, display, and tracking beacon, and special software. The display can store jobs in its memory or the system can be run in the field using a laptop computer. 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[®], do not enter pit until DrillLok 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 78.
2. Clean area around exit point.
3. If using DrillLok[®] mode, tracker operator remotely disables drilling unit thrust/pullback and rotation hydraulics using DrillLok. Tracker operator waits for green light to enter pit and change tools.

If not using DrillLok 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 152.

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)

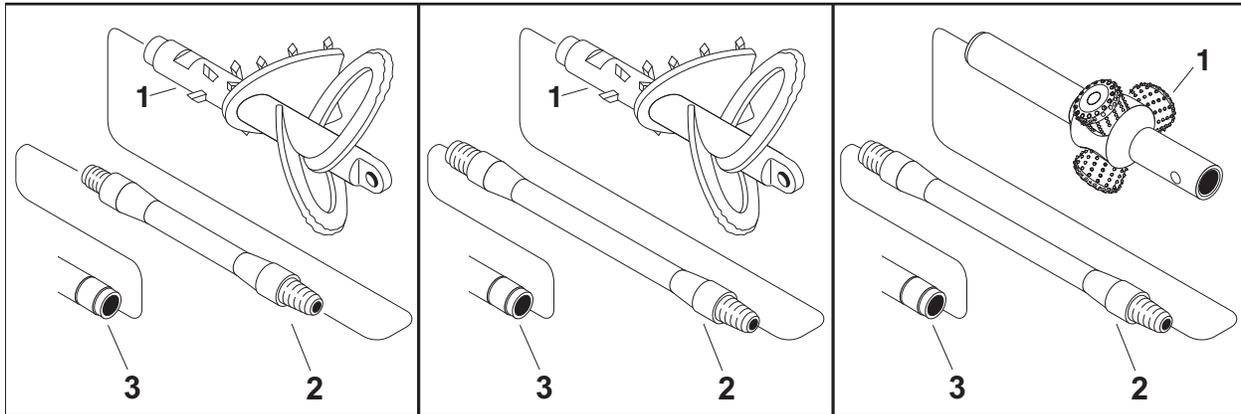
To help avoid injury: Continue to use strike system during backreaming.



⚠ 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[®] (see page 146).
- 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 149.
2. Determine fluid rate requirements and install appropriate nozzles to provide sufficient flow. See “Backream Fluid Requirements” on page 150 and “Nozzles” on page 147.
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 148.
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 152.
9. Use Hydratong wrenches to attach backreamer/beacon housing assembly to transition sub. See “Hydratong Wrenches” on page 152.
10. Attach additional pullback devices or product to end of backreamer/beacon housing assembly.



Begin Backream

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

Remove Pipe

1. Enable automated pipeloader system (automated pipeloader control only). See “Enable Automated Pipeloader System” on page 115.
2. Clamp pipes. See “Clamp Pipe” on page 110.
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
<ul style="list-style-type: none"> • Open grippers. • Lift pipe off shuttles. • Extend shuttles to spindle position. • Close grippers. Leave grippers loose enough to allow pipe to rotate. • Lower lifters. 	<ul style="list-style-type: none"> • 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
<ul style="list-style-type: none"> • 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. 	<ul style="list-style-type: none"> • 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
<ul style="list-style-type: none"> • Move shuttle under pipe box to shuttle stop. • Release grippers. • Raise lift arms to place pipe in box. • Lube front threads. 	<ul style="list-style-type: none"> • 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 152.

Systems and Equipment

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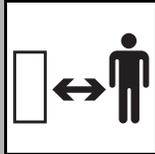
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Anchor System

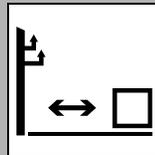
Three methods for anchoring this unit are available: anchors, alternate anchors, and a combination of both. Choose the correct method based on jobsite conditions.



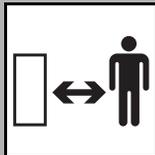
WARNING Crushing weight could cause death or serious injury. Use proper procedures and equipment or stay away 274-204.

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

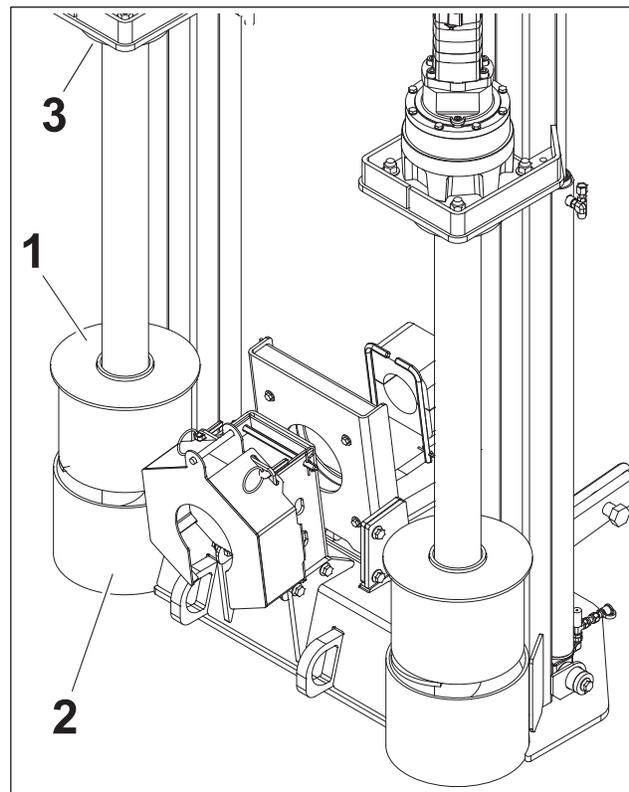
IMPORTANT: Do not attempt to operate anchor controls while drill fluid is on. Drill fluid operation may divert power from anchor system so that anchor controls perform poorly.

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.

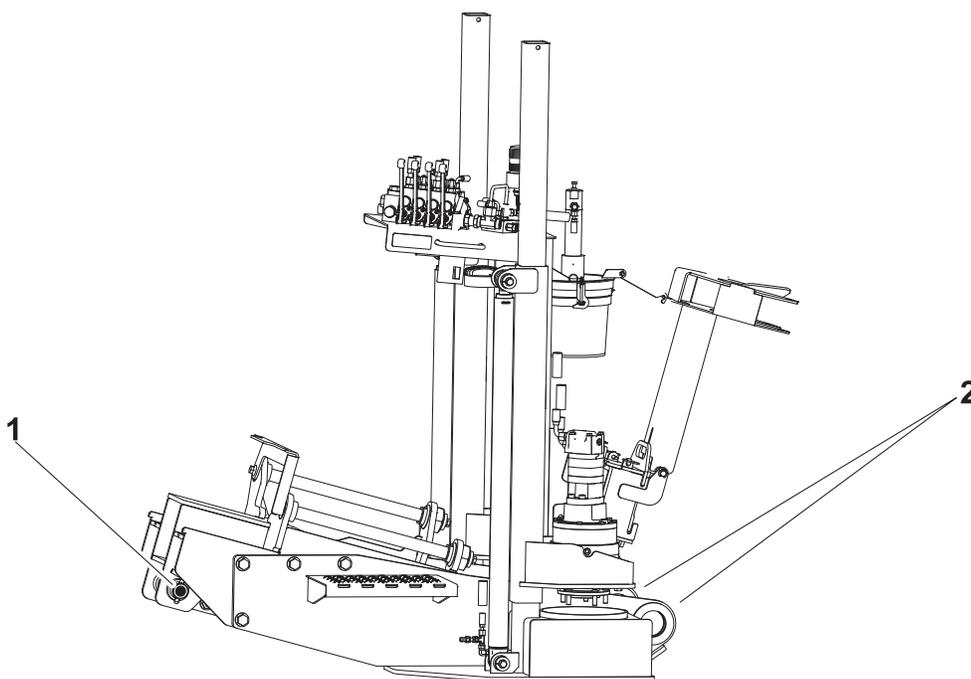
3. Carefully position cap (1) into centering tube (2) as anchor is being driven into the ground.
4. Anchor is set when auger shaft flange (3) rests firmly on cap (1) and centering tube (2).
5. Repeat process for other anchor.

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. Drill operator and tracker operator must wear protective boots, and the drill operator must have protective gloves within reach, all 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 18,000 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 75. Review safety procedures before each job.

If an electric strike occurs, immediately contact your local Ditch Witch® dealer to have the electric strike system tested.

FCC Statement

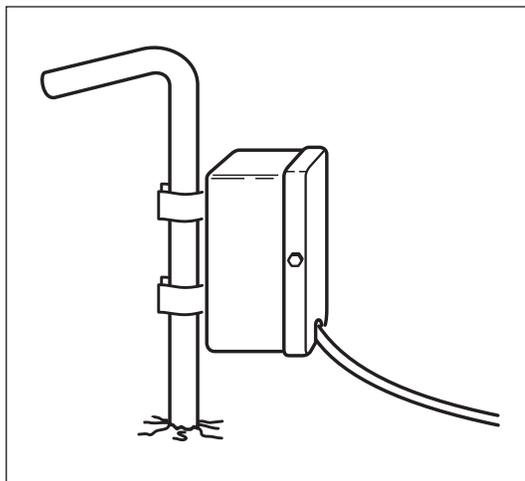
The Electric Strike System has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment 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 139.

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
ESID detected but not OK. Red icon shown on machine display. 	Problems in startup	Go to ESID menu and select test function. If problem goes away, retest strike system
	No power to strike system control module	Check drilling unit electrical 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	
dc513 Test Wire shows on machine display	Test wire not connected	Check that test wire is connected to ESID control module
		Check that test wire is connected to machine display
		Have ESID control module checked or replaced
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 alarm and connect to external 12V power source. 2. If alarm does not work, replace it.
	Defective control module	Have control module checked or replaced

Problem	Possible cause	Possible solution
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
dc518 POST AC I code displays and red ESID current indicator icon shows on machine display. 	Improper connections with control module	Check cable connections on control module and current transformer
	Defective current transformer	1. Disconnect current transformer. 2. Check for 20-40 ohms from pin 1 to pin 4, 20-40 ohms from pin 1 to pin 2, and less than 1 ohm from pin 2 to pin 4.
	Defective current transformer cable	1. Disconnect cable from transformer and control module. 2. Check continuity of cable. 3. If continuity is zero or cable is damaged, replace.
	Defective control module	Have control module checked or replaced
dc517 POST AC V code displays and red ESID voltage icon shows on machine display. 	Improper connection of voltage limiter to ground stake	Check voltage limiter connection to ground stake and verify that ground stake is driven into the ground
	Improper connections with control module.	Check cable connection on control module.
	Defective voltage limiter	Have voltage limiter checked or replaced
	Defective control module	Have control module checked or replaced

Use Electric Strike Simulator

Use the Electric Strike Simulator (p/n 259-506) to test voltage and current sensors on ESID. If readings are less than indicated here, replace 9V battery in simulator and retest. If readings are still less than indicated, contact your Ditch Witch® dealer to have ESID repaired before drilling.



Current Test

To test for current at normal levels:

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

To test for current at strike levels:

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

With two loops,

- Current "A" should be 80% or higher.
- Strike indication might go on and off.

With three loops,

- Current should be 130% or higher.
- Strike indication should be continuous.

Voltage Test

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

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

Drilling Fluid



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 145.

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

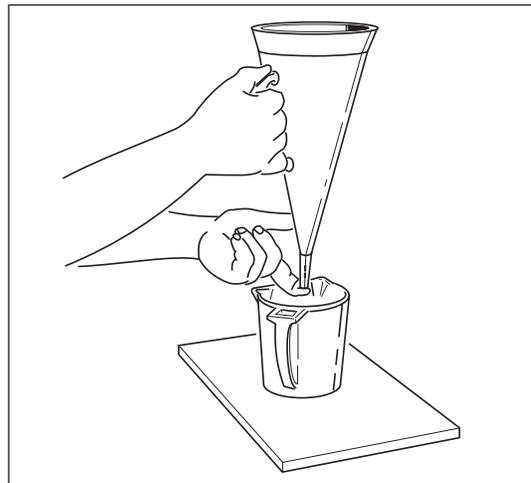
Viscosity is the measure of internal resistance of a fluid to flow; the greater the resistance, the higher the viscosity. Viscosity of drilling fluids must be controlled.

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.

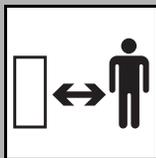
1. Using wash hose and a clean container, take a fresh sample of drilling fluid. The sample must be at least 1.5 qt (1.4 L).
2. With finger over bottom of funnel, fill with fluid from the container through the screen until fluid reaches the bottom of the screen.
3. Move funnel over 1 qt (.95 L) container.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

Overview



⚠ DANGER

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

To help avoid injury:

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

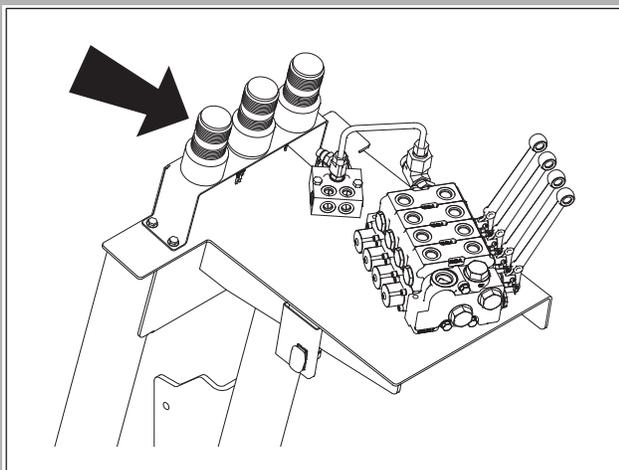
This mode allows the tracker operator to disable hydraulic power to drilling unit thrust and rotation.

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 light (shown), located on drilling unit anchoring console, is on. If it is, thrust and rotation have been disabled by DrillLok.

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

See "DrillLok® key" on page 56.



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Operation with Subsite® Electronics Tracking Equipment: See tracker manual.

Operation without Subsite® Electronics 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

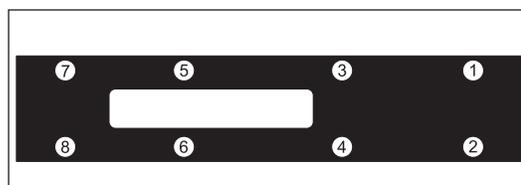
Beacon Installation

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

Lid Installation

IMPORTANT: Lid bolts are one-time-use parts. Install new bolts each time lid is installed.

1. Clean all threads, bolt holes and mating surfaces.
2. Follow torque sequence (shown).
3. Torque bolts to 60-70 ft•lb (81-95 N•m).
4. 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.	<p>U.S. A 6-in backreamer requires at least 1.47 gal/ft.</p> <hr/> <p>Metric A 152-mm backreamer requires at least 18.24 L/m.</p>
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.	<p>U.S. 1.5 gal x 2 ft/min = 3 gal for each minute of backreaming.</p> <hr/> <p>Metric 18 L x .5 m/min = 9 L for each minute of backreaming</p>

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

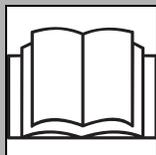
Backream Fluid Requirements

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

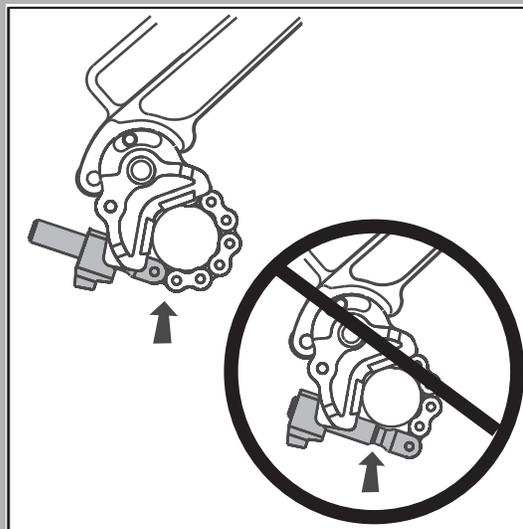
To attach or remove downhole tools, use the Hydratong wrenches to join or break the joint.



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

To help avoid injury:

- Ensure only chain tongs and chain are in contact with pipe (shown) and that chain is correctly wrapped. Do not use Hydratong with chain bushing pin touching pipe (shown).
- Stand away from the Hydratong when using it.



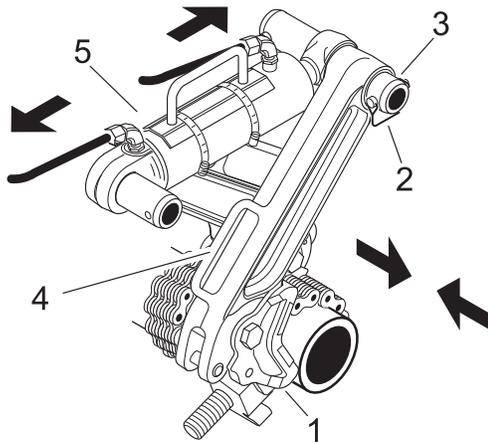
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DANGER Moving tools will kill or injure. Never use pipe wrenches on drill string. 273-278

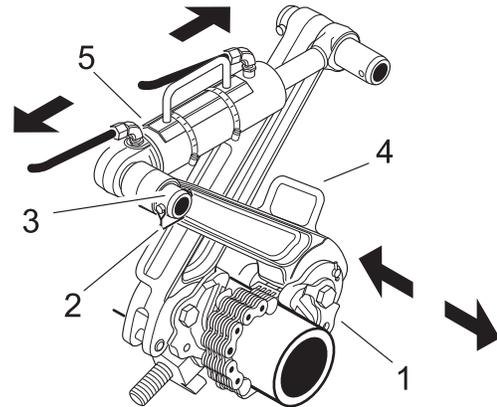
1. To join, apply TJC to threads and hand tighten joint.
2. Verify chain tong size is appropriate for pipe diameter. New chain tongs work with pipe diameter 4 1/2 in to 5 in (11.43 cm to 12.7 cm). To accommodate 3 5/8 in to 4 3/8 in (9.2 cm to 11.1 cm) pipe, remove one chain link.

3. Attach Hydratong in either the join or break position.



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Join

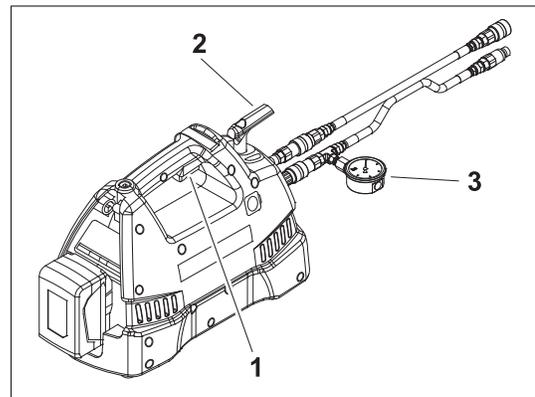


Break



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.
4. Remove all slack from wrench and joint.
 5. To join, use the scribe line method to prepare joints for proper tightening. See "Scribe Line Method" on page 154.
 6. Connect Hydratong power pack to cylinder..
 7. To tighten or loosen joint, move shuttle valve handle (2, shown) toward the A position on pump and press power switch (1, shown) to extend cylinder.
 8. To reposition chain tongs and continue tightening or loosening joint, move handle to the B position and then press power switch to retract cylinder.
 9. Monitor gauge (3, shown) and refer to decal on pump to achieve the approximate torque value.



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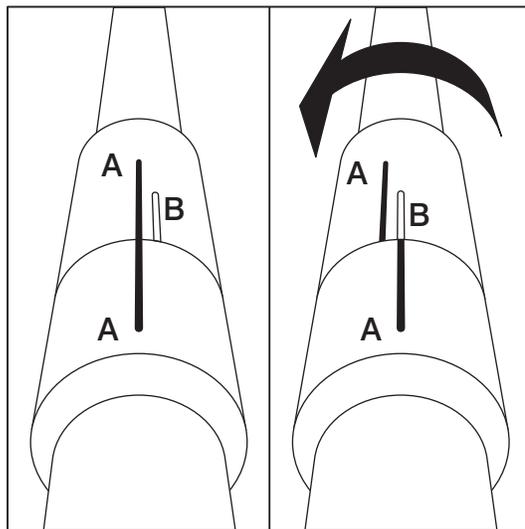
IMPORTANT: Gauge gives an estimate of torque. Use scribe line method to verify proper make-up torque.

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

Scribe Line Method

1. To join, scribe straight line across joint on both sides of separating line (A).
2. 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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Drill Pipe

Perform Regular Drill Pipe Care

Precondition New Pipe



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

1. **Hand-lubricate** entire surface of threads and shoulders of both ends of pipe with copper base tool joint compound. See "Recommended Lubricants/Service Key" on page 192 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 192 for correct lubricant.

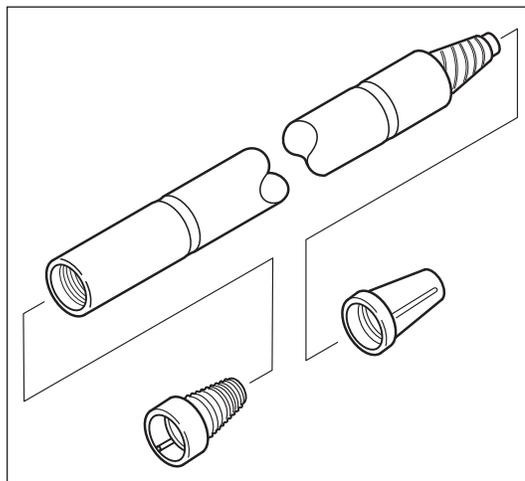
Clean the Threads

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 155.

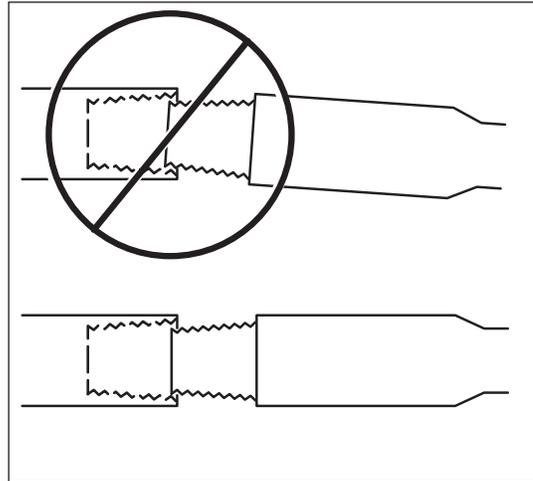
Rotate Pipe Order

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.



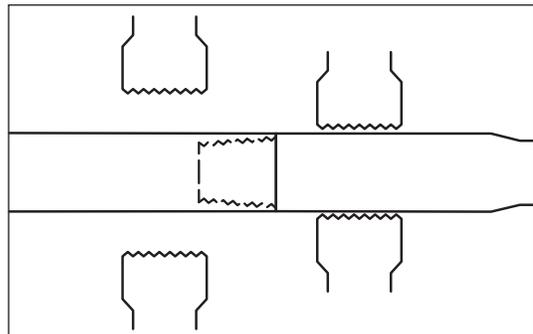
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Clamp Pipe Correctly

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 110 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.

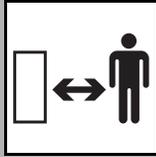
Do not Overwork the Pipe

Never exceed the bend radius for your pipe. See “Plan Bore Path” on page 77. Do not oversteer.

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

Pipe Boxes

Remove/Install Pipe Box

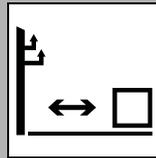


WARNING

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 235 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.



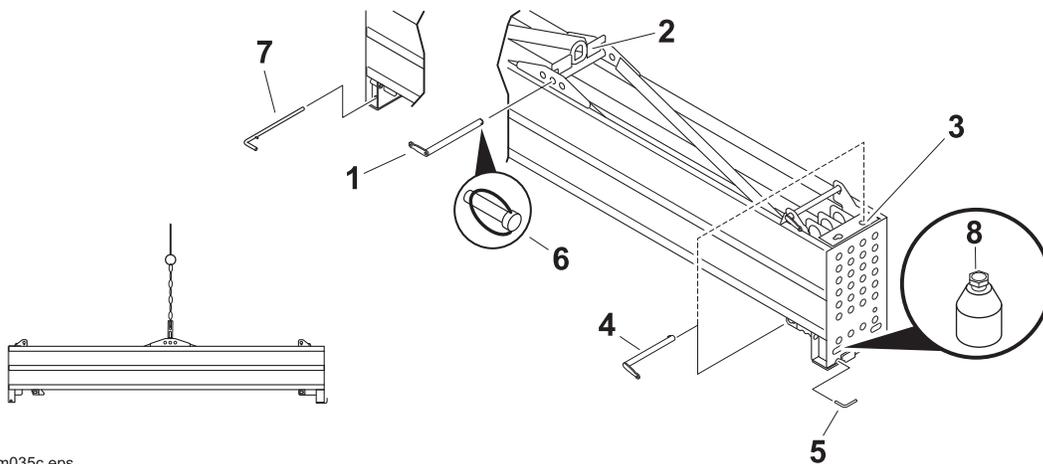
Position Lift Pin Block

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) 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 100 for more information.



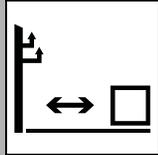
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Install Pipe Box

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.



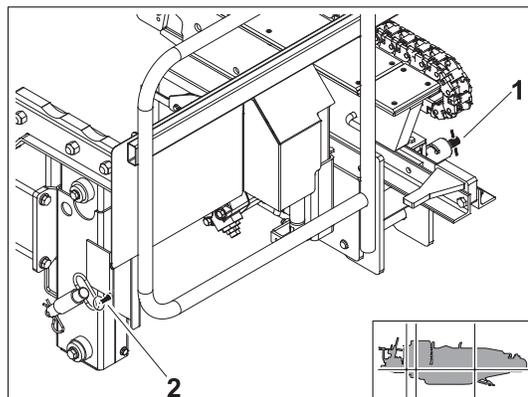
WARNING Read operator's manual. Know how to use all controls. Your safety is at stake. 273-475

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.

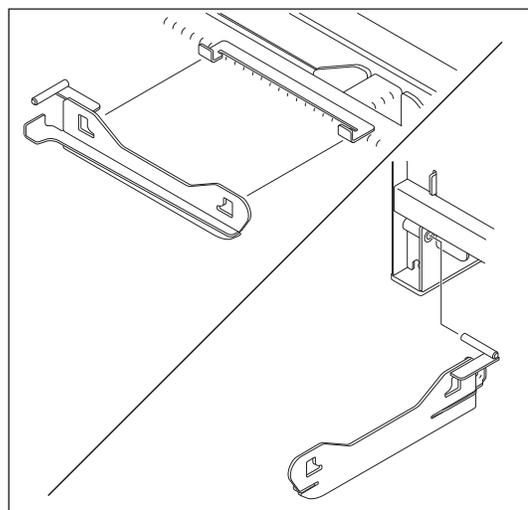
Add Single Pipe

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.



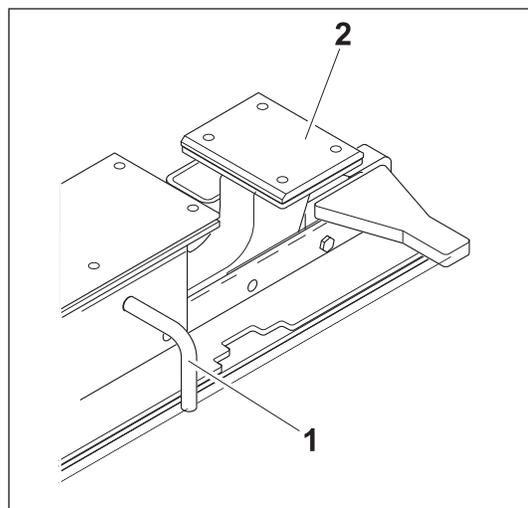
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6. Remove pipe stop (shown, stored on outside of drill frame).
7. Unpin (1) and lower shuttle guard. Unpin (2) drill pipe lifter cover at both ends and lower.
8. Press bottom of shuttle lockout switch to allow shuttle movement and move at least 10' (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.

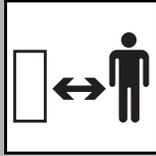


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12. Pull and hold pins (1) on each shuttle and slide out auxiliary pipe loaders (2).



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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.

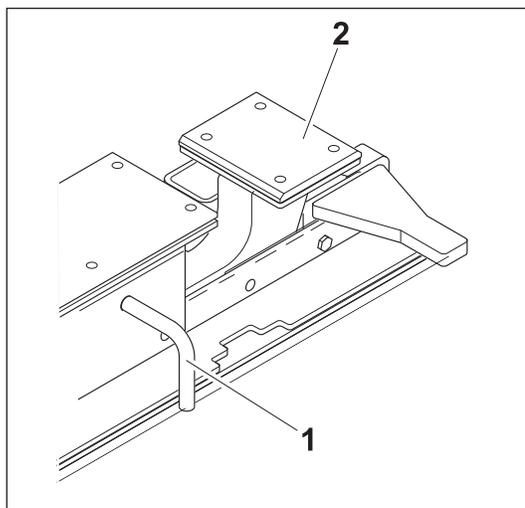


13. Load a pipe in auxiliary pipe loaders and rest it against pipe stop.
14. Press bottom of shuttle lockout switch to allow shuttle movement and move at least 10' (3 m) away from the machine.
15. Move auxiliary pipe loaders under outer row (fourth row if using JT pipe, third row if using AT pipe).
16. 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.

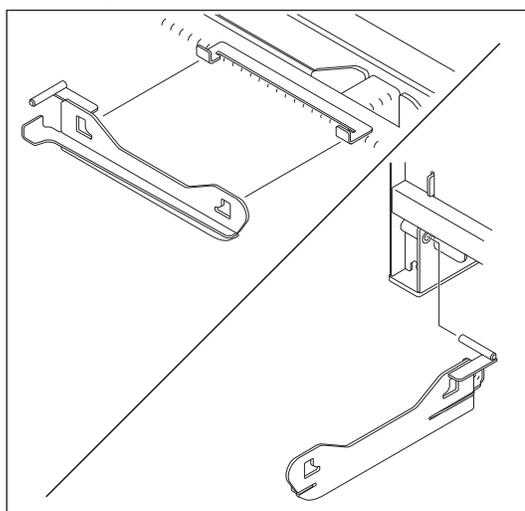
Remove Single Pipe

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.

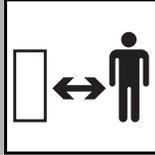
1. Ensure shuttle stop is fully lowered.
2. Move shuttles out fully.
3. Press top of shuttle lockout switch to prevent shuttle operation.
4. Pull and hold pins (1) on each shuttle and slide out auxiliary pipe loaders (2).
5. Unpin both ends of drill pipe lifter cover and lower.
6. Ensure pipe stop (shown) 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.



j07om037c.eps



j07om038c.eps



WARNING

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

To help avoid injury:

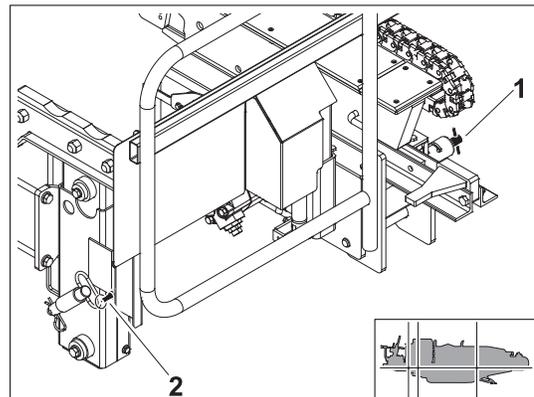
- Have enough people on hand to manually add or remove single pipe to pipe box.
- Move 10' away from machine after pipe is placed in auxiliary pipe loaders.

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 126.



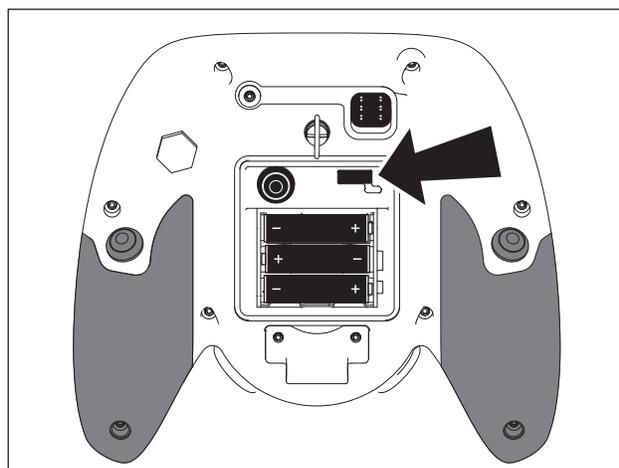
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Wireless Ground Drive Controller

Before each use

1. Check transmitter unit battery status. Replace batteries if necessary. See page 231.
2. Ensure USB key (shown) is installed. This key is a lockout feature to prevent unauthorized use.



Remote_USB.eps

Operation



270-6037

Equipment can be operated by remote control. Stay away.

To help avoid injury:

- Only operate remote control from the ground.
- Keep drilling unit in sight at all times when using wireless ground drive controller.
- Keep a safe distance away from drilling unit when operating wireless ground drive controller.
- Ensure bystanders are not near the area the drilling unit will be driven.
- Remove strap from around neck when using wireless controller near moving parts. Place wireless controller in storage box after use. Take care not to store with neck strap on top of switches.

EMERGENCY STOP: Press engine stop on wireless remote or machine.

IMPORTANT: Operator station must be empty to operate wireless ground drive control.

1. Start the remote transmitter by moving the power/start/horn switch up until communication link indicator is steady yellow and then blinks green. Clear wireless remote control light (page 4) will shine on the machine being controlled.
2. Move power/start/horn switch up again with speed/direction control in neutral until horn sounds.

IMPORTANT: Wireless controller will shut down after one minute of inactivity. Move power/start/horn switch up to restart.

3. To drive machine, select the desired drive mode. See "Menu select switch" on page 54. Press one or both operator presence switches and then set throttle and use the joystick to steer.
4. Shut down the transmitter by moving power/start/horn switch down until LED indicators go off.

Troubleshooting

If drilling unit does not respond as expected when using wireless ground drive, turn transmitter off and use alternate ground drive controls.

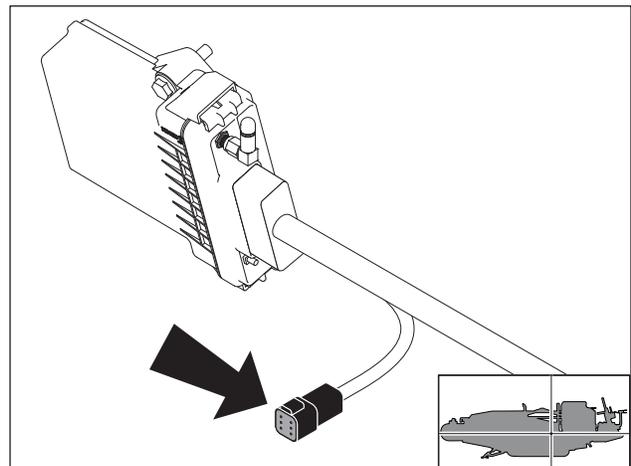
If communication link indicator is blinking yellow, communication between transmitter and receiver has stopped. Move wireless remote closer to machine while maintaining a safe distance. If in an area with interference, try changing the channel (see below).

If communication link indicator is red, communication has been lost. Shut down wireless remote and restart to try to enable communication. If that doesn't work, contact your Ditch Witch® dealer.

If battery and communication link indicators both display red for several seconds and then the wireless controller shuts off, USB key is not installed.

To change channels:

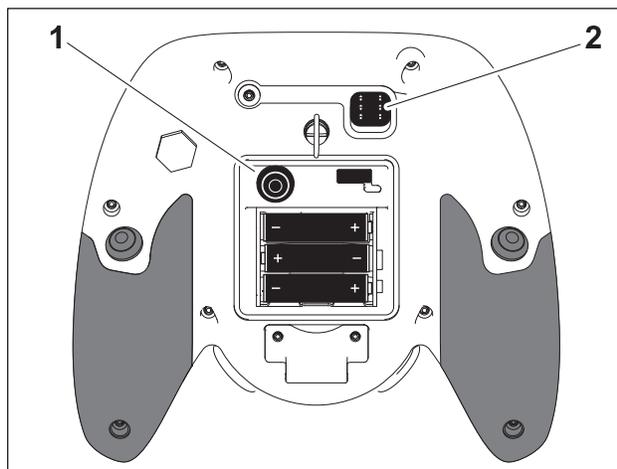
1. Turn machine ignition key on with engine off.
2. Connect harness (shown) to transmitter (2).
3. Ensure battery indicator is solid green.



j50om054w.eps



4. Press the channel switch (1) until communication link indicator begins to blink green/yellow and then release the channel switch.
 - Rapid blinking green indicator signals successful channel connection.
 - Blinking yellow indicator signals unsuccessful channel connection.



Remote_Channel.eps

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
<ol style="list-style-type: none"> 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. 	<ol style="list-style-type: none"> 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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)	<p>IMPORTANT: Outer pipe rotation speed is automatically limited when inner rotation is on.</p> <ul style="list-style-type: none"> • 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

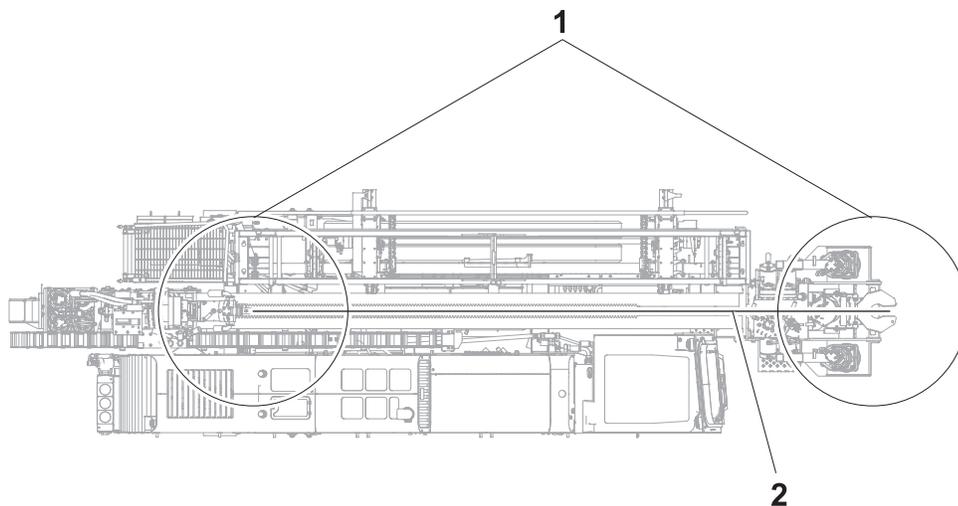
1. Position joystick out of neutral in direction of prior cruise (forward or backward).
2. Press RESUME. Green control cycle light will come on.

Wireline Tracking

IMPORTANT: This section is intended as an overview for the JT60 drilling unit operator. During most bores, a wireline tracking specialist is responsible for making wireline connections. For specific information about wireline tracking, including system operation and safety precautions, consult your wireline tracking equipment vendor.



The JT60 can be modified to operate a wireline tracking system by installing kit 190-2384. Wireline tracking uses a transmitter in the drilling head that is hard wired through the drill string to an offboard computer station at the rear of the unit. Each time pipe is added to the drill string, a new section of wireline is inserted through the new pipe, gearbox, and water swivel, then spliced to the tracking system. The operator must be aware of the wireline tracking specialist's activity at the front and rear of the machine.

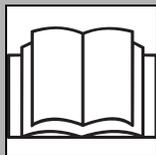


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1. Operator awareness zones

2. Wireline

Operation



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

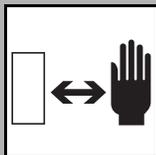


Turning shaft will kill you or crush arm or leg. Stay away.

To help avoid injury:

- Ensure that thrust and rotation are disabled or in restricted mode while wireline tracking specialist is working at front and rear of machine.
- Do not drive unit from the wireline platform.

1. Connect drill head, transition sub, and wireline beacon housing.
2. Drill first pipe. After first pipe is downhole, clamp pipe in wrenches.
3. Position next pipe in shuttles.



Moving parts could cut off hand or foot. Stay away. 275-184,

273-437,

To help avoid injury:

- DO NOT operate pipe box, pipeloading, anchor, setup controls, or any other controls while tracking specialist is making wireline connections.
- Maintain constant two-way communication with tracking specialist.

4. The wireline tracking specialist will:
 - Turn the wireline restricted operating mode (ROM) switch to the ON position to slow thrust and rotation. See "Wireline restricted operating mode switch" on page 63.
 - Insert a section of wireline through the pipe in the shuttles.
 - Splice one end of the new wire to the wireline in the clamped pipe.
 - Insert the other end (rear of machine) through the spindle, gearbox, and water swivel.
5. Use the pipeloading controls to move the new pipe into position and makeup the joint.
6. The wireline tracking specialist will:
 - Remove slack in the wireline.
 - Secure the wireline at the spindle.
 - Connect the wireline to the offboard computer.
 - Turn the wireline ROM switch to the OFF position to enable unrestricted thrust and rotation.
7. Install next new section of pipe.
8. Continue process for duration of bore.

Diagnostic Codes

The JT100 is equipped with two diagnostic systems: engine and machine. The engine diagnostic system detects critical and non-critical errors within the engine operating system and communicates fault codes on the display. The machine diagnostic system detects essential and non-essential errors within the automated machine control system. These error codes appear on the display.



To hide/recall active codes:

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

Press the soft key on the display for the diagnostic message center. Press soft key on the right to hide/recall the messages. The message box will disappear, but the Warning or Stop message will remain on the screen until the fault is cleared.

Electronic Controlled Engine Overview

This unit is equipped with a self-diagnostic computer-controlled engine management system. An ECU (Electronic Control Unit) monitors engine performance and makes adjustments to optimize that performance.

Indicators, plus diagnostic codes and messages, on the engine display tell the operator about potential engine problems and certain engine events. Depending on the severity of the problem, the ECU may reduce engine power or speed or may shut the engine down. The ECU also stores all diagnostic codes regardless of severity.

Reading Engine Diagnostic Codes

Engine diagnostic codes are shown in pop-up messages on the engine display. Amber or yellow messages indicate problems that should be addressed but do not need immediate attention. Red messages indicate problems that need immediate attention. Failure to address a problem indicated by a red message will generally result in the engine derating or shutting down.

Engine Diagnostic Codes

Note the SPN, FMI, and description of the diagnostic code for future reference, if needed. See "Appendix" on page 247 for list of codes.

Reading Machine Diagnostic Codes

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

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

Code Severity Levels

Diagnostic codes are given one of two levels of severity.

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

Machine Diagnostic Codes

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

IMPORTANT: All machine diagnostic codes begin with "SPN521," followed by the three digit code number, followed by "FMI31." For example, code 12 will appear as SPN521012FMI31.



Code	Display	Condition	Result	Severity
012	START MSG	normal entry into diagnostic mode	code is not stored	n/a
013	m12VOLT OUTPUT	no 12V power to main controller	drill and drive are blocked	essential
014	m5VOLT OUTPUT	no 5V power from main controller	drill and drive are blocked	essential
015	m6VOLT DRIVER	incorrect voltage on 6V driver on main controller	drive is blocked	essential
016	p12VOLT OUT	no 12V power to pipe controller	drill fluid is blocked	essential
017	p5VOLT OUT	no 5V power from pipe controller	drill fluid is blocked	essential
018	p6VOLT DRIVER	incorrect voltage on 6V driver on pipe controller	code is stored	essential
019	MISC OUTPUT	unknown output driver continuity problem	code is stored	non-essential
020	pMISC OUTPUT	unknown output driver continuity problem in pipe controller	code is stored	non-essential
021	FRWRNCH CLOSE	no continuity to front wrench close solenoid	code is stored	non-essential
023	REWRNCH CLOSE	no continuity to rear wrench close solenoid	code is stored	non-essential
025	WRNCH CW ROT	no continuity to wrench cw rotate solenoid	code is stored	non-essential
031	WRNCH CCW ROT	no continuity to wrench ccw rotate solenoid	code is stored	non-essential
032	SHUTTLE EXT	no continuity to shuttle extend solenoid	add pipe or remove pipe is aborted and code is stored	non-essential
033	SHUTTLE RET	no continuity to shuttle retract solenoid	add pipe or remove pipe is aborted and code is stored	non-essential

Code	Display	Condition	Result	Severity
034	PIPE LIFT	no continuity to pipe lift solenoid	add pipe or remove pipe is aborted and code is stored	non-essential
035	PIPE LOWER	no continuity to pipe lower solenoid	add pipe or remove pipe is aborted and code is stored	non-essential
041	PIPE GRIP	no continuity to pipe grip solenoid	add pipe or remove pipe is aborted and code is stored	non-essential
042	PIPE REL	no continuity to pipe release solenoid	add pipe or remove pipe is aborted and code is stored	non-essential
044	LUBE FRONT	no continuity to lube front solenoid	code is stored	non-essential
045	THRUST 2 SPD	no continuity to thrust two-speed solenoid	code is stored	non-essential
046	AUX DUMP	no continuity to auxiliary dump valve	add pipe or remove pipe is aborted and code is stored	non-essential
047	PIPE BOX IN	no continuity to pipe box in solenoid	code is stored	non-essential
048	PIPE BOX OUT	no continuity to pipe box out solenoid	code is stored	non-essential
051	ROTCW/LTREV	no continuity to rotation cw/left track reverse solenoid	cruise control, carve mode, and drive are blocked	essential
052	ROTCCW/LTFWD	no continuity to rotation ccw/left track forward solenoid	cruise control, carve mode, and drive are blocked	essential
053	THR FWD/RTFWD	no continuity to thrust forward/right track forward solenoid	cruise control, carve mode, and drive are blocked	essential
054	THR BWD/RTREV	no continuity to thrust backward/right track reverse solenoid	cruise control, carve mode, and drive are blocked	essential
055	THR BRAKE REL	no continuity to thrust brake valve	cruise control and carve mode are blocked	essential
057	DRV BRAKE REL	no continuity to ground brake solenoid	code is stored	essential
058	DRIVE SELECT	no continuity to drive selector valve	drive is blocked	essential
059	TKR CNT LIGHT	no continuity to DrillLok [®] light	code is stored	non-essential
061	DFLUID PUMP	no continuity to drilling fluid pump solenoid	code is stored	essential

Code	Display	Condition	Result	Severity
063	DFLUID ENABLE	no continuity to fluid enable solenoid	code is stored	essential
064	DFLUID 2 SPD	no continuity to fluid two-speed solenoid	code is stored	non-essential
074	INNER ROT CW	no continuity to inner rotation clockwise solenoid	code is stored	essential
075	INNER ROT CCW	no continuity to inner rotation counter-clockwise solenoid	code is stored	essential
076	THRUST LIMIT	no continuity to thrust limit solenoid	code is stored	non-essential
081	MAIN WRONG ID	main controller has pipe ID on CAN ID line	controller runs in service mode	essential
082	PIPE WRONG ID	pipe controller has main ID on CAN ID line	controller runs in service mode	essential
083	MAIN INVAL ID	main controller has invalid ID on CAN ID line	controller runs in service mode	essential
084	PIPE INVAL ID	pipe controller has invalid ID on CAN ID line	controller runs in service mode	essential
085	MAIN NOSAV ID	main controller has no saved ID	controller runs in service mode	essential
086	PIPE NOSAV ID	pipe controller has no saved ID	controller runs in pipeloader service mode	essential
087	HARNESS POSN	ID state does not agree with harness position and cannot be resolved	controller runs in EDT only mode	essential
088	CAN BOOT TO	timeout has occurred while waiting for CAN system to boot	controller runs in service mode	essential
091	CAN PHYS ERR	errors on the CAN Bus totaling 275 have been logged	code is stored	non-essential
092	MAIN BUS OFF	main controller has shutdown CAN communications	controller runs in main service mode	essential
093	PIPE BUS OFF	pipe controller has shutdown CAN communications	controller runs in pipeloader service mode	essential
094	MAIN PROTOCOL	main controller has an incorrect protocol message	code is stored	non-essential



Code	Display	Condition	Result	Severity
095	PIPE PROTOCOL	pipe controller has an incorrect protocol message	code is stored	non-essential
096	MAIN NG FAIL	main controller has detected node guard timeout	controller runs in main service mode	essential
097	PIPE NG FAIL	pipe controller has missed a node guard from the master	controller runs in pipeloader service mode	essential
098	MAIN LOG FAIL	pipe controller has had an internal software failure	controller runs in main service mode	essential
099	PIPE LOG FAIL	pipe controller has had an internal software failure	controller runs in pipeloader service mode	essential
111	TETH NG FAIL	tether controller has missed a node guard from the main controller	drive is blocked	essential
112	ESID NG FAIL	ESID controller has missed a node guard from the main controller	code is stored	non-essential
113	ICTR NG FAIL	machine display has missed a node guard from the main controller	code is stored	non-essential
131	THREAR HSW	no continuity to thrust rear home switch	add pipe and remove pipe are blocked	non-essential
132	THFRNT HSW	no continuity to thrust front home switch	add pipe and remove pipe are blocked	non-essential
133	SHUTTL HSW	no continuity to shuttle home switch	add pipe and remove pipe are blocked	non-essential
134	FWRNCH PSW	no continuity to front wrench switch	add pipe and remove pipe are blocked	non-essential
136	TH REAR STOP	no continuity to thrust rear stop switch	add pipe and remove pipe are blocked	non-essential
137	PIPE UP PSW	no continuity to pipe up switch	pipe box movement is blocked and code is stored	non-essential
138	FRONT BOX HSW	no continuity to front pipe box switch	code is stored	non-essential
139	REAR BOX HSW	no continuity to rear pipe box switch	code is stored	non-essential
141	ROTATE POS	no continuity to rotation position sensor	code is stored	non-essential
143	DFLUID GPM	no continuity to drilling fluid speed sensor	code is stored	non-essential

Code	Display	Condition	Result	Severity
146	FLOAT POS	no continuity to float position sensor	assisted makeup is blocked and code is stored	non-essential
147	TKR CONTROL	no continuity to DrillLok [®] input	code is stored	non-essential
149	ANCHOR ON PSW	no continuity to anchor pressure switch	code is stored	non-essential
151	DRL JOY L/R	drill joystick left/right out of range	rotation, cruise control, and carve mode are blocked	essential
152	DRL JOY F/B	drill joystick forward/backward out of range	thrust, cruise control, and carve mode are blocked	essential
153	DRV JOY L/R	drive joystick left/right out of range	drive is blocked	essential
154	DRV JOY F/B	drive joystick forward/backward out of range	drive is blocked	essential
156	DR FLUID POT	drilling fluid potentiometer out of range	code is stored	essential
158	FAN POSN SEN	no information from engine fan pulse pickup sensor	code is stored and fan is controlled without feedback	non-essential
161	ROT PRES SEN	rotation pressure sensor out of range	code is stored	non-essential
162	THR PRES SEN	thrust pressure sensor out of range	code is stored	non-essential
163	DFLD PRES SENS	drilling fluid pressure sensor out of range	code is stored	non-essential
165	SHUTL STOP SW	no continuity to shuttle stop switch	shuttles are blocked	non-essential
171	PIPE GRIP RSW	no continuity to pipe grip rocker switch	code is stored	non-essential
172	SHUTTLE RSW	no continuity to pipe shuttle rocker switch	code is stored	non-essential
173	PIPE LIFT RSW	no continuity to pipe lift rocker switch	code is stored	non-essential
174	PIPE BOX RSW	no continuity to pipe box rocker switch	code is stored	non-essential
175	PIPE LUBE RSW	no continuity to pipe lube rocker switch	code is stored	non-essential
181	FRONT WR RSW	no continuity to front wrench rocker switch	code is stored	non-essential



Code	Display	Condition	Result	Severity
182	REAR WR RSW	no continuity to rear wrench rocker switch	code is stored	non-essential
183	ROT WR RSW	no continuity to rotating wrench rocker switch	code is stored	non-essential
184	THROTTLE RSW	no continuity to throttle rocker switch	code is stored	non-essential
185	SET/RES RSW	no continuity to set/resume rocker switch	code is stored	non-essential
191	JT/AT RSW	no continuity to JT/AT rocker switch	code is stored	non-essential
192	INNER ROT RSW	no continuity to inner rotation rocker switch	inner rotation is blocked	essential
193	INNER ROT POT	inner rotation potentiometer out of range	inner rotation is blocked	essential
194	INNER ROT JOG	inner rotation jog switch out of range	code is stored	non-essential
195	INNER ROT POS	no continuity to inner rotation position sensor	dither compensation is blocked	non-essential
196	IROT PRES SEN	inner rotation pressure out of range	code is stored	non-essential
221	LOW VOLTAGE	system voltage is below 12.5V	code is stored	non-essential
222	INNER ROT SPD	inner rotation position sensor not changing	dither compensation is blocked	non-essential
223	ROTATE SPD	rotation position sensor not changing	full auto pipe is blocked	non-essential
231	PIPELOADER RSW	more than two pipeloader rocker switches are active	pipeloader functions are blocked	essential
233	DRL/DRV SW	both drill (in seat) and drive (tether) operator presence inputs are present	unit will not drill or drive; will recover if condition clears	essential
234	ADDP/REMP SW	add pipe and remove pipe inputs both on	add pipe and remove pipe are blocked	non-essential
235	TH F/R HSW	front and rear home switch inputs both on	add pipe and remove pipe are blocked	non-essential
241	SHUTTLE RESP	shuttles not responding correctly	add pipe or remove pipe is aborted and code is stored	non-essential

Code	Display	Condition	Result	Severity
251	FLOAT ZERO	float sensor is reading too low	assisted makeup is blocked and code is stored	non-essential
252	FLOAT RANGE	float sensor is reading out of range	assisted makeup is blocked and code is stored	non-essential
253	A2D SYNCH	questionable voltage reading on controller circuit board	code is stored	non-essential
254	SETUP TABLE	error reading setup table information	add pipe and remove pipe are blocked	essential
255	MISC CODE	undefinable diagnostic code reported	code is stored	non-essential



IMPORTANT: All ESID diagnostic codes begin with “dc,” followed by the three digit code number. For example, code 502 will appear as dc502.

Code	Display	Condition	Result	Severity
502	2.5V REF	2.5V reference error in ESID	internal reference failure, ESID may not give valid readings	
503	-5V REF	-5V reference error in ESID	internal reference failure, ESID may not give valid readings	
504	CLK RESP	clock response error	clock may not be working	
505	LCD RESP	LCD response error	LCD display may not work	
506	LED RESP	LED response error	LED display may not work	
507	LCD CONTR	LCD contrast error	LCD contrast not saved properly	
508	COP RESET	cop watchdog error	processor has reset, unknown status of ESID code	
510	STRB DVR	strobe driver output error	strobe may not function	
511	HORN DVR	horn driver output error	horn may not function	
512	BAT POWER	battery power/horn driver error	strike hold on power may not function	
513	TEST WIRE	no continuity on test wire for testing ESID	display may not be able to reset ESID	
515	STR VOLT	strike voltage input error		
516	STR COIL	strike current input error		

Code	Display	Condition	Result	Severity
517	POST AC V	self test ac voltage input error	self test of ac voltage stake failed	
518	POST AC I	self test ac current input error	self test of ac current coil failed	
519	POST DC V	self test dc voltage input error	self test of dc voltage input amplifier failed	
520	POST DC I	self test dc current input error	self test of dc current input amplifier failed	
521	V NOT GND	strike voltage input stake not grounded	self test of voltage stake failed	
541	ESID PHYS ERR	errors on the CAN Bus totaling 275 have been logged	code is stored in ESID	
542	ESID BUS OFF	ESID has shutdown CAN communications	CAN information is no longer transmitted to display	
546	MAIN NG FAIL	ESID has not received the Node Guard message from the Main Controller	ESID access via the CAN BUS may not work, but ESID will still sound strike alarms	essential
588	EEP WRITE	EEProm write error	ESID may not be able to record strike history	
589	MISC CODE	invalid error report entry	software error report	

Complete the Job

Chapter Contents

Antifreeze Drilling Unit	184
• Add Antifreeze	184
• Reclaim Antifreeze	185
Rinse Equipment	186
• Using Washwand	186
Disconnect	187
Stow Tools	187

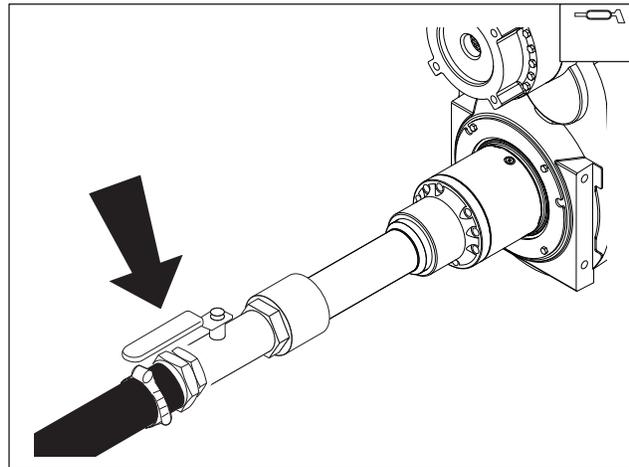


Antifreeze Drilling Unit

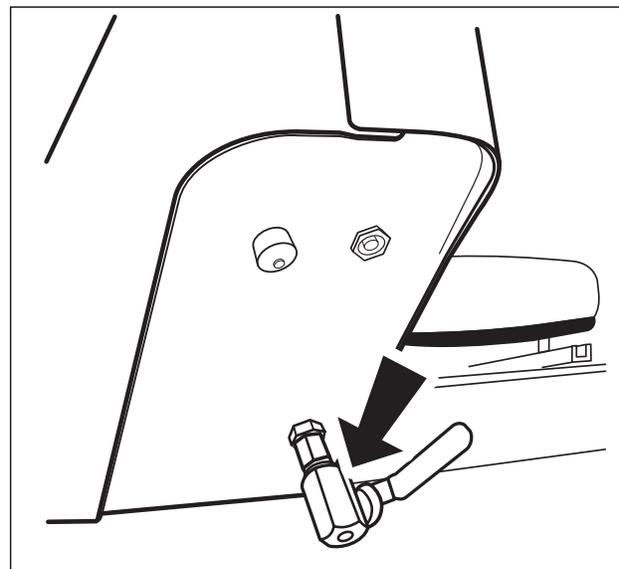
Your drilling unit can be left overnight in freezing conditions by filling fluid lines with a polypropylene-based antifreeze (p/n 265-644) with optional antifreeze system before shutdown.

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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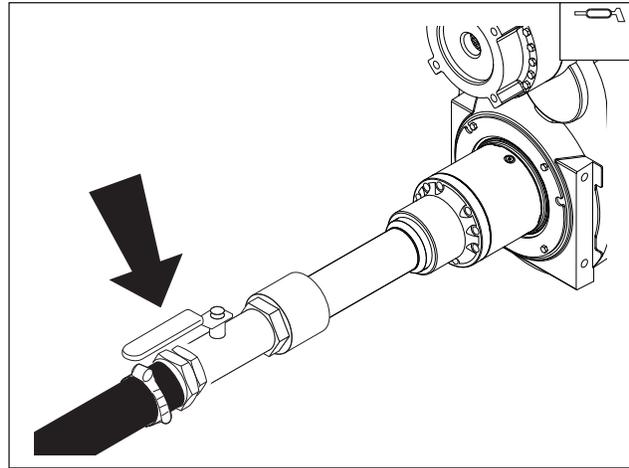


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Reclaim Antifreeze

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.

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.

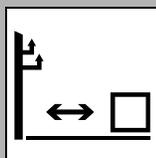


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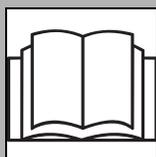
Rinse Equipment

Using Washwand


⚠ DANGER

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

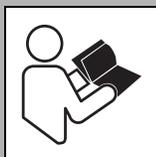
To help avoid injury: Do not point washwand spray at overhead power lines.


⚠ WARNING

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

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 107.


⚠ WARNING

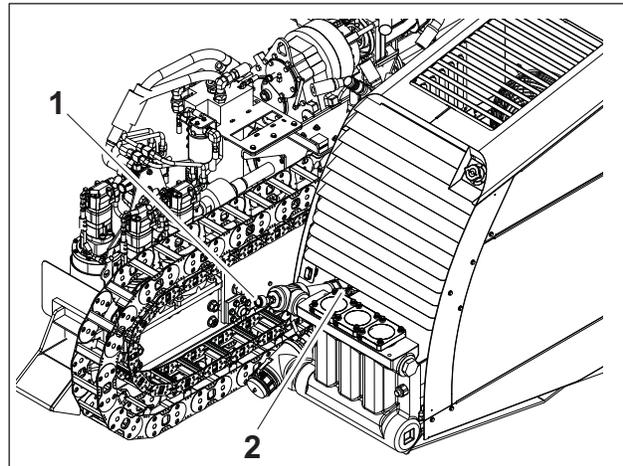
Pressurized fluid or air could pierce skin and cause severe injury. Refer to operator's manual for proper use. 270-6035

To help avoid injury: Never point washwand spray at people, animals or plants.

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.



j40om056w.eps



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.

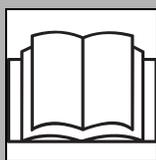
Service

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Service Precautions



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

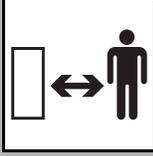
NOTICE: Welding can damage electronics.

- 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.

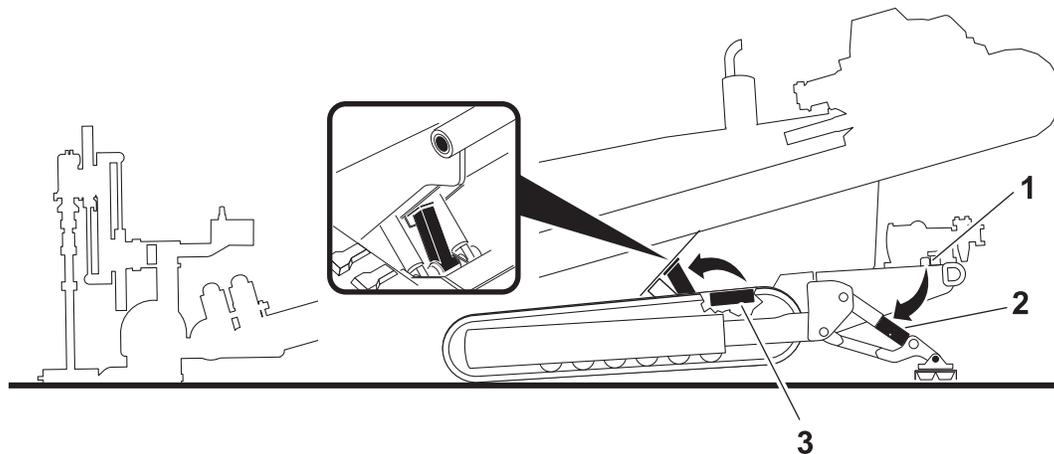
Washing Precaution

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		
 DEO	Diesel engine oil meeting or exceeding Cummins [®] 20081, API CJ-4, ACEA E9. <ul style="list-style-type: none"> • 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. <p>API American Petroleum Institute, ACEA European Automobile Manufacturer's Association.</p>		
 DEF	Diesel exhaust fluid (DEF) meeting ISO 22241-1 or DIN 70070		
 DEAC	Diesel engine antifreeze/coolant meeting CES 14603 See "Approved Coolant" on page 193.		
 PTF	Powershift transmission fluid: Phillips 66 [®] Torque Fluid high-performance, multipurpose, heavy-duty torque converter fluid for use in off-highway powershift transmissions		
 MPG	Multipurpose grease. Use polyurea based NLGI GC-LB Grade 1.5 or lithium based NLGI GC-LB Grade 2.		
 WRG	Multipurpose extreme pressure water resistant grease. Use polyurea based NLGI GC-LB Grade 2		
 EPS	Extreme pressure spray lubricant, Lubriplate LO152-063 or equivalent		
 MPL	Multipurpose gear oil meeting API service classification GL-5 (SAE 80W90)		
 THF	Tractor hydraulic fluid, similar to Phillips 66 PowerTran Fluid, Mobilfluid [®] 423, Chevron Tractor Hydraulic Fluid, Texaco [®] TDH Oil, or equivalent		
 TJC	Tool joint compound: Ditch Witch [®] standard (p/n 259-858) or environmental (p/n 256-1005)		
	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 239.

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

IMPORTANT: Use the "Service Record" on page 245 to record all required service to your machine.

Approved Coolant

This unit was filled with coolant meeting Cummins® CES 14603 before shipment from factory. Add or replace only with coolant meeting this specification, such as Fleetguard® ES Compleat coolant. This coolant is available, pre-diluted, from your Ditch Witch dealer as part number 255-1055. Contact your Cummins service partner for a full list of approved coolants meeting CES 14603.

NOTICE:

- Do not use water or high-silicate automotive-type coolant. This will lead to engine damage or premature engine failure.
- Do not mix heavy-duty diesel engine coolant and automotive-type coolant. This will lead to coolant breakdown and engine damage.



Approved Fuel

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



WARNING

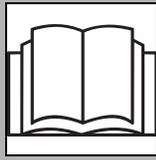
Avoid static electricity when fueling. Ultra Low Sulfur Diesel (ULSD) poses a greater static ignition hazard than earlier diesel formulations. Avoid death or serious injury from fire or explosion. Consult with your fuel system supplier to ensure the delivery system is in compliance with fueling standards for proper grounding and bonding practices.

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 the U.S. and Canada, or 10 mg/kg in EU and Japan) 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.

Diesel Exhaust Fluid (DEF)



⚠ WARNING Incorrect procedures could result in death, injury, or property damage. Learn to use equipment correctly.

To help avoid injury:

- Diesel exhaust fluid is corrosive. Avoid spills. If spill occurs wipe clean immediately.
- Avoid contact with skin. If contact occurs, rinse with water immediately.
- Avoid contact with eyes. If contact occurs, seek medical help immediately.
- Avoid ingestion. If ingested, seek medical help immediately.

This engine requires diesel exhaust fluid (DEF) to meet emission regulations. Use only high quality DEF meeting ISO 22241-1 or DIN 70070 requirements. Running this engine without DEF will increase exhaust emissions and cause engine to derate. Do not dilute or contaminate DEF or substitute other fluids. Tampering with the DEF system will increase exhaust emissions and cause the engine to derate.

DEF has other common names such as Urea, AUS 32, AdBlue, NOx Reduction Agent, and Catalyst Solution.

DEF freezes at 11.3°F (-11.5°C) but the system is designed to prevent freezing during normal operation. If DEF freezes in the tank when the engine is shut down, the system will quickly thaw DEF when engine is started.

DEF has a limited shelf life. In ideal conditions, minimum expected shelf life is 18 months. At temperatures higher than 90°F (32°C), DEF will degrade more rapidly. Do not store in direct sunlight.

Storage and transfer equipment must be compatible with DEF. Most materials (especially hoses) are not compatible and will degrade and contaminate DEF. Never use contaminated DEF. Containers made of polyethylene or polypropylene are recommended.

This machine will consume DEF at a rate between 2 and 3% of diesel consumption. Many factors affect consumption rate, but a good rule of thumb is to fill the DEF tank every time the diesel tank is filled.

Exhaust Cleaning

This engine has a Selective Catalytic Reduction (SCR) system that uses a small amount of DEF to convert NOx emissions in the exhaust into nitrogen and water. The SCR system cleans itself automatically, unless it is manually inhibited by the operator.

Automatic exhaust cleaning happens during normal machine operation when sensors in the engine determine the need. During an engine exhaust cleaning cycle, engine exhaust can reach high temperatures. When this happens, the high exhaust temperature icon will light.



If the jobsite is in an area where high exhaust temperature might cause a problem, inhibit exhaust cleaning through the Tier 4 menu (see "System settings key" on page 29) for the duration of the job and return to automatic cleaning when the job is finished. The exhaust cleaning inhibited icon will light and remain on until the system is returned to automatic exhaust cleaning mode.



The exhaust cleaning icon will light when the system is inhibited and an exhaust cleaning cycle is needed.



- The icon will light when an automatic cleaning is needed. If the area will allow it, return the unit to automatic cleaning mode in the Tier 4 menu and let it run automatically.
- The icon will flash when a manual cleaning is needed. Set the engine to low throttle with no load and initiate the manual exhaust cleaning cycle through the Tier 4 menu. The light will continue to flash until the manual exhaust cleaning cycle is finished (approximately 30 minutes).
- A manual exhaust cleaning cycle is required after automatic exhaust cleaning has been inhibited multiple times. If manual cleaning is not done when indicated, the engine will derate.

Each Use

Location	Task	Notes
DOWNHOLE TOOLS	AT Rockmaster [®] tool	WRG AT only; pump seal grease (p/n 255-1019)

NOTICE: See "Drill Pipe" on page 155 for information and precautions regarding drill pipe.

Downhole Tools

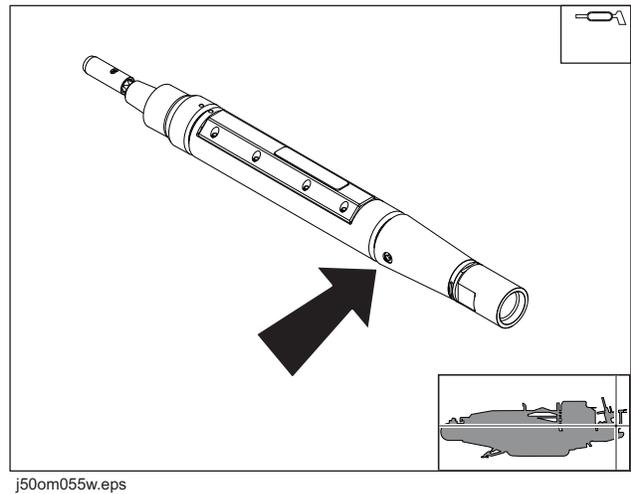
Lube Rockmaster[®] Tool

Lube Rockmaster tool before first use, every 8 hours, and after every bore.

1. Remove plug (shown) from tool body and install zerk.
2. Inject WRG into zerk while rotating the bit.

IMPORTANT: Do not use calcium-based grease. Use only Ditch Witch[®] recommended grease or equivalent.

3. Continue pumping until grease seeps into the gap between the tool body and the bit.
4. Remove zerk and reinstall plug.

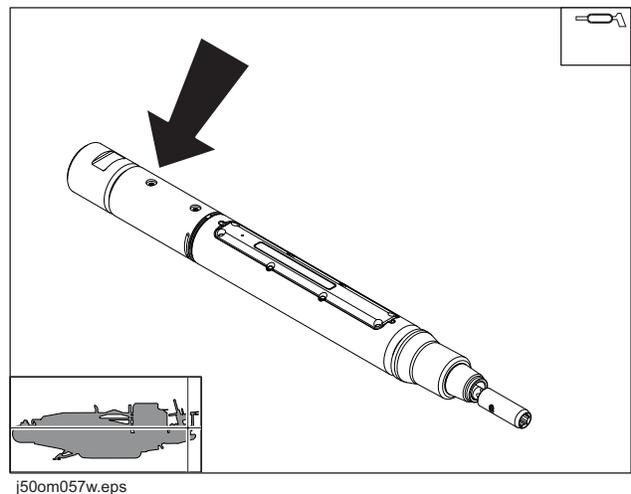


For Rockmaster tool 400-1200 only:

1. Remove plug (shown) from tool body and install zerk.
2. Inject WRG into zerk.

IMPORTANT: Do not use calcium-based grease. Use only Ditch Witch[®] recommended grease or equivalent.

3. Continue pumping until grease seeps into gap between tool body and the bit.
4. Remove grease gun and step away. Communicate to drill operator to rotate bit.



5. Repeat steps 2-4 until grease that seeps into gap between tool body and the bit is free from contaminants.

IMPORTANT: If more than one cup of drilling fluid is displaced while greasing, inspect and repack bearings and replace seals.

6. Remove zerk and reinstall plug.



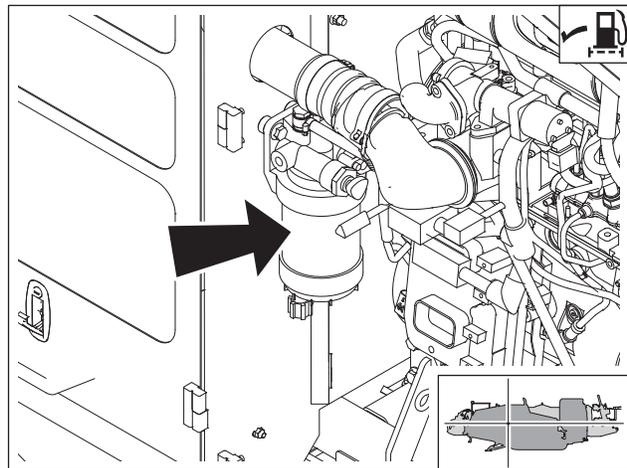
Startup/10 Hour

Location	Task	Notes
DRILLING UNIT	Check fuel filter water separators	
	Check engine oil level	DEO
	Check engine coolant level	DEAC
	Check hydraulic hoses	
	Empty dust ejector valve	
	Check hydraulic fluid level	THF
	Check fluid pump oil level	TF30
	Test pipel loader control switches	
	Check pipe lube applicator	
	Check pipe auto lubricator spray nozzle	
	Check pipe auto lubricator level	TJC
	Check drilling fluid y-strainer	
	Inspect crankcase breather tube	
	Check liner washer fluid level	

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.

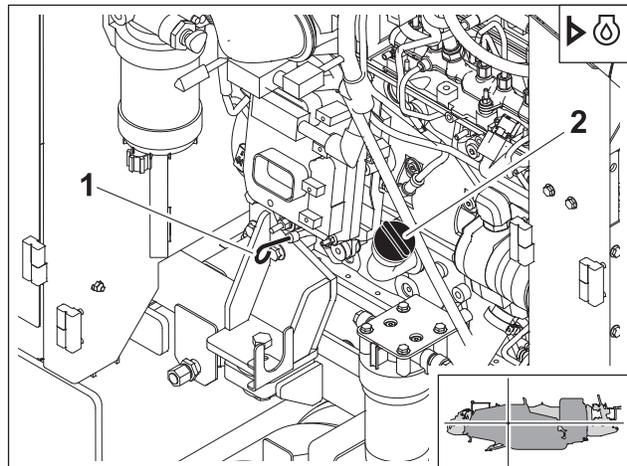


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Check Engine Oil Level

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

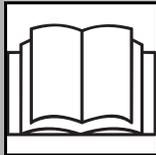
IMPORTANT: See "Recommended Lubricants/Service Key" on page 192 for more information on engine oil.



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Check Engine Coolant Level



⚠ WARNING

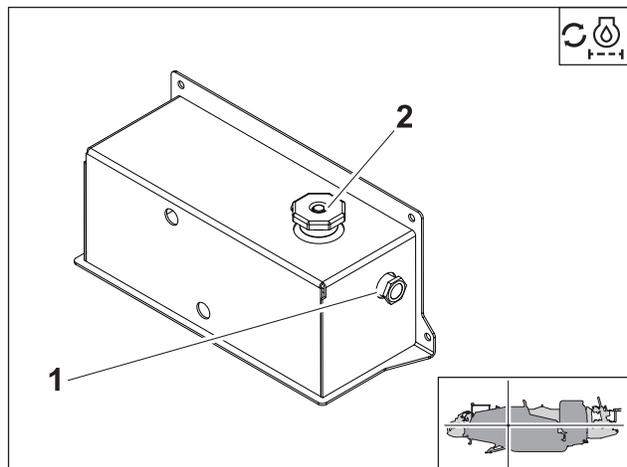
Contents under pressure. Relieve pressure before opening. Death or injury could occur.

To help avoid injury:

- Do not remove the pressure cap from a hot engine.
- Wait until the coolant temperature is below 122°F (50°C) before removing pressure cap.
- Do not stand near or over the expansion tank while operating the engine with the pressure cap off.

With engine cool, check coolant level at fill neck (1) in expansion tank before startup and every 10 hours of operation. Maintain coolant level at bottom of fill neck. If low, add approved coolant at fill (2) according to instructions on page 220.

IMPORTANT: See "Approved Coolant" on page 193 for information on approved coolant.



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Check Hydraulic Hoses

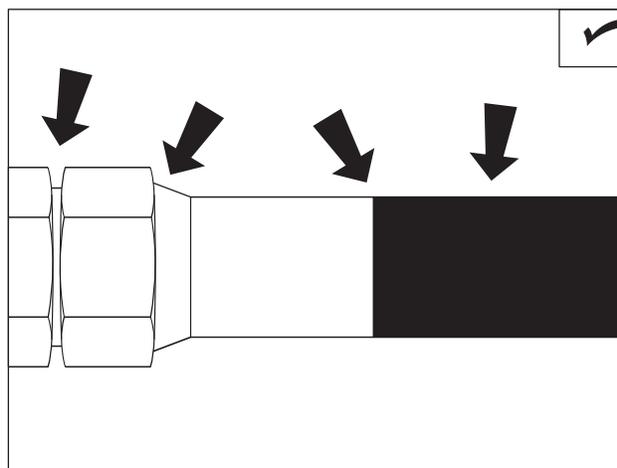


WARNING Pressurized fluid or air could pierce skin and cause severe injury. Refer to operator's manual for proper use. 270-6035

To help avoid injury:

- 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.

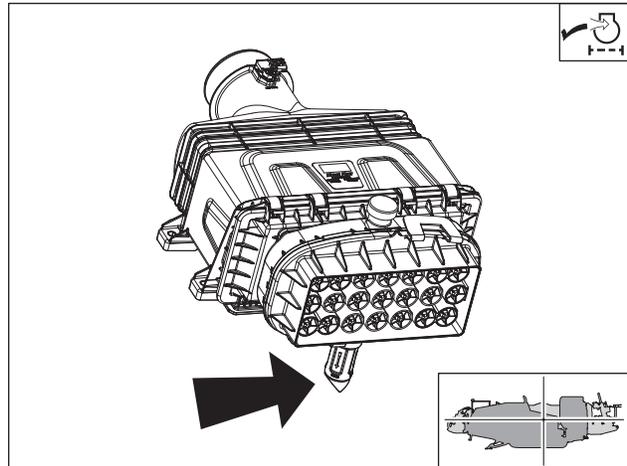
Check hydraulic hoses for leaks before startup and every 10 hours of operation.



CheckHoses.eps

Empty Dust Ejector Valve

Empty dust ejector valve (shown) before startup and every 10 hours of operation. Ensure that valve is not inverted, damaged, plugged or cracked.

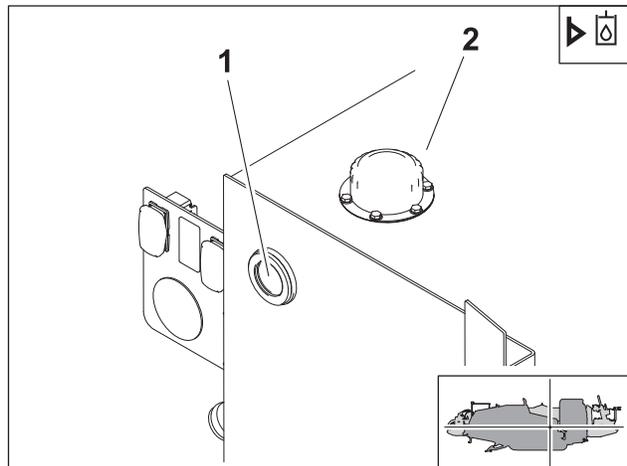


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Check Hydraulic Fluid Level

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).

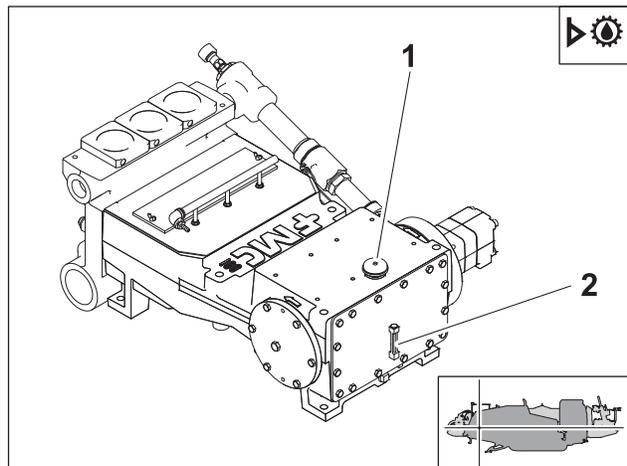
IMPORTANT: If hydraulic system must be opened for repair, install new filter (p/n 157-486) for first 50 hours of operation. If this filter becomes plugged in fewer than 20 hours, replace with clean filter. After 50 hours of normal operation, replace with clean filter.



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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 PTF30.



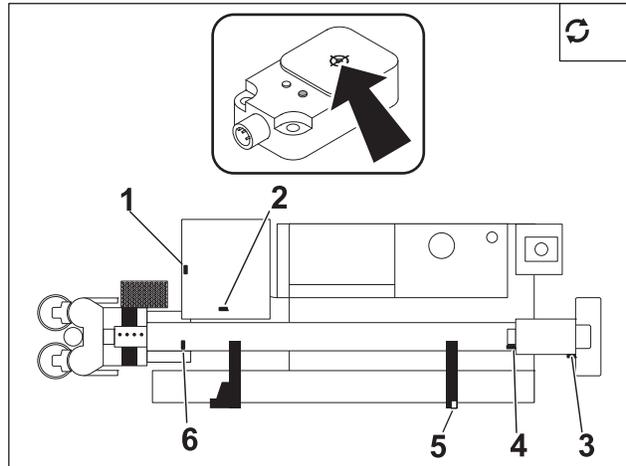
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Test Pipeloader Control Switches

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



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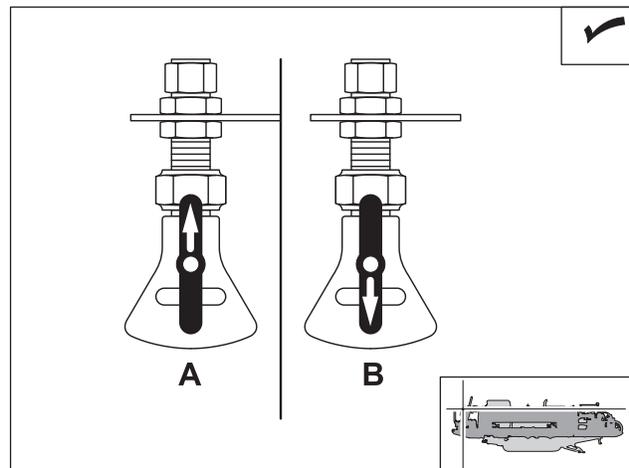
To test:

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

Check Pipe Auto Lubricator Spray Nozzle

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

NOTICE: Ditch Witch® tool joint compound is specially formulated to work with Ditch Witch pipe lubrication system. Use of other tool joint compounds will clog system. See “Recommended Lubricants/Service Key” on page 192 for more information.



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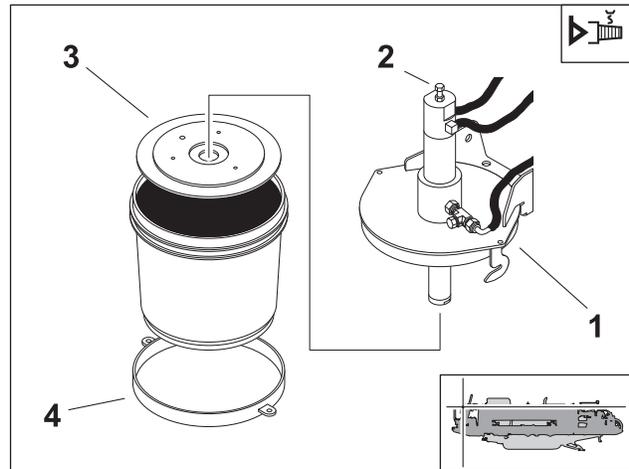
To clean:

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 Level

Check pipe auto lubricator TJC level before startup and every 10 hours of operation. Change pail as needed. See "Change Pipe Auto Lubricator Pail" on page 227 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 192 for more information.

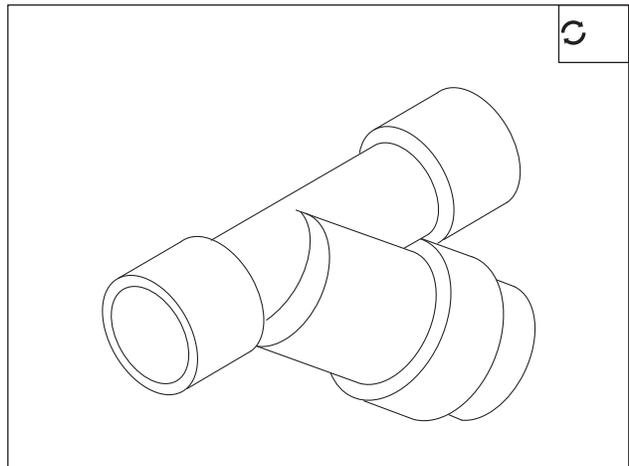


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Clean Drilling Fluid Y-Strainer

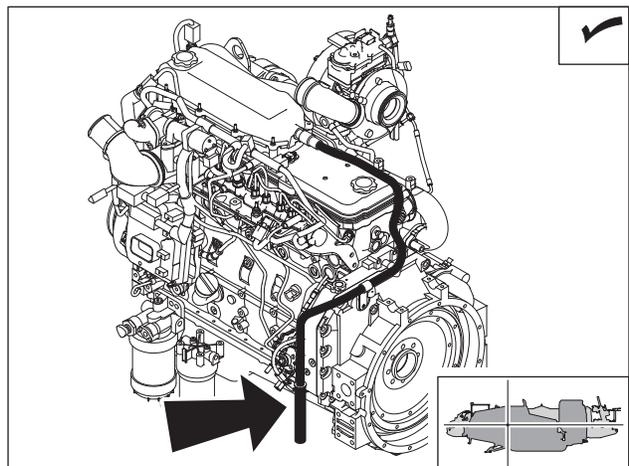
Clean drilling fluid y-strainer before startup and every 10 hours of operation. Ensure that strainer is free of debris.



Y_Strainer_Clean.eps

Inspect Crankcase Breather Tube

Inspect crankcase breather tube (shown) for debris before startup and every 10 hours of operation.

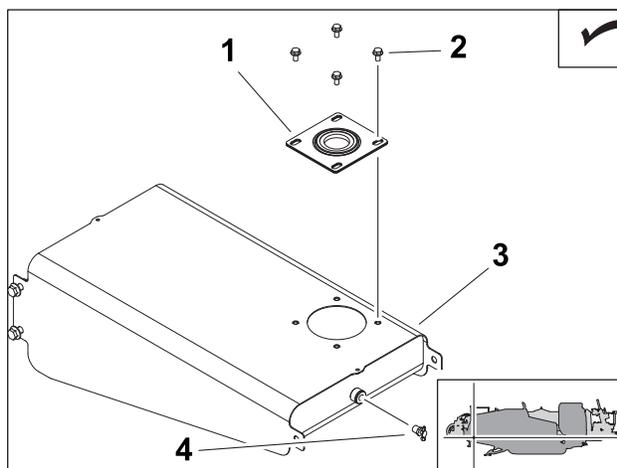


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Check Liner Washer Fluid Level

Check liner washer fluid is full to the drain valve (4) before startup and every 10 hours of operation.

To check fluid remove tank flange (1) from wash tank (3) by removing screws. at tank flange (1) and fill as needed.



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50 Hour

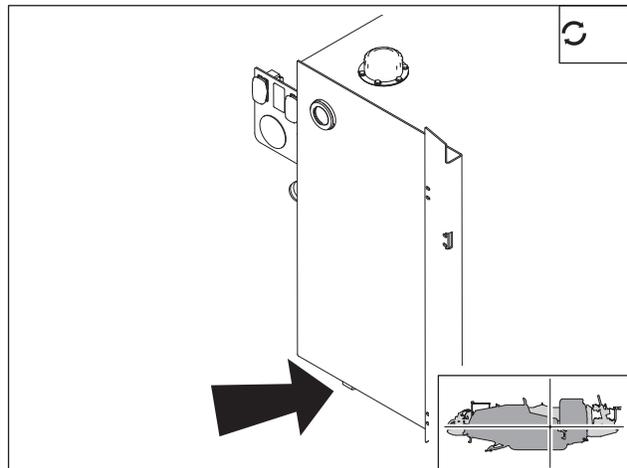
Location	Task	Notes
DRILLING UNIT	Drain water from hydraulic tank	
	Change fluid pump oil	initial service, PTF
	Change hydraulic filters	initial service
	Check ground drive gearbox oil level	2 gearboxes, MPL
	Check rotation gearbox oil level	MPL
	Check thrust drive gearbox oil level	4 gearboxes, MPL
	Check anchor gearbox oil level	
	Check radiator for debris	
	Check hex	EPL spray
	Clean liner washer tank strainer	
DOWNHOLE TOOLS	Rebuild Rockmaster [®] tool	AT only; kit available



Drilling Unit

Drain Water from Hydraulic Tank

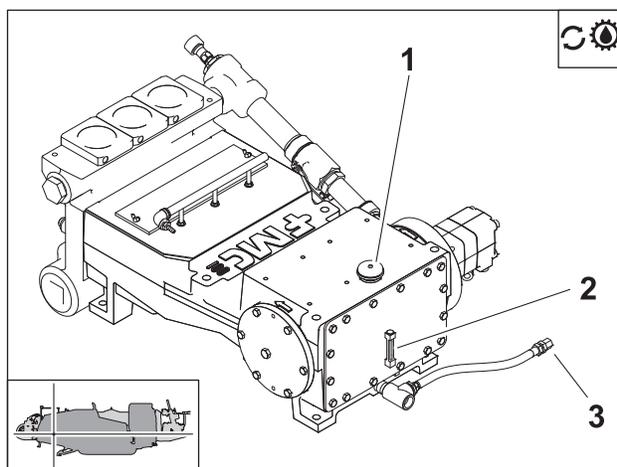
Drain water out of tank every 50 hours. To drain, turn plug slightly until water comes out. After all water has drained, tighten plug.



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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 PTF. Capacity for 150 gpm pump is 10 qt (9.4 L).

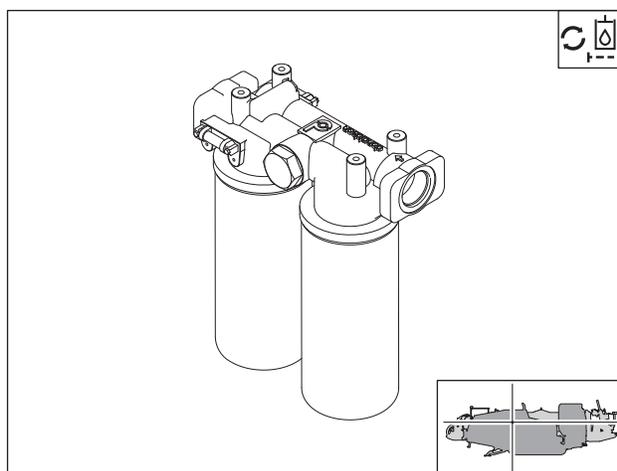


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Change Hydraulic Filters (Initial Service)

Change the hydraulic filters after first 50 hours. Replace filters every 500 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

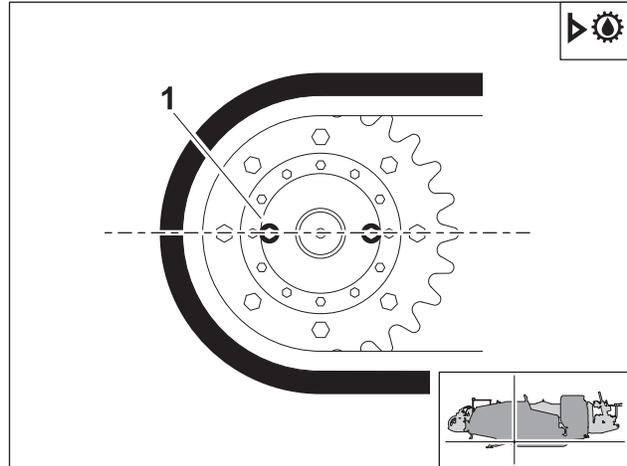
Check oil level in both ground drive gearboxes every 50 hours.

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.



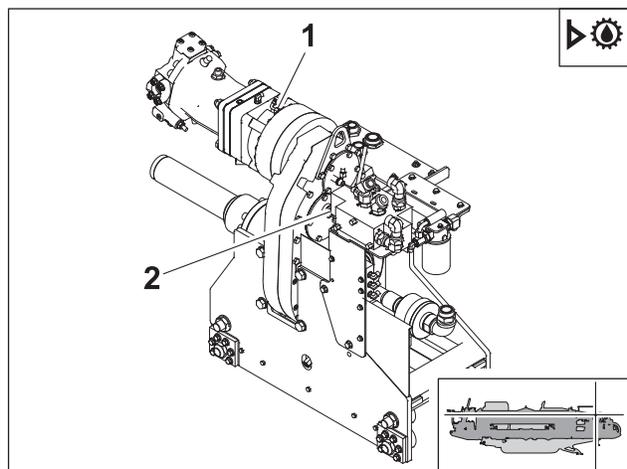
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Check Rotation Gearbox Oil Level

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.

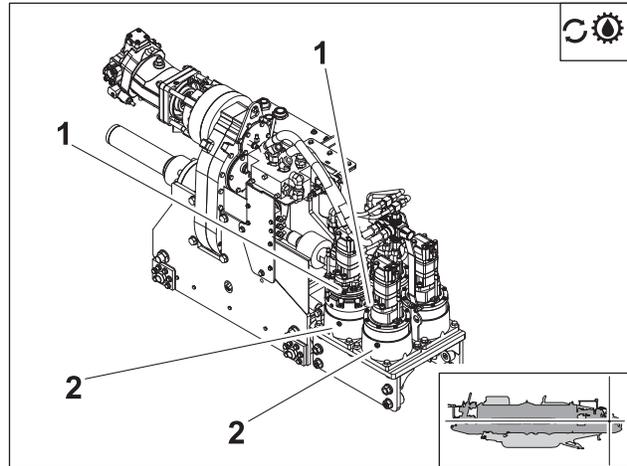


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Check Thrust Drive Gearbox Oil Level

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.

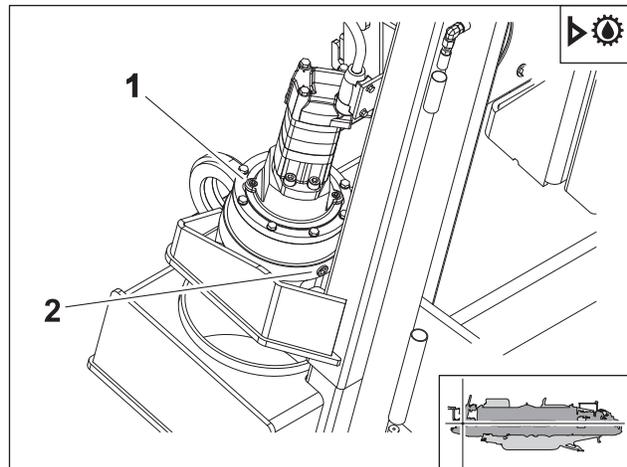


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Check Anchor Gearbox Oil Level

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.

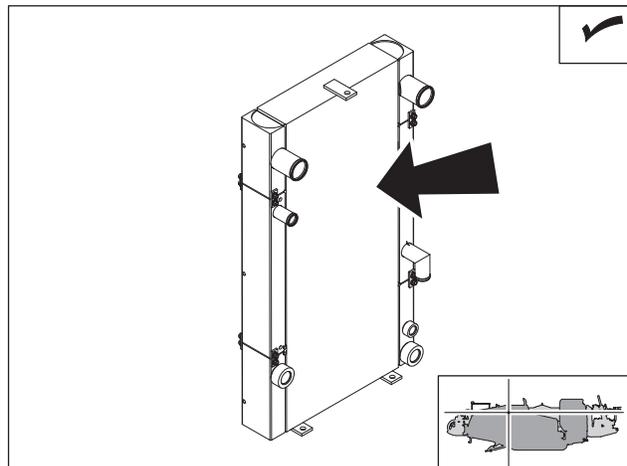


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Check Radiator For Debris

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.



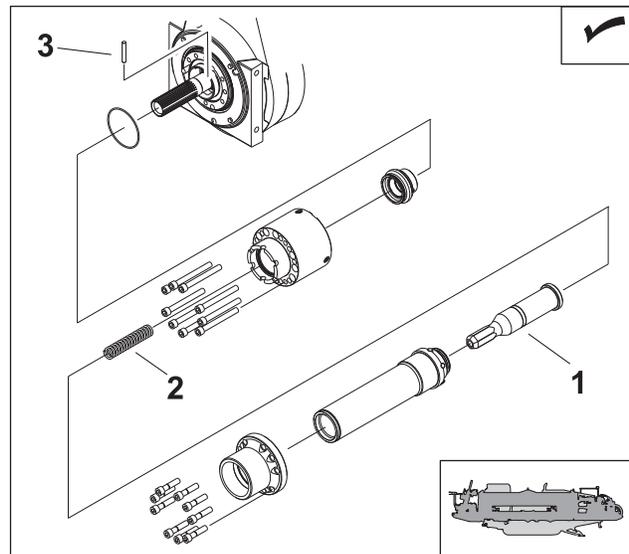
j52om024h.eps

Check Hex

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 230.

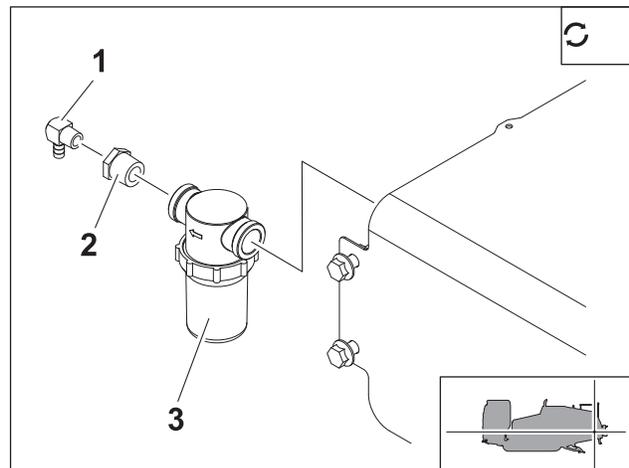


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Clean Liner Washer Tank Strainer

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.



j52om025h.eps

Downhole Tools

Rebuild Rockmaster® Tool

Rebuild downhole tool every 50 hours as measured by inner rotation hourmeter. Use kits indicated by the chart below to rebuild downhole tool. Kits are available at your Ditch Witch® dealer.

Rebuild Kit	Rockmaster Tool
191-208	350-1254
	400-1314
	401-329
	401-159
190-2084	400-1200

200 Hour

Location	Task	Notes
DOWNHOLE TOOL	Replace drive shaft on AT Rockmaster® housing (excluding 400-1200)	

Replace Drive Shaft

Replace drive shaft on AT Rockmaster housing (excluding 400-1200) every 200 hours as measured by inner rotation hourmeter when rebuilding AT Rockmaster tool. See your Ditch Witch® dealer for parts.

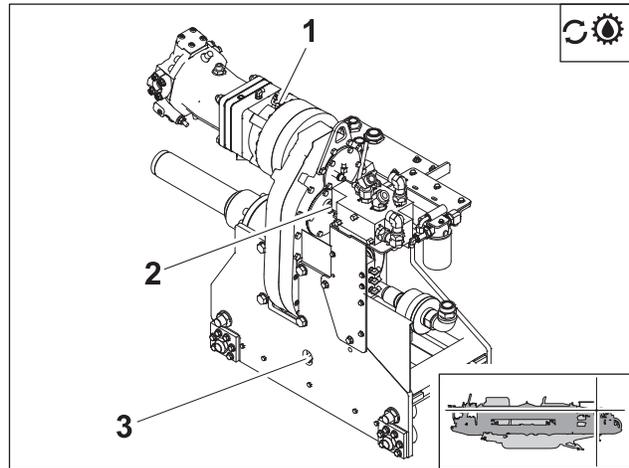
250 Hour

Location	Task	Notes
DRILLING UNIT	Change rotation gearbox oil	MPL
	Inspect air intake system	

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).

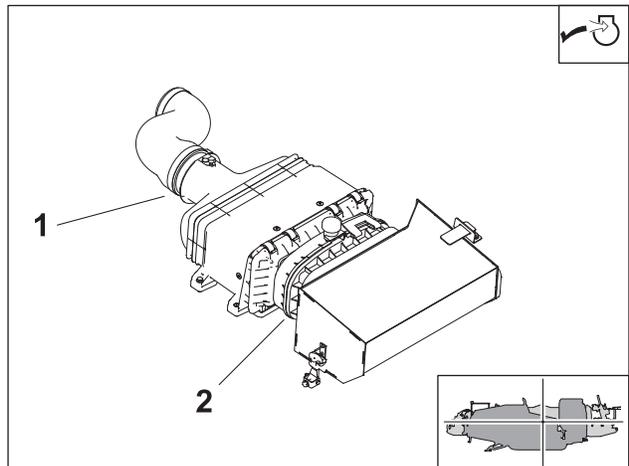
IMPORTANT: Drill frame must be level for accurate reading.



j52om026h.eps

Inspect Air Intake System

Inspect intake piping (1) for cracked hoses, loose clamps, or punctures. Inspect seal (2) for damage. Verify a positive seal to the air box. Tighten or replace parts as necessary.



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500 Hour

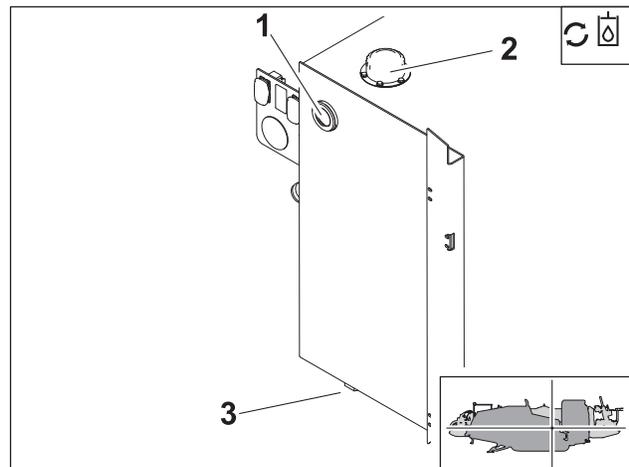
Location	Task	Notes
DRILLING UNIT	Change hydraulic fluid and filters	THF, extreme temperatures
	Change engine oil and filter	DEO
	Change fuel filters	

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 (3), change filters, and refill with THF at hydraulic fluid fill (1,2). 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.

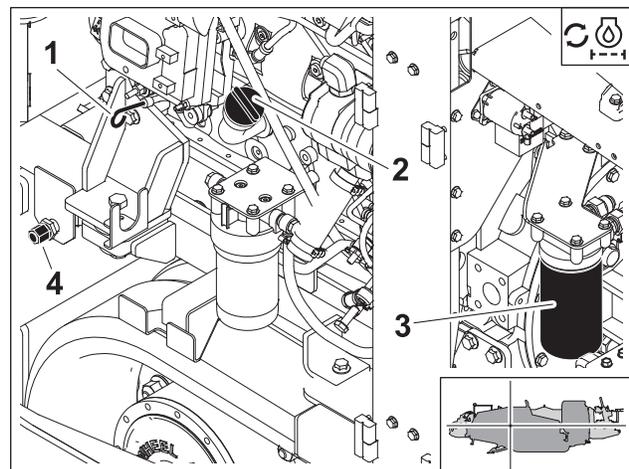


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Change Engine Oil and Filter

Change engine oil and filter every 500 hours

1. While oil is warm, remove drain plug (3). Drain oil and replace plug
2. Remove filter (4) and replace with new filter each time oil is changed.
3. Add DEO at fill (2).
4. Check oil level at dipstick (1).

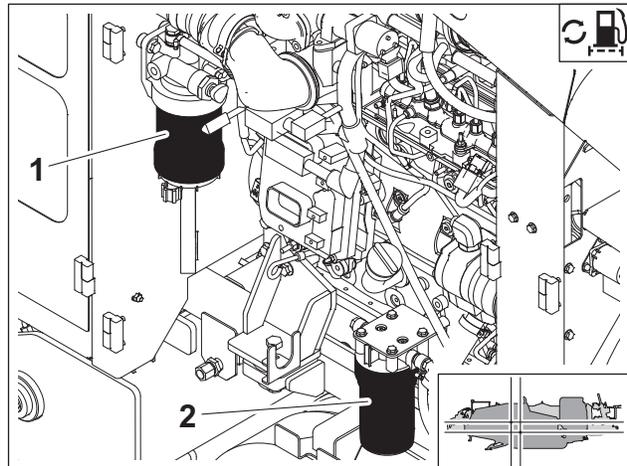


j52om010h.eps

Change Fuel Filters

Replace fuel pre-filter(1) and primary fuel filter (2) every 500 hours.

IMPORTANT: Do not prefill filters with diesel.
Use hand pump to prime.



j52om073h.eps



1000 Hour

Location	Task	Notes
DRILLING UNIT	Change hydraulic fluid and filters	normal conditions
	Change ground drive gearbox oil	2 gearboxes, MPL
	Change JT rotation gearbox oil	2 gearboxes, MPL
	Change AT rotation gearbox oil	2 gearboxes, MPL
	Change thrust drive gearbox oil	2 gearboxes, MPL
	Change spindle brake oil	THF
	Change fluid pump oil	PTF
	Change anchor driver gearbox oil	
	Lube SaverLok [®] wrench collar and sliding output shaft	EPS
	Change engine drive belt	
	Replace diesel exhaust fluid (DEF) tank filter	
	Change rotation, thrust, and fluid pump remote charge filter	

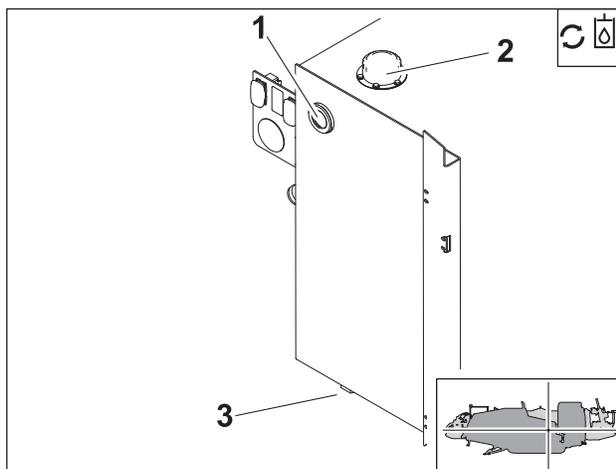
Drilling Unit

Change Hydraulic Fluid and Filters (Normal Conditions)

Change hydraulic fluid and three filters every 1000 hours for normal service. Drain hydraulic fluid (3), change filters, and refill with THF at hydraulic fluid fill (1, 2). 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.



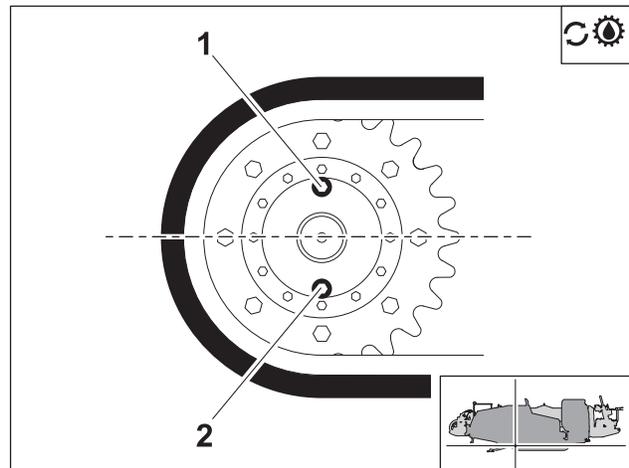
j52om027h.eps

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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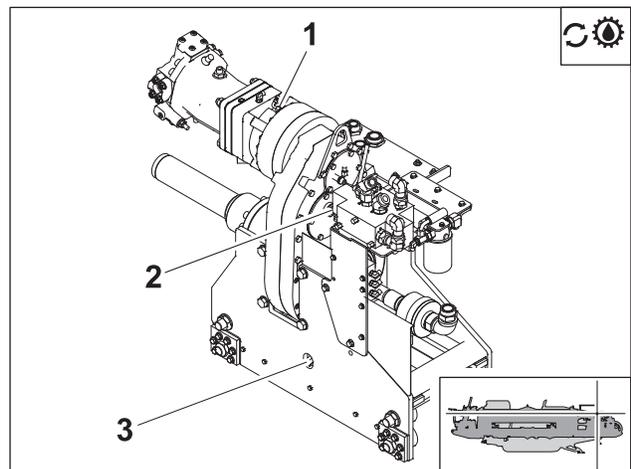


IMPORTANT:

- 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 JT Rotation Gearbox Oil

Move carriage down drill frame until it is even with cab. Swing cab out for access to gearbox. Drain oil at gearbox oil drain (2) every 1000 hours. Replace drain plug and add MPL at fill plug (1) until fluid level is approximately 1/3 of the way up the sight tube (shown). Replace fill plug.

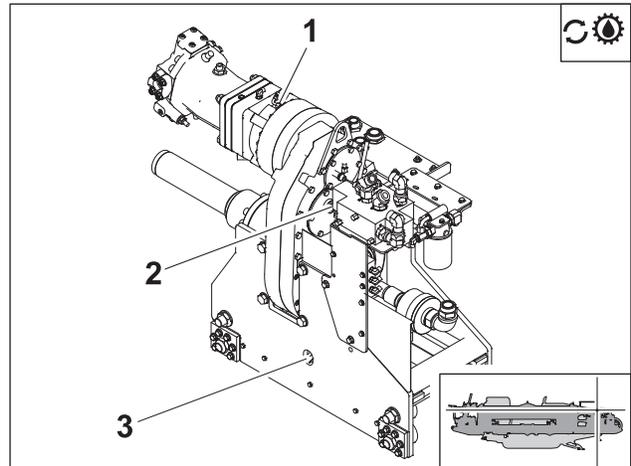


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Change AT Rotation Gearbox Oil

Drain oil at gearbox oil drain (3) every 1000 hours. Add 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.



j52om026h.eps

Change Thrust Drive Gearbox Oil

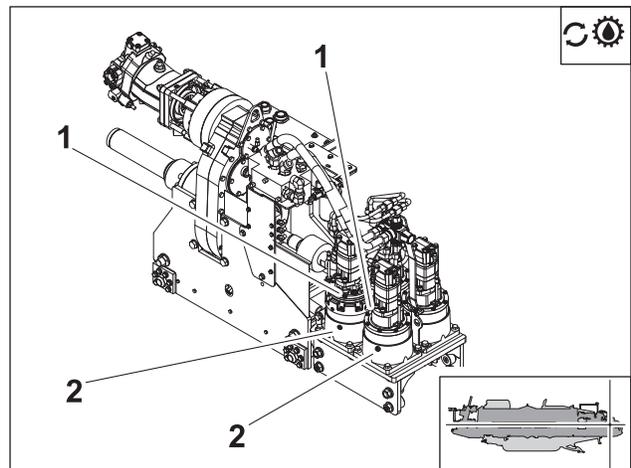
Change thrust drive gearbox oil every 1000 hours. Capacity is 26 oz (0.77 L) of MPL per gearbox.

To change:

1. Ensure that drill frame is level.

IMPORTANT: Gearbox must be level for accurate reading.

2. Remove four plugs (1) and drain oil from each gearbox. Use suction to remove all oil from gearboxes.
3. Remove four fill plugs (2, 3).
4. Add MPL to each gearbox until oil level reaches plug 1.
5. Install all plugs.

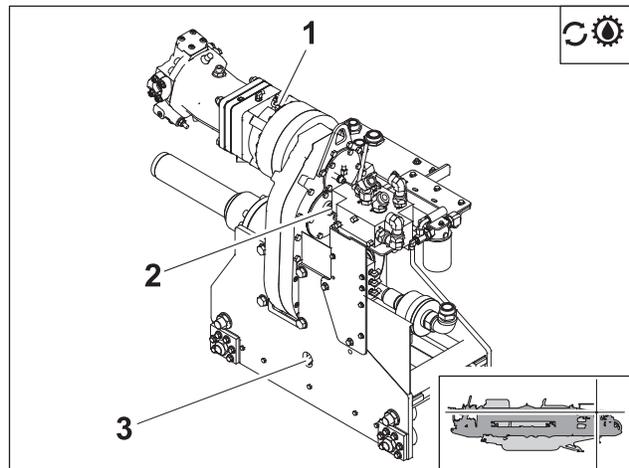


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Change Rotation Gearbox Oil

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.



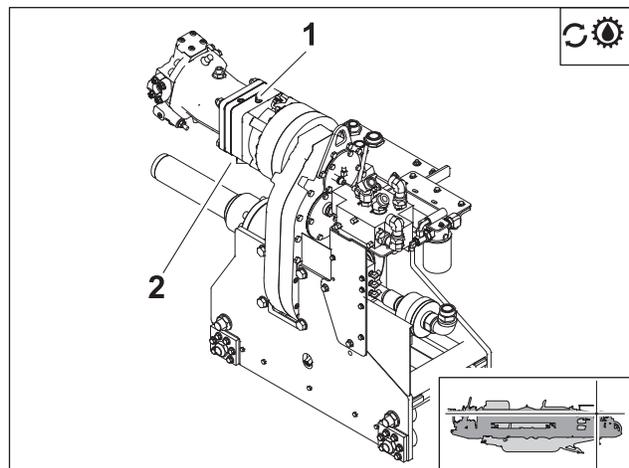
j52om026h.eps

Change Spindle Brake Oil

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

To change:

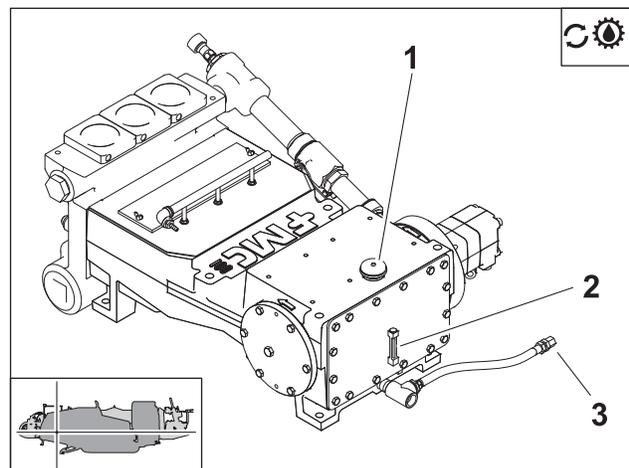
1. Remove plug on bottom of brake.
2. Refill with THF at fill plug (2). Do not overfill.
3. Reinstall outer rotation motor.



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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 PTF30.



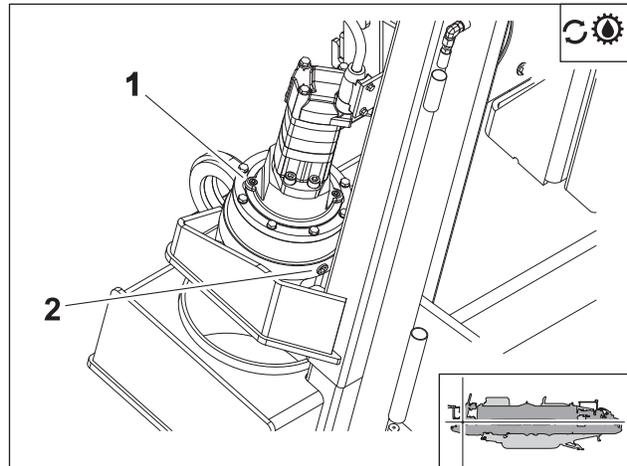
j52om018h.eps



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.



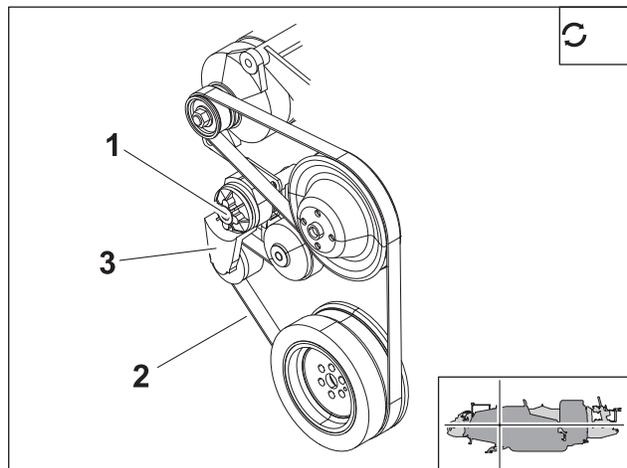
j52om032h.eps

Change Engine Drive Belt

Change drive belt every 1000 hours.

To change

1. Turn off engine and remove key.
2. Use a 1/2" drive ratchet at pulley (1) to remove tension.
3. Remove belt (2).
4. Inspect engine belt tensioner (3) for damage and debris.
5. Install new belt.

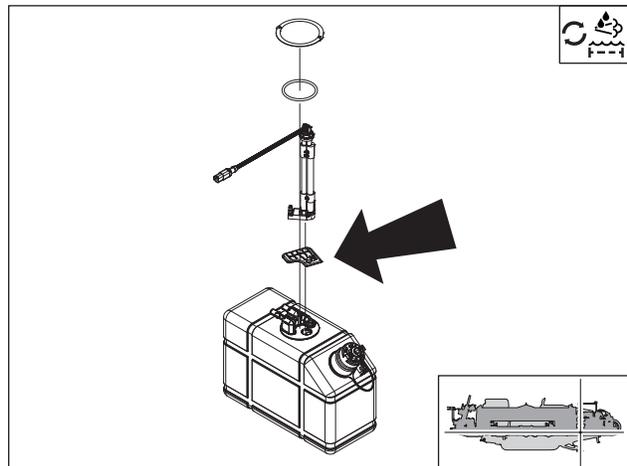


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Change Diesel Exhaust Fluid (DEF) Tank Filter

Change DEF filter (shown) every 1000 hours. Contact your Ditch Witch® dealer for more detailed information.

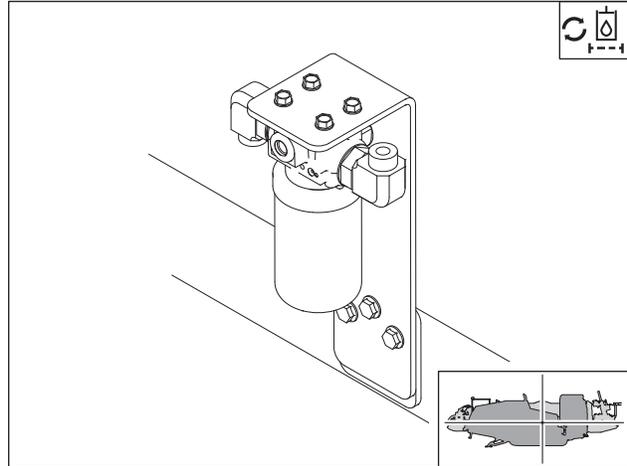
1. Remove multifunction head unit from DEF tank. Take care not to damage unit during removal.
2. Remove retention screw and discard.
3. Pull filter off suction tube and discard.
4. Position new filter suction tube housing onto the bottom of the suction tube and press flush against bottom of heater tube fin. Ensure filter retention screw aligns with retention screw housing.
5. Install new retention screw.
6. Install multifunction head unit into DEF tank. Take care not to damage unit during installation.



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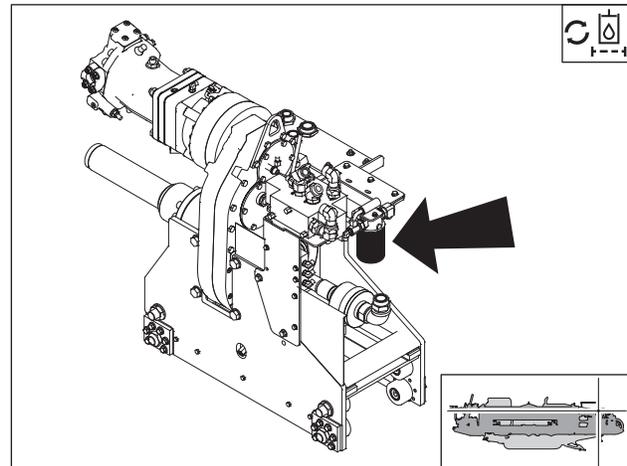
Change Rotation, Thrust, and Fluid Pump Remote Charge Filter

Change remote charge filter every 1000 hours, when changing hydraulic fluid.



j52om028h.eps

Change rotation, thrust filter every 1000 hours.



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2000 Hour

Location	Task	Notes
DRILLING UNIT	Change JT fluid pump oil	PTF
	Change engine coolant	DEAC
	Replace crankcase ventilation filter	

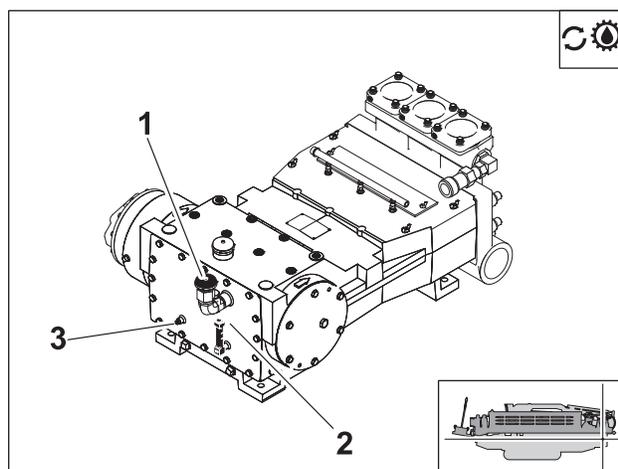
Drilling Unit

Change JT Fluid Pump Oil

Change fluid pump oil every 2000 hours.

To change:

1. Drain oil at plug (3). Ensure that the drain plug is cleaned of debris before reinstalling.
2. Add 12 qt (11.3 L) of PTF at fill (1) until oil level is at middle of sight tube (2).



j48om028h.eps

Change Engine Coolant



⚠ WARNING Contents under pressure. Relieve pressure before opening. Death or injury could occur.

To help avoid injury:

- Do not remove the pressure cap from a hot engine.
- Wait until the coolant temperature is below 122°F (50°C) before removing pressure cap.
- Do not stand near or over the expansion tank while operating the engine with the pressure cap off.

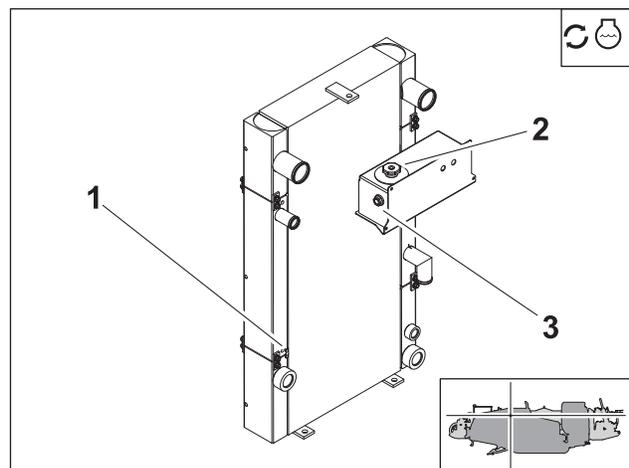


⚠ CAUTION Improper handling or use of chemicals may result in illness, injury, or equipment damage. Follow instructions on labels and in material safety data sheets (MSDS).

To help avoid injury:

- Keep coolant away from children and pets.
- Dispose of coolant in accordance with local environmental regulations.

Drain cooling system at drain (3) every two years or 2000 hours. Add DEAC at radiator cap (2) according to instructions below until fluid level is to the halfway point on the sight glass (1).



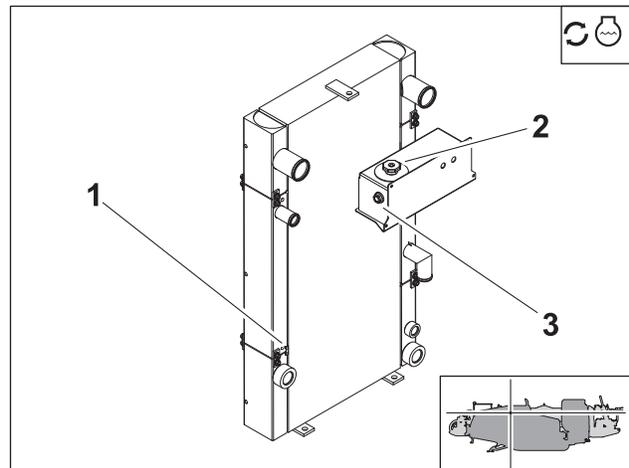
j52om035h.eps

To fill

NOTICE:

- The cooling system must be filled and vented properly to prevent air locks from causing serious engine damage.
- Do not operate the engine with the pressure cap off at temperatures above 200°F (93°C).
- Allow the system temperature to cool to ambient before adding coolant.
- The use of non-approved coolant may lead to engine damage or premature engine failure and will void engine warranty.
- See “Approved Coolant” on page 193 for list of approved coolants.
- Use only distilled water for mixing coolants. Do not use tap water.

1. Open all shutoff valves, if equipped, to ensure as much air as possible will be purged from the heating circuit.
2. Remove pressure cap (1) on expansion tank.
3. Add coolant at a rate of 3 gpm (11.4 L/min) or less until fluid is to the halfway point on the sight glass (2).
4. Keep engine off for 2-3 minutes to allow the system to naturally free trapped air and let coolant level stabilize.
5. Add additional coolant to bring the coolant level back to the halfway point on the sight glass (2).
6. Set cab heater switches to maximum heat in order to allow maximum coolant flow through the heater core.
7. With pressure cap removed, start the engine and run at low throttle for 2 minutes.
8. Shut the engine off and add coolant to bring the level back to the halfway point on the sight glass (2).
9. With the pressure cap removed, start the engine and increase the speed to high throttle.
10. Let the engine run until the thermostat opens, approximately 10 minutes.
11. Shut engine off and allow it to cool to ambient temperature. Do not install pressure cap.
12. Add additional coolant, if needed, to bring the level back to the halfway point on the sight glass (2).
13. Install the pressure cap.
14. Start the engine and increase speed to high throttle.
15. Continue until it reaches a temperature of 176°F (80°C) and check for coolant leaks.



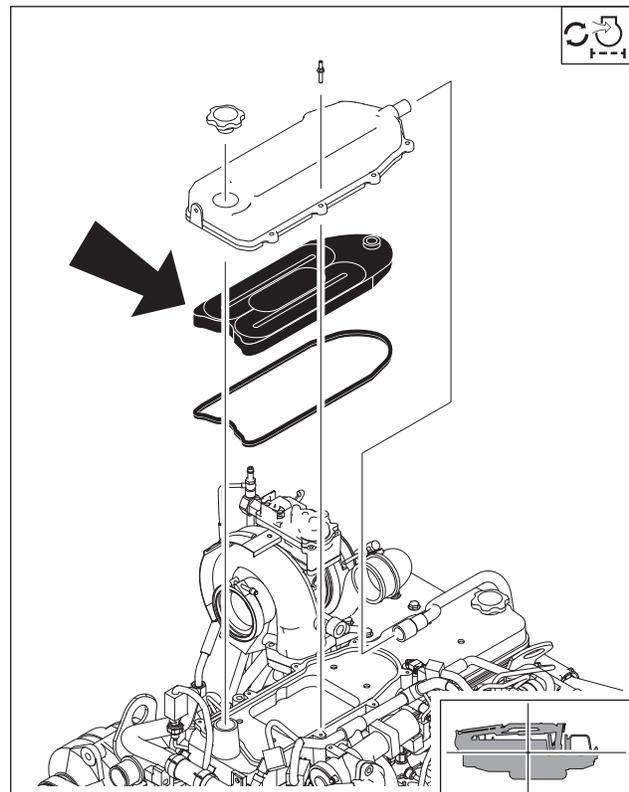
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Replace Crankcase Breather Filter

Replace crankcase breather filter every 2000 hours.

To replace:

1. Disconnect crankcase ventilation hose.
2. Turn breather housing cover knob counterclockwise and remove securing screws.
3. Remove filter element (shown).
4. Install the new filter element either end up in the crankcase ventilation breather housing.
5. Install breather housing cover using screws and turning cover knob clockwise.
6. Install crankcase ventilation hose.



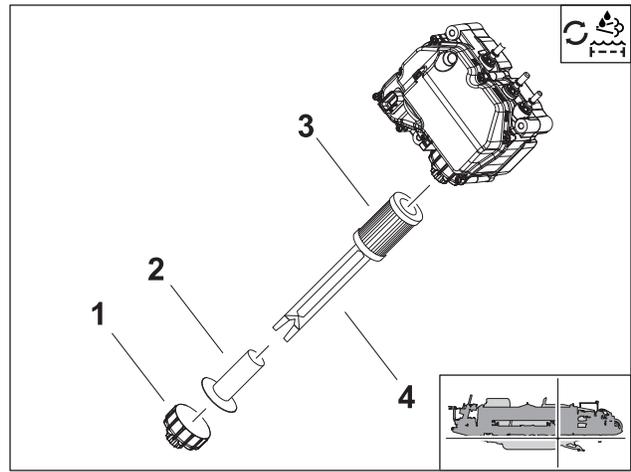
4500 Hour

Replace Diesel Exhaust Fluid (DEF) Pump Filter

Replace diesel exhaust fluid (DEF) pump filter every 4500 hours or every 3 years.

To remove:

1. Unscrew DEF filter cap (1) and inspect threads for damage. Replace if needed.
2. Remove the DEF filter equalizing element (2).
3. Remove DEF dosing unit filter element (3) using disposable service tool (4).



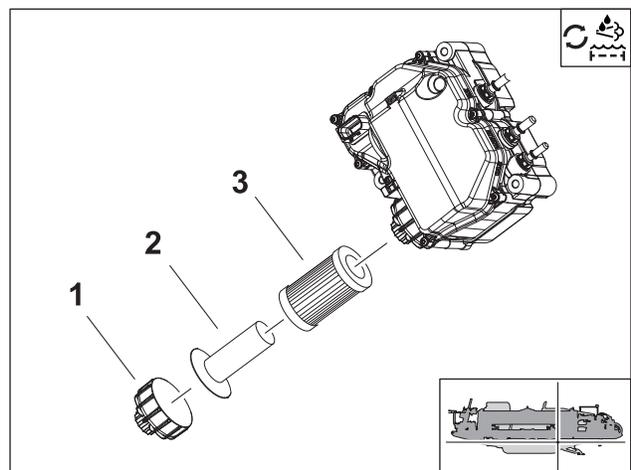
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IMPORTANT: A disposable service tool is included with the filter to aid in filter removal.

- Use the color of the plastic on the filter to determine which end of the tool to use.
- When inserting the tool, a “click” sound will indicate proper engagement with the filter.

To install:

1. Slide DEF filter equalizing element (2) into the DEF filter cartridge (3).
2. Insert filter equalizing element and filter cartridge assembly into the DEF dosing unit.
3. Install cap (1) and tighten to 177 in•lb (20 N•m).



j52om037h.eps

As Needed

Location	Task	Notes
DRILLING UNIT	Change air filter	
	Change pipe auto lubricator pail	TJC
	Change hydraulic filters	any time system is opened
	Check pipeloader inserts	
	Check front pipe glide blocks	
	Check wrench jaw inserts	
	Check fluid pump ball valve	
	Check track tension and condition	
	Check track support slide pads	
	Check SaverLok [®] System	
	Clean crankcase breather tube	
	Change inner water swivel (seal kit)	
	Change wireless ground drive controller batteries	
	Check batteries	
	Charge battery	



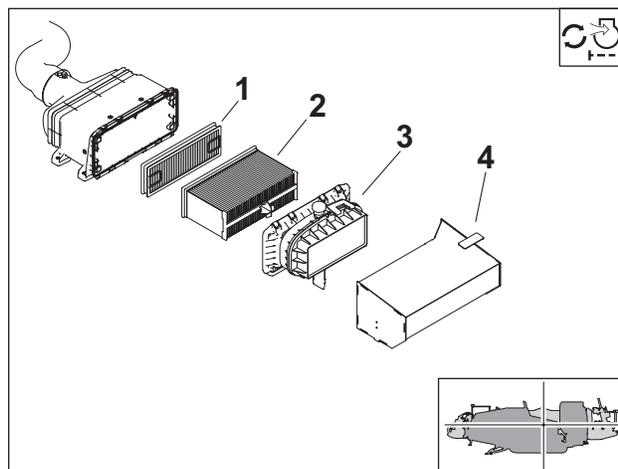
Drilling Unit

Change Air Filter

Change air filter when indicated by the display. Replace secondary element (1) every third change of primary filter (2).

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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To change

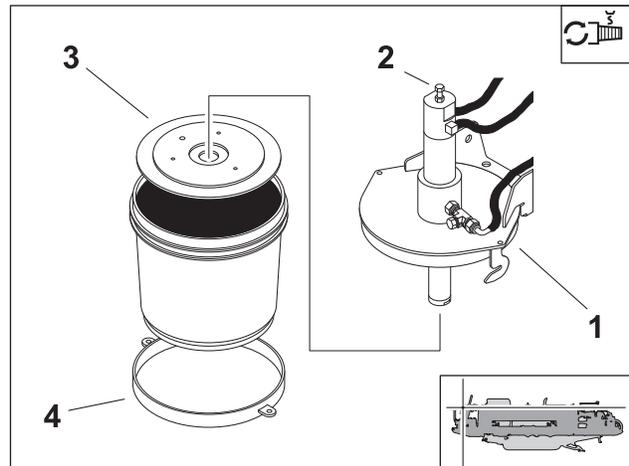
1. Remove air box (4) by disengaging the latch.
2. Remove air filter cover (3).
3. Remove primary element (2) and secondary element (1).
4. Wipe inside of air filter cover (3) and air box (5).
5. Install new elements. Be sure to position primary filter as shown.
6. Install cover (3).
7. Install air box (4), ensure seal engages air filter cover.

Change Pipe Auto Lubricator Pail

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

To change pail:

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



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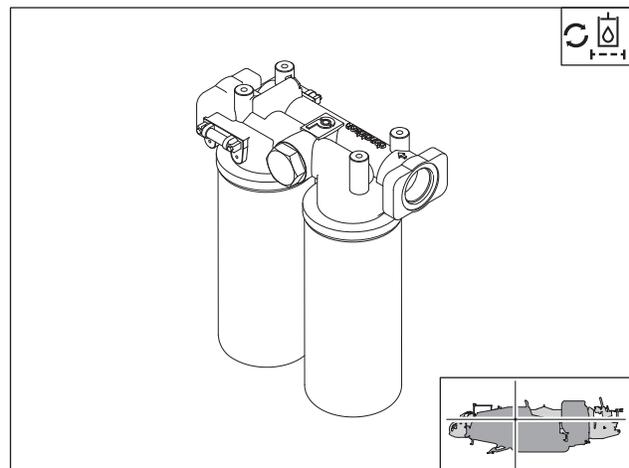
IMPORTANT: Use only genuine Ditch Witch® tool joint compound to maintain warranty. See “Recommended Lubricants/Service Key” on page 192 for more information.

Change Hydraulic Filters (Anytime System Opened)

Change the 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.



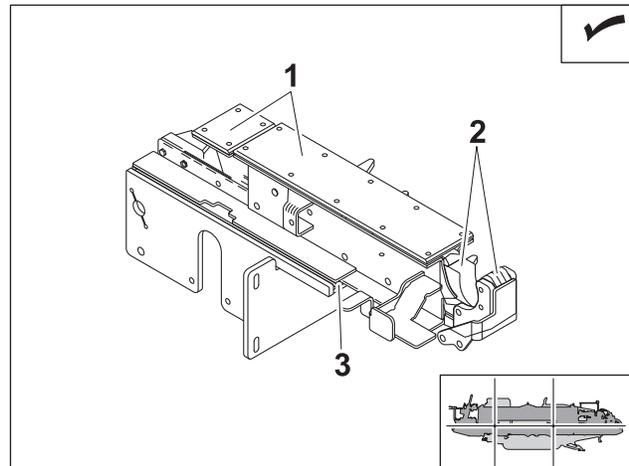
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Check Pipeloader Inserts

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

1. 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.



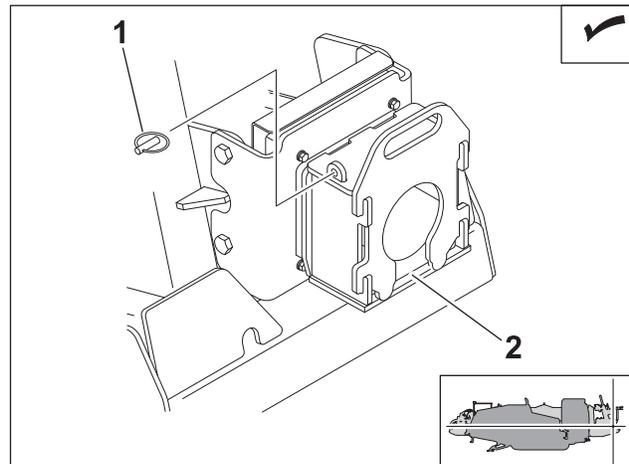
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Check Front Pipe Guide Blocks

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:

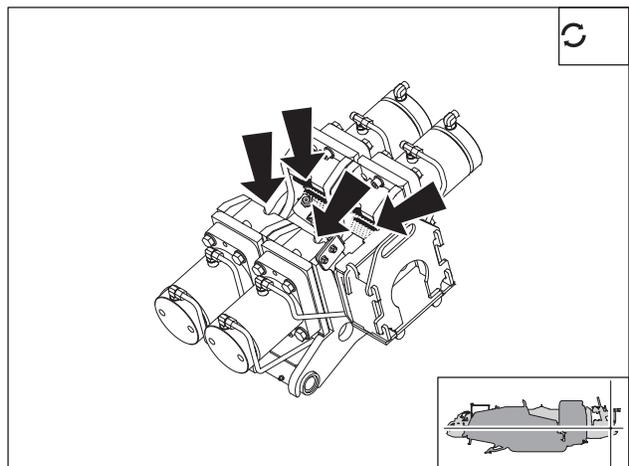
1. Remove lynch pins (1, one on each side).
2. Remove guide blocks (2).
3. Replace in reverse order.



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Check Wrench Jaw Inserts

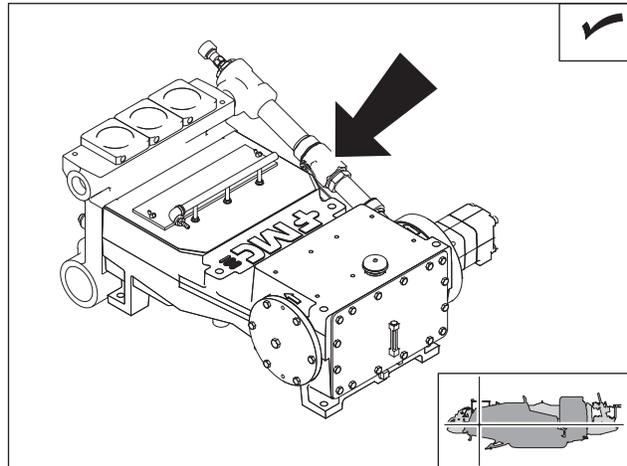
Check front and rear inserts and hardware for wear. See your Ditch Witch® dealer for replacement inserts.



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Check Fluid Pump Ball Valve

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



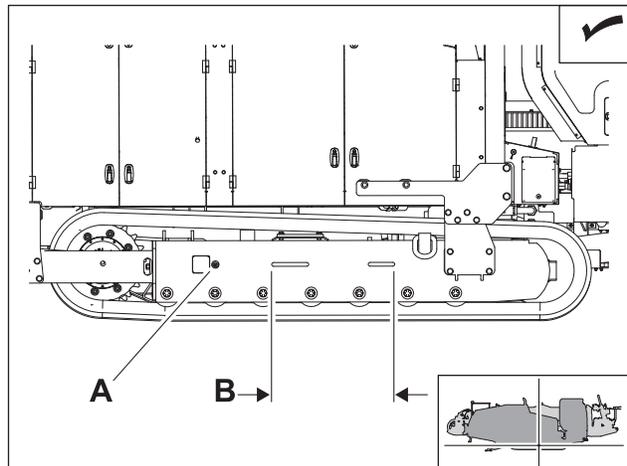
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Check Track Tension and Condition

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

To adjust:

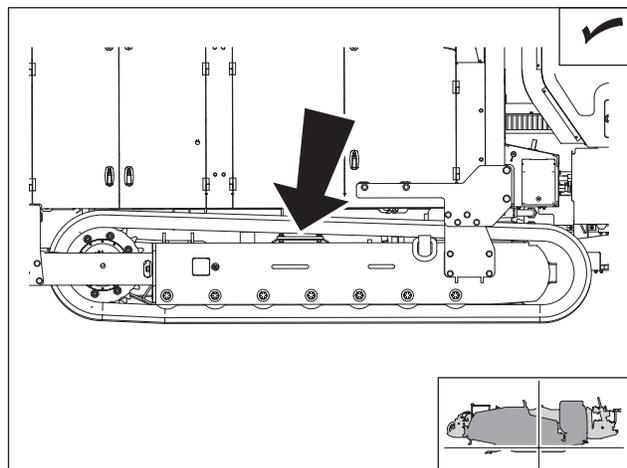
1. Pump MPG into fitting (A) until spring height is 17 3/4-18" (451-457 mm) when measured through windows (B).
2. Drive straight forward one machine length and check tension again.



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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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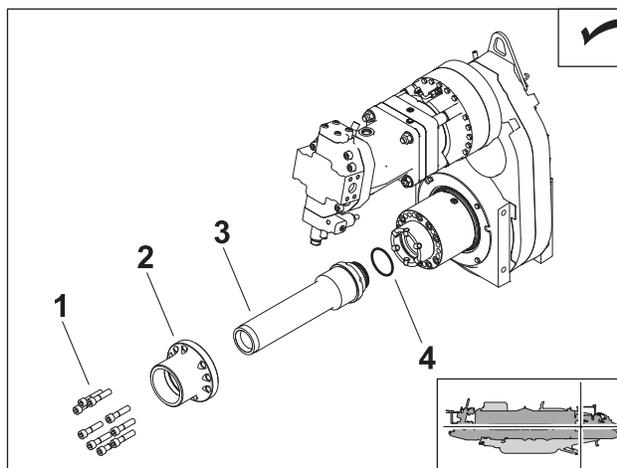


Check SaverLok® System

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

To replace:

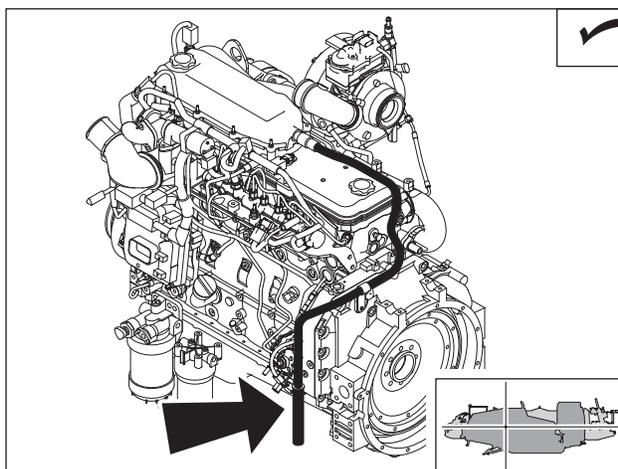
1. Remove nine bolts (1) from the flange (2), then remove the flange and SaverLok® body (3) from connection.
2. Remove and replace o-ring (4), if necessary.
3. Reuse the flange to attach the SaverLok body. Apply hydraulic fluid or Loctite® 242 or equivalent to threads and install bolts and tighten in 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).



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Clean Crankcase Breather Tube

Clean crankcase breather tube with detergent and warm water as needed.



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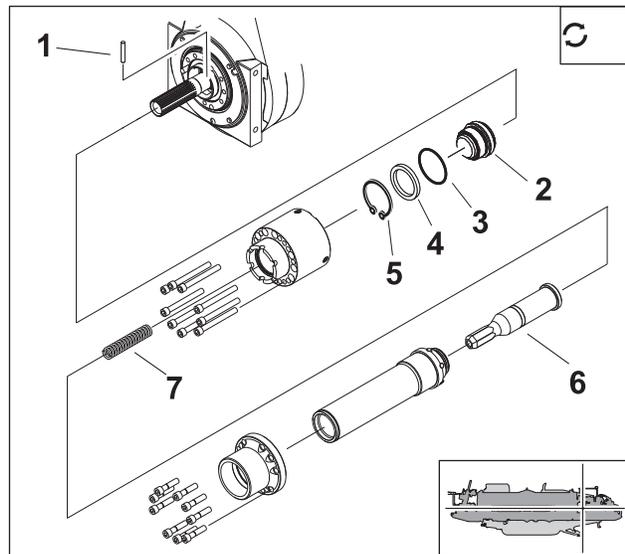
Change Inner Water Swivel (Seal Kit)

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.



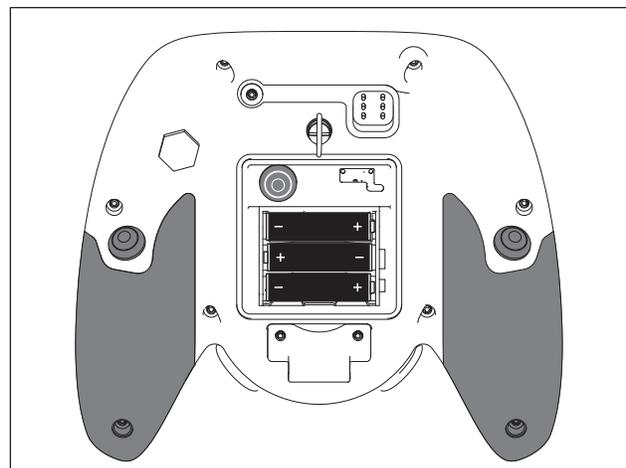
4. Inspect dowel pin (1). To replace, drive new pin into different hole until top of pin is flush with shaft larger diameter.
5. Slide new main body (2) onto drive shaft. Replace o-ring (3).
6. Lightly coat seal (3) with SAE 30 engine oil and install onto main body.

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 230.

Change Wireless Ground Drive Controller Batteries

Replace batteries when low battery indicator is displayed. Install 6 AA batteries as shown.



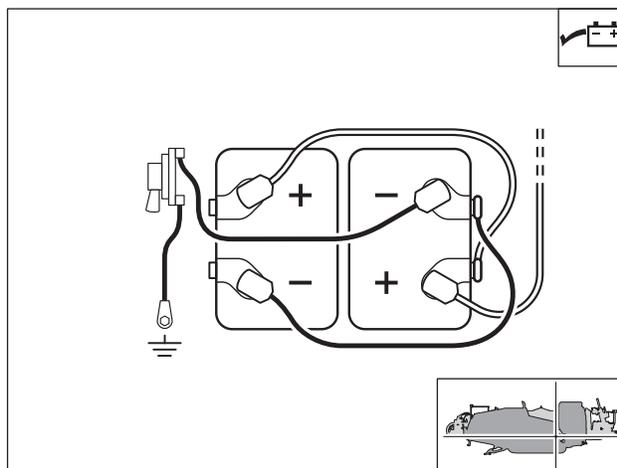
Remote_Battery.eps

Check Batteries

Check batteries as needed. 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. Connect battery cable clamps, **positive (+)** cable first.
7. Tighten any loose connections.
8. Ensure that battery tiedowns are secure.
9. Turn battery disconnect switch to the on position.



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WARNING

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

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

Charge Battery



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

To help avoid injury:

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



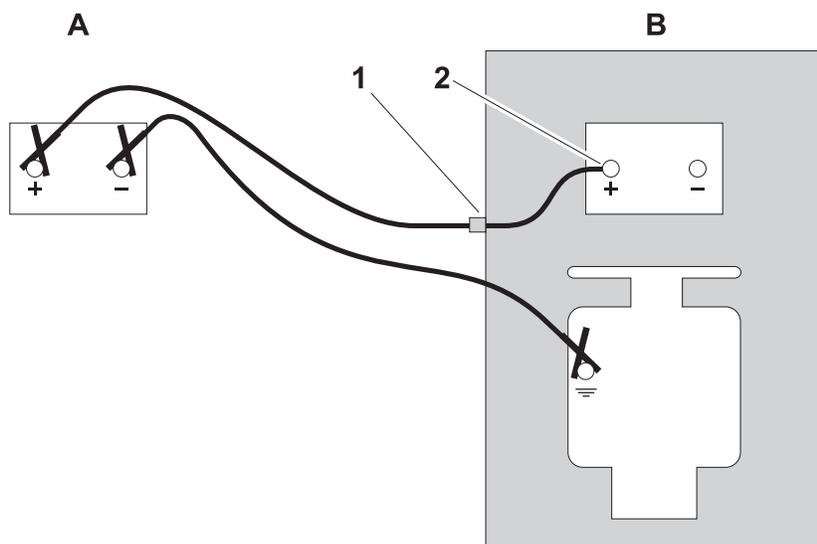
Before You Start

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

Read all steps thoroughly and review illustration before performing procedure.

Charging Procedure (Engine Off)

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



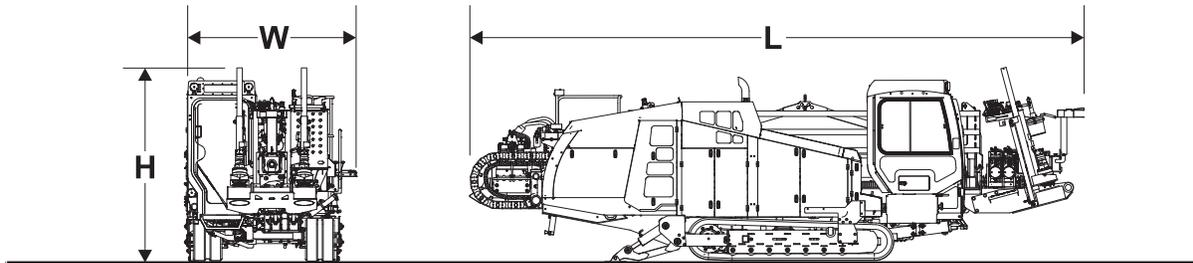
3. Inspect battery in disabled vehicle (B) for signs of cracking, bulging, leaking, or other damage. Connect red positive (+) jumper cable clamp to positive (+) post (2) of battery in disabled vehicle first.

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

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

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

Specifications



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Dimensions		U.S.	Metric
L, 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)		101 in	2.57 m
Angle of approach		18°	18°
Angle of departure		13°	13°
Weight (per SAE J2022)			
	JT mode	31,080 lb	14,098 kg
	AT mode	31,080 lb	14,098 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

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			
Fuel: diesel			
Cooling medium: liquid			
Cylinders: 6			
Injection: Direct			
Aspiration: turbocharged and charge air cooled			
Displacement		409 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)	200 hp	149 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	19 qt	18 L
Engine cooling system	31 qt	29 L
Antifreeze tank	16 gal	60 L
Diesel exhaust fluid tank	3.6 gal	13.6 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/sec² 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.

Declaration of Conformity Information

Countries in the European Union should have received a Declaration of Conformity (DOC) with this machine similar to the example below.

The Charles Machine Works, Inc.
PO Box 66
1959 West Fir Avenue
Perry, Oklahoma, USA 73077-0066
Phone: 580 572 3784
FAX: 580 572 3525

Declares that the product:

Model: **Ditch Witch® XXXX**
Type: **(machine type)**
Engine Power: **xxx kW**
Serial Number: **CMWXXXXXXXXXXXXXX**

Conforms to the requirements of:

2006/42/EC Machinery Directive
2014/30/EU Electromagnetic Compatibility Directive
2000/14/EC Noise Emission Directive

Measured sound power level (Annex V): **xxx dBA**
Guaranteed sound power level (Annex V): **xxx dBA**

The Technical Construction File is maintained at the manufacturer's location.

The manufacturer's European representative is:

Ditch Witch Barcelona
International Underground Systems, S.L.
C/EL PLA, 130 * Poligon Industrial El Pla
08980 Sant Feliu De Llobregat * Spain
Phone: +34 93 632 7344
FAX: +34 93 632 7343

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 replacement 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.

**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.

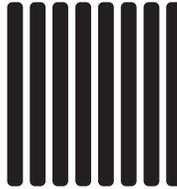
This will enable you to receive updates on this equipment as well as information on new products of interest.

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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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

Appendix



Chapter Contents

Engine Diagnostic Codes

J1939_SPN	J1939_FMI	Cummins' Fault Code	Circuit	Cummins Detailed Description	JT25/JT30	JT60/JT100
27	4	2272	EGR Valve Position Circuit	Voltage below normal, or shorted to low source	X	X
81	16	2754	Engine Diesel Particulate Filter Intake Pressure	Data Valid But Above Normal Operating Range , Moderately Severe Level		X
84	2	241	Wheel-Based Vehicle Speed	Data erratic, intermittent or incorrect	X	X
84	10	242	Wheel-Based Vehicle Speed	Sensor Circuit tampering has been detected , Abnormal rate of change		X
84	19	3525	Wheel-Based Vehicle Speed	Received Network Data In Error		X
91	0	148	Accelerator Pedal or Lever Position Sensor 1	Data valid but above normal operational range , Most Severe Level	X	X
91	1	147	Accelerator Pedal or Lever Position 1 Sensor Circuit Frequency	Data valid but below normal operating Range	X	X
91	2	1242	Accelerator Pedal or Lever Position Sensor 1	Data erratic, intermittent or incorrect	X	X
91	3	131	Accelerator Pedal or Lever Position Sensor 1 Circuit	Voltage above normal, or shorted to high source	X	X
91	4	132	Accelerator Pedal or Lever Position Sensor 1 Circuit	Voltage below normal, or shorted to low source	X	X
91	9	3326	SAE J1939 Multiplexed Accelerator Pedal or Lever Sensor System	Abnormal update rate	X	X
91	19	1515	SAE J1939 Multiplexed Accelerator Pedal or Lever Sensor System	Received Network Data In Error	X	X
94	3	546	Fuel Delivery Pressure Sensor Circuit	Voltage above normal, or shorted to high source	X	X
94	4	547	Fuel Delivery Pressure Sensor Circuit	Voltage below normal, or shorted to low source	X	X
95	16	2372	Fuel Filter Differential Pressure	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
97	3	428	Water in Fuel Indicator Sensor Circuit	Voltage above normal, or shorted to high source	X	X
97	4	429	Water in Fuel Indicator Sensor Circuit	Voltage below normal, or shorted to low source	X	X
97	15	418	Water in Fuel Indicator	Data Valid But Above Normal Operating Range , Least Severe Level	X	X
97	16	1852	Water in Fuel Indicator	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
100	1	415	Engine Oil Rifle Pressure	Data valid but below normal operational range , Most Severe Level	X	X
100	2	435	Engine Oil Rifle Pressure	Data erratic, intermittent or incorrect	X	X
100	3	135	Engine Oil Rifle Pressure 1 Sensor Circuit	Voltage above normal, or shorted to high source	X	X
100	4	141	Engine Oil Rifle Pressure 1 Sensor Circuit	Voltage below normal, or shorted to low source	X	X
100	18	143	Engine Oil Rifle Pressure	Data Valid But Below Normal Operating Range , Moderately Severe Level	X	X
101	0	556	Crankcase Pressure	Data valid but above normal operational range , Most Severe Level	X	X
101	2	1942	Crankcase Pressure	Data erratic, intermittent or incorrect	X	X
101	3	1843	Crankcase Pressure Circuit	Voltage above normal, or shorted to high source	X	X
101	4	1844	Crankcase Pressure Circuit	Voltage below normal, or shorted to low source	X	X
101	15	1974	Crankcase Pressure	Data Valid But Above Normal Operating Range , Least Severe Level	X	X
101	16	555	Crankcase Pressure	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
102	3	122	Intake Manifold 1 Pressure Sensor Circuit	Voltage above normal, or shorted to high source	X	X
102	4	123	Intake Manifold 1 Pressure Sensor Circuit	Voltage below normal, or shorted to low source	X	X
102	16	124	Intake Manifold 1 Pressure	Data Valid But Above Normal Operating Range , Moderately Severe Level		X
103	15	2288	Turbocharger 1 Speed	Data Valid But Above Normal Operating Range , Least Severe Level	X	X
103	16	595	Turbocharger 1 Speed	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
103	18	687	Turbocharger 1 Speed	Data Valid But Below Normal Operating Range , Moderately Severe Level	X	X
105	0	155	Intake Manifold 1 Temperature	Data valid but above normal operational range , Most Severe Level	X	X
105	3	153	Intake Manifold 1 Temperature Sensor Circuit	Voltage above normal, or shorted to high source	X	X
105	4	154	Intake Manifold 1 Temperature Sensor Circuit	Voltage below normal, or shorted to low source	X	X
105	15	2964	Intake Manifold 1 Temperature	Data Valid But Above Normal Operating Range , Least Severe Level	X	X
105	16	488	Intake Manifold 1 Temperature	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
107	15	5576	Engine Air Filter Differential Pressure	Data Valid But Above Normal Operating Range , Least Severe Level	X	X
107	16	3341	Engine Air Filter Differential Pressure	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
108	3	221	Barometric Pressure Sensor Circuit	Voltage above normal, or shorted to high source		X
108	4	222	Barometric Pressure Sensor Circuit	Voltage above normal, or shorted to low source		X
110	0	151	Engine Coolant Temperature	Data valid but above normal operational range , Most Severe Level	X	X
110	3	144	Engine Coolant Temperature 1 Sensor Circuit	Voltage above normal, or shorted to high source	X	X
110	4	145	Engine Coolant Temperature 1 Sensor Circuit	Voltage below normal, or shorted to low source	X	X
110	16	146	Engine Coolant Temperature	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
110	31	2646	Engine Coolant Temperature	Condition Exists	X	X
110	31	2659	Engine Coolant Temperature	Condition Exists	X	X
111	1	235	Coolant Level	Data valid but below normal operational range , Most Severe Level	X	X

J1939_SPN	J1939_FMI	Cummins' Fault Code	Circuit	Cummins Detailed Description	JT25/JT30	JT60/JT100
111	3	195	Coolant Level Sensor 1 Circuit	Voltage above normal, or shorted to high source	X	X
111	4	196	Coolant Level Sensor 1 Circuit	Voltage below normal, or shorted to low source	X	X
111	9	3613	SAE J1939 Multiplexing PGN Timeout Error	Abnormal update rate		X
111	17	2448	Coolant Level	Data Valid But Below Normal Operating Range , Least Severe Level	X	X
111	18	197	Coolant Level	Data Valid But Below Normal Operating Range , Moderately Severe Level	X	X
111	19	3614	Coolant Level Sensor	Received Network Data in Error		X
157	0	449	Injector Metering Rail 1 Pressure	Data valid but above normal operational range , Most Severe Level	X	X
157	3	451	Injector Metering Rail 1 Pressure Sensor Circuit	Voltage above normal, or shorted to high source	X	X
157	4	452	Injector Metering Rail 1 Pressure Sensor Circuit	Voltage below normal, or shorted to low source	X	X
157	16	553	Injector Metering Rail 1 Pressure	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
157	18	559	Injector Metering Rail 1 Pressure	Data Valid But Below Normal Operating Range , Moderately Severe Level	X	X
168	16	442	Battery 1 Voltage	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
168	17	3724	Battery 1 Voltage	Data Valid But Below Normal Operating Range , Least Severe Level	X	X
168	18	441	Battery 1 Voltage	Data Valid But Below Normal Operating Range , Moderately Severe Level	X	X
171	3	249	Ambient Air Temperature Sensor 1 Circuit	Voltage above normal, or shorted to high source		X
171	4	256	Ambient Air Temperature Sensor 1 Circuit	Voltage below normal, or shorted to low source		X
171	9	3531	Ambient Air Temperature	Abnormal update rate		X
190	0	234	Engine Crankshaft Speed/Position	Data valid but above normal operational range , Most Severe Level	X	X
190	2	689	Engine Crankshaft Speed/Position	Data erratic, intermittent or incorrect	X	X
190	2	2321	Engine Crankshaft Speed/Position	Data erratic, intermittent or incorrect	X	X
190	16	2468	Engine Crankshaft Speed/Position	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
191	9	3328	Transmission Output Shaft Speed	Abnormal update rate		X
191	16	349	Transmission Output Shaft Speed	Data Valid But Above Normal Operating Range , Moderately Severe Level		X
191	18	489	Transmission Output Shaft Speed	Data Valid But Below Normal Operating Range , Moderately Severe Level		X
191	19	3418	Transmission Output Shaft Speed	Received Network Data In Error		X
237	13	4517	Vehicle Identification Number	Out of Calibration	X	X
411	2	1866	Exhaust Gas Recirculation Differential Pressure	Data erratic, intermittent or incorrect	X	X
411	3	2273	Exhaust Gas Recirculation Differential Pressure Sensor Circuit	Voltage above normal, or shorted to high source	X	X
411	4	2274	Exhaust Gas Recirculation Differential Pressure Sensor Circuit	Voltage below normal, or shorted to low source	X	X
412	3	2375	Exhaust Gas Recirculation Temperature Sensor Circuit	Voltage above normal, or shorted to high source	X	X
412	4	2376	Exhaust Gas Recirculation Temperature Sensor Circuit	Voltage below normal, or shorted to low source	X	X
412	15	2961	Exhaust Gas Recirculation Temperature	Data Valid But Above Normal Operating Range , Least Severe Level	X	X
412	16	2962	Exhaust Gas Recirculation Temperature	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
441	3	293	Auxiliary Temperature Sensor Input 1 Circuit	Voltage above normal, or shorted to high source		X
441	4	294	Auxiliary Temperature Sensor Input 1 Circuit	Voltage below normal, or shorted to low source		X
441	14	292	Auxiliary Temperature Sensor Input 1	Special Instructions		X
442	3	3765	Auxiliary Temperature Sensor Input 2 Circuit	Voltage above normal, or shorted to high source		X
442	4	3766	Auxiliary Temperature Sensor Input 2 Circuit	Voltage below normal, or shorted to low source		X
558	2	431	Accelerator Pedal or Lever Idle Validation Switch	Data erratic, intermittent or incorrect	X	X
558	13	432	Accelerator Pedal or Lever Idle Validation Switch Circuit	Out of Calibration	X	X
558	19	3527	Accelerator Pedal or Lever Idle Validation Switch	Received Network Data In Error	X	X
563	9	3488	Anti-Lock Braking (ABS) Active	Anti-Lock Braking (ABS) Controller , Abnormal update rate	X	X
563	31	4215	Anti-Lock Braking (ABS) Active	Condition Exists	X	X
611	2	523	Auxiliary Intermediate (PTO) Speed Switch Validation	Data erratic, intermittent or incorrect		X
612	2	115	Engine Magnetic Speed/Position Lost Both of Two Signals	Data erratic, intermittent or incorrect	X	X
625	9	291	Proprietary Datalink Error (OEM/Vehicle Datalink)	Abnormal update rate	X	X
629	12	111	Engine Control Module Critical Internal Failure	Bad intelligent device or component	X	X
629	12	343	Engine Control Module Warning Internal Hardware Failure	Bad intelligent device or component	X	X
630	12	3697	Engine Control Module Calibration Memory	Bad intelligent device or component	X	X
633	31	2311	Electronic Fuel Injection Control Valve Circuit	Condition Exists	X	X
639	9	285	SAE J1939 Multiplexing PGN Timeout Error	Abnormal update rate	X	X
639	13	286	SAE J1939 Multiplexing Configuration Error	Out of Calibration	X	X
640	14	599	Auxiliary Commanded Dual Output Shutdown	Special Instructions		X
641	7	2387	VGT Actuator Driver Circuit (Motor)	Mechanical system not responding or out of adjustment	X	X
641	9	2636	VGT Actuator Driver Circuit	Abnormal update rate	X	X
641	11	2198	VGT Actuator Driver Circuit	Root Cause Not Known	X	X
641	12	2634	VGT Actuator Controller	Bad intelligent device or component	X	X

J1939_SPN	J1939_FMI	Cummins' Fault Code	Circuit	Cummins Detailed Description	JT25/JT30	JT60/JT100
641	13	1898	VGT Actuator Controller	Out of Calibration	X	X
641	13	2449	VGT Actuator Controller	Out of Calibration	X	X
641	15	1962	VGT Actuator Driver Over Temperature (Calculated)	Data Valid But Above Normal Operating Range , Least Severe Level	X	X
641	31	2635	VGT Actuator Driver Circuit	Condition Exists	X	X
644	2	237	External Speed Command Input (Multiple Unit Synchronization)	Data erratic, intermittent or incorrect	X	
647	3	2377	Fan Control Circuit	Voltage above normal, or shorted to high source	X	X
647	4	245	Fan Control Circuit	Voltage below normal, or shorted to low source	X	X
651	5	322	Injector Solenoid Driver Cylinder 1 Circuit	Current below normal or open circuit	X	X
652	5	331	Injector Solenoid Driver Cylinder 2 Circuit	Current below normal or open circuit	X	X
652	7	1141	Injector Solenoid Driver Cylinder 2	Mechanical system not responding or out of adjustment	X	X
653	5	324	Injector Solenoid Driver Cylinder 3 Circuit	Current below normal or open circuit	X	X
653	7	1142	Injector Solenoid Driver Cylinder 3	Mechanical system not responding or out of adjustment	X	X
654	5	332	Injector Solenoid Driver Cylinder 4 Circuit	Current below normal or open circuit	X	X
654	7	1143	Injector Solenoid Driver Cylinder 4	Mechanical system not responding or out of adjustment	X	X
655	5	323	Injector Solenoid Driver Cylinder 5 Circuit	Current below normal or open circuit	X	X
655	7	1144	Injector Solenoid Driver Cylinder 5	Mechanical system not responding or out of adjustment		X
656	5	325	Injector Solenoid Driver Cylinder 6 Circuit	Current below normal or open circuit	X	X
656	7	1145	Injector Solenoid Driver Cylinder 6	Mechanical system not responding or out of adjustment		X
677	3	584	Starter Relay Driver Circuit	Voltage above normal, or shorted to high source	X	X
677	4	585	Starter Relay Driver Circuit	Voltage below normal, or shorted to low source	X	X
697	3	2557	Auxiliary PWM Driver 1 Circuit	Voltage above normal, or shorted to high source	X	X
697	4	2558	Auxiliary PWM Driver 1 Circuit	Voltage below normal, or shorted to low source	X	X
701	14	4734	Auxiliary Input/Output 1	Special Instructions	X	X
702	3	527	Auxiliary Input/Output 2 Circuit	Voltage above normal, or shorted to high source		X
703	3	529	Auxiliary Input/Output 3 Circuit	Voltage above normal, or shorted to high source		X
723	2	778	Engine Camshaft Speed / Position Sensor	Data erratic, intermittent or incorrect	X	X
723	2	2322	Engine Camshaft Speed / Position Sensor	Data erratic, intermittent or incorrect	X	X
723	7	731	Engine Speed / Position Camshaft and Crankshaft Misalignment	Mechanical system not responding or out of adjustment	X	X
729	3	2555	Engine Intake Air Heater 1 Circuit	Voltage above normal, or shorted to high source	X	X
729	4	2556	Engine Intake Air Heater 1 Circuit	Voltage below normal, or shorted to low source	X	X
748	9	3641	Transmission Output Retarder	Abnormal update rate	X	X
974	3	133	Remote Accelerator Pedal or Lever Position Sensor 1 Circuit	Voltage above normal, or shorted to high source	X	X
974	4	134	Remote Accelerator Pedal or Lever Position Sensor 1 Circuit	Voltage below normal, or shorted to low source	X	X
974	19	288	SAE J1939 Multiplexing Remote Accelerator Pedal or Lever Position Sensor System	Received Network Data In Error	X	X
1073	3	2367	Engine Brake Actuator Driver Output 2 Circuit	Voltage above normal, or shorted to high source		X
1073	4	2363	Engine Brake Actuator Driver Output 2 Circuit	Voltage below normal, or shorted to low source		X
1081	9	3555	Engine Wait to Start Lamp	Abnormal update rate	X	X
1172	3	691	Turbocharger 1 Compressor Intake Temperature Circuit	Voltage above normal, or shorted to high source	X	X
1172	4	692	Turbocharger 1 Compressor Intake Temperature Circuit	Voltage below normal, or shorted to low source	X	X
1176	2	743	Turbocharger 1 Compressor Intake Pressure	Data erratic, intermittent or incorrect	X	X
1176	3	741	Turbocharger 1 Compressor Intake Pressure Circuit	Voltage above normal, or shorted to high source	X	X
1176	4	742	Turbocharger 1 Compressor Intake Pressure Circuit	Voltage below normal, or shorted to low source	X	X
1194	13	3298	Anti	theft Encryption Seed , Out of Calibration	X	X
1209	2	2554	Exhaust Gas Pressure 1	Data erratic, intermittent or incorrect	X	X
1209	3	2373	Exhaust Gas Pressure Sensor 1 Circuit	Voltage above normal, or shorted to high source	X	X
1209	4	2374	Exhaust Gas Pressure Sensor 1 Circuit	Voltage below normal, or shorted to low source	X	X
1231	2	3329	J1939 Network #2	Data erratic, intermittent or incorrect	X	X
1235	2	3331	J1939 Network #3	Data erratic, intermittent or incorrect	X	X
1267	3	338	Idle Shutdown Vehicle Accessories Relay Driver Circuit	Voltage above normal, or shorted to high source		X
1267	4	339	Idle Shutdown Vehicle Accessories Relay Driver Circuit	Voltage below normal, or shorted to low source		X
1323	31	1654	Engine Misfire Cylinder 1	Condition Exists	X	X
1324	31	1655	Engine Misfire Cylinder 2	Condition Exists	X	X
1325	31	1656	Engine Misfire Cylinder 3	Condition Exists	X	X
1326	31	1657	Engine Misfire Cylinder 4	Condition Exists	X	X
1327	31	1658	Engine Misfire Cylinder 5	Condition Exists		X
1328	31	1659	Engine Misfire Cylinder 6	Condition Exists		X
1347	3	272	Engine Fuel Pump Pressurizing Assembly 1 Circuit	Voltage above normal, or shorted to high source	X	X
1347	4	271	Engine Fuel Pump Pressurizing Assembly 1 Circuit	Voltage below normal, or shorted to low source	X	X
1347	7	281	Engine Fuel Pump Pressurizing Assembly 1	Mechanical system not responding or out of adjustment	X	X
1349	3	483	Injector Metering Rail 2 Pressure Sensor Circuit	Voltage above normal, or shorted to high source	X	X
1377	2	497	Multiple Unit Synchronization Switch	Data erratic, intermittent or incorrect		X
1378	31	649	Engine Oil Change Interval	Condition Exists	X	X
1387	3	1539	Auxiliary Pressure Sensor Input 1 Circuit	Voltage above normal, or shorted to high source		X
1387	4	1621	Auxiliary Pressure Sensor Input 1 Circuit	Voltage below normal, or shorted to low source		X
1388	3	297	Auxiliary Pressure Sensor Input 2 Circuit	Voltage above normal, or shorted to high source		X
1388	4	298	Auxiliary Pressure Sensor Input 2 Circuit	Voltage below normal, or shorted to low source		X

J1939_SPN	J1939_FMI	Cummins' Fault Code	Circuit	Cummins Detailed Description	JT25/JT30	JT60/JT100
1388	14	296	Auxiliary Pressure Sensor Input 2	Special Instructions		X
1569	31	3714	Engine Protection Torque Derate	Condition Exists	X	X
1623	9	3186	Tachograph Output Shaft Speed	Abnormal update rate		X
1623	13	5248	Tachograph Output Shaft Speed	Out of Calibration		X
1623	19	3213	Tachograph Output Shaft Speed	Received Network Data In Error		X
1632	14	2998	Engine Torque Limit Feature	Special Instructions		X
1639	0	4789	Fan Speed	Data Valid but Above Normal Operational Range , Most Severe Level	X	X
1639	1	4791	Fan Speed	Data Valid but Below Normal Operational Range , Most Severe Level	X	X
1668	2	4437	J1939 Network #4	Data erratic, intermittent or incorrect	X	X
1675	31	3737	Engine Starter Mode Overcrank Protection	Condition Exists	X	X
1761	1	1673	Aftertreatment 1 Diesel Exhaust Fluid Tank Level	Data valid but below normal operational range , Most Severe Level	X	X
1761	3	1669	Aftertreatment 1 Diesel Exhaust Fluid Tank Level Sensor Circuit	Voltage above normal, or shorted to high source	X	X
1761	4	1668	Aftertreatment 1 Diesel Exhaust Fluid Tank Level Sensor Circuit	Voltage below normal, or shorted to low source	X	X
1761	10	4769	Aftertreatment 1 Diesel Exhaust Fluid Tank Level Sensor	Abnormal Rate of Change	X	X
1761	11	4739	Aftertreatment 1 Diesel Exhaust Fluid Tank Level Sensor	Root Cause Not Known	X	X
1761	13	4732	Aftertreatment 1 Diesel Exhaust Fluid Tank Level Sensor	Out of Calibration		X
1761	17	3497	Aftertreatment 1 Diesel Exhaust Fluid Tank Level	Data Valid But Below Normal Operating Range , Least Severe Level	X	X
1761	18	3498	Aftertreatment 1 Diesel Exhaust Fluid Tank Level	Data Valid But Below Normal Operating Range , Moderately Severe Level	X	X
2623	3	1239	Accelerator Pedal or Lever Position Sensor 2 Circuit	Voltage above normal, or shorted to high source	X	X
2623	4	1241	Accelerator Pedal or Lever Position Sensor 2 Circuit	Voltage below normal, or shorted to low source	X	X
2630	3	2571	Engine Charge Air Cooler Outlet Temperature	Voltage above normal, or shorted to high source		X
2630	4	2572	Engine Charge Air Cooler Outlet Temperature	Voltage below normal, or shorted to low source		X
2789	15	2346	Turbocharger Turbine Intake Temperature	Data Valid But Above Normal Operating Range , Least Severe	X	X
2791	5	2349	EGR Valve Control Circuit	Current below normal or open circuit	X	X
2791	6	2353	EGR Valve Control Circuit	Current above normal or grounded circuit	X	X
2791	7	2357	EGR Valve Control Circuit	Mechanical system not responding or out of adjustment	X	X
2791	13	1896	EGR Valve Controller	Out of Calibration	X	X
2791	15	1961	EGR Valve Control Circuit Over Temperature	Data Valid But Above Normal Operating Range , Least Severe Level	X	X
3031	2	1679	Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature	Data erratic, intermittent or incorrect	X	X
3031	3	1678	Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature Sensor	Voltage above normal, or shorted to high source	X	X
3031	4	1677	Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature Sensor	Voltage below normal, or shorted to low source	X	X
3031	9	4572	Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature	Abnormal Update Rate	X	X
3031	11	4737	Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature	Root Cause Not Known		X
3031	13	4731	Aftertreatment 1 Diesel Exhaust Fluid Tank Temperature Sensor	Out of Calibration		X
3216	2	3228	Aftertreatment 1 Intake NOx Sensor	Data erratic, intermittent or incorrect	X	X
3216	4	1885	Aftertreatment 1 Intake NOx Sensor Circuit	Voltage below normal, or shorted to low source	X	X
3216	9	3232	Aftertreatment 1 Intake NOx Sensor	Abnormal update rate	X	X
3216	10	3725	Aftertreatment 1 Intake NOx Sensor	Abnormal rate of change	X	X
3216	13	3718	Aftertreatment 1 Intake NOx	Out of Calibration	X	X
3216	16	3726	Aftertreatment 1 Intake NOx	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
3216	20	3748	Aftertreatment 1 Intake NOx Sensor	Data not Rational , Drifted High	X	X
3218	2	3682	Aftertreatment 1 Intake NOx Sensor Power Supply	Data erratic, intermittent or incorrect	X	X
3226	2	1694	Aftertreatment 1 Outlet NOx Sensor	Data erratic, intermittent or incorrect	X	X
3226	4	1887	Aftertreatment 1 Outlet NOx Sensor Circuit	Voltage below normal, or shorted to low source	X	X
3226	9	2771	Aftertreatment 1 Outlet NOx Sensor	Abnormal update rate	X	X
3226	10	3545	Aftertreatment 1 Outlet NOx Sensor	Abnormal rate of change	X	X
3226	13	3717	Aftertreatment 1 Outlet NOx Sensor	Out of Calibration	X	X
3226	20	3749	Aftertreatment 1 Outlet NOx Sensor	Data not Rational , Drifted High	X	X
3228	2	3681	Aftertreatment 1 Outlet NOx Sensor Power Supply	Data erratic, intermittent or incorrect	X	X
3246	3	3319	Aftertreatment 1 Diesel Particulate Filter Outlet Temperature Sensor Circuit	Voltage above normal, or shorted to high source	X	X
3361	2	2976	Aftertreatment 1 Diesel Exhaust Fluid Dosing Unit Temperature	Data erratic, intermittent or incorrect	X	X
3361	3	3558	Aftertreatment 1 Diesel Exhaust Fluid Dosing Unit	Voltage above normal, or shorted to high source	X	X
3361	4	3559	Aftertreatment 1 Diesel Exhaust Fluid Dosing Unit	Voltage below normal, or shorted to low source	X	X
3362	31	1682	Aftertreatment 1 Diesel Exhaust Fluid Dosing Unit Input Lines	Condition Exists	X	X
3363	3	1683	Aftertreatment 1 Diesel Exhaust Fluid Tank Heater	Voltage above normal, or shorted to high source	X	X

J1939_SPN	J1939_FMI	Cummins Fault Code	Circuit	Cummins Detailed Description	JT25/JT30	JT60/JT100
3363	4	1684	Aftertreatment 1 Diesel Exhaust Fluid Tank Heater	Voltage below normal, or shorted to low source	X	X
3363	7	3242	Aftertreatment 1 Diesel Exhaust Fluid Tank Heater	Mechanical system not responding or out of adjustment	X	X
3363	16	1713	Aftertreatment 1 Diesel Exhaust Fluid Tank Heater	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
3363	18	1712	Aftertreatment 1 Diesel Exhaust Fluid Tank Heater	Data Valid But Below Normal Operating Range , Moderately Severe Level	X	X
3364	2	3878	Aftertreatment Diesel Exhaust Fluid Quality	Data erratic, intermittent or incorrect	X	X
3364	3	1686	Aftertreatment Diesel Exhaust Fluid Quality Sensor Circuit	Voltage above normal, or shorted to high source	X	X
3364	4	1685	Aftertreatment Diesel Exhaust Fluid Quality Sensor Circuit	Voltage below normal, or shorted to low source	X	X
3364	5	4741	Aftertreatment Diesel Exhaust Fluid Quality Sensor Circuit	Current below normal or open circuit	X	X
3364	6	4742	Aftertreatment Diesel Exhaust Fluid Quality Sensor Circuit	Current above normal or grounded circuit	X	X
3364	7	3876	Aftertreatment Diesel Exhaust Fluid Quality Sensor	Mechanical system not responding or out of adjustment	X	X
3364	9	3868	Aftertreatment Diesel Exhaust Fluid Quality	Abnormal update rate	X	X
3364	10	4277	Aftertreatment Diesel Exhaust Fluid Quality	Abnormal Rate of Change	X	X
3364	11	1715	Aftertreatment Diesel Exhaust Fluid Quality	Root Cause Not Known	X	X
3364	12	3877	Aftertreatment Diesel Exhaust Fluid Quality Sensor	Bad intelligent device or component		X
3364	13	1714	Aftertreatment Diesel Exhaust Fluid Quality	Out of Calibration	X	X
3364	15	4842	Aftertreatment Diesel Exhaust Fluid Quality	Data Valid But Above Normal Operating Range , Least Severe Level	X	X
3364	18	3867	Aftertreatment Diesel Exhaust Fluid Quality	Data Valid But Below Normal Operating Range , Moderate Severe Level	X	X
3364	19	4241	Aftertreatment Diesel Exhaust Fluid Quality	Received Network Data In Error	X	X
3509	3	386	Sensor Supply 1 Circuit	Voltage above normal, or shorted to high source	X	X
3509	4	352	Sensor Supply 1 Circuit	Voltage below normal, or shorted to low source	X	X
3510	3	227	Sensor Supply 2 Circuit	Voltage above normal, or shorted to high source	X	X
3510	4	187	Sensor Supply 2 Circuit	Voltage below normal, or shorted to low source	X	X
3511	3	239	Sensor Supply 3 Circuit	Voltage above normal, or shorted to high source	X	X
3511	4	238	Sensor Supply 3 Circuit	Voltage below normal, or shorted to low source	X	X
3512	3	2185	Sensor Supply 4 Circuit	Voltage above normal, or shorted to high source	X	X
3512	4	2186	Sensor Supply 4 Circuit	Voltage below normal, or shorted to low source	X	X
3513	3	1695	Sensor Supply 5	Voltage above normal, or shorted to high source	X	X
3513	4	1696	Sensor Supply 5	Voltage below normal, or shorted to low source	X	X
3514	3	515	Sensor Supply 6 Circuit	Voltage above normal, or shorted to high source	X	X
3514	4	516	Sensor Supply 6 Circuit	Voltage below normal, or shorted to low source	X	X
3515	5	4743	Aftertreatment 1 Diesel Exhaust Fluid Temperature 2 Sensor Circuit	Current below normal or open circuit	X	X
3515	6	4744	Aftertreatment 1 Diesel Exhaust Fluid Temperature 2 Sensor Circuit	Current above normal or grounded	X	X
3515	10	4243	Aftertreatment 1 Diesel Exhaust Fluid Temperature 2	Abnormal Rate of Change	X	X
3515	11	4745	Aftertreatment 1 Diesel Exhaust Fluid Temperature 2	Root Cause Not Known	X	X
3521	11	4768	Aftertreatment 1 Diesel Exhaust Fluid Property	Root Cause Not Known	X	X
3597	2	1117	Power Supply Lost With Ignition On	Data erratic, intermittent or incorrect	X	X
3597	12	351	Injector Power Supply	Bad intelligent device or component	X	X
3597	18	1938	ECU Power Output Supply Voltage 1	Data Valid But Below Normal Operating Range , Moderately Severe Level	X	X
3667	2	5221	Engine Air Shutoff Status	Data erratic, intermittent or incorrect		X
3667	3	3139	Engine Air Shutoff Circuit	Voltage above normal, or shorted to high source		X
3667	4	3141	Engine Air Shutoff Circuit	Voltage below normal, or shorted to low source		X
3667	7	4484	Engine Air Shutoff	Mechanical System Not Responding or Out of Adjustment		X
3695	2	4213	Aftertreatment Regeneration Inhibit Switch	Data erratic, intermittent or incorrect	X	X
4094	31	3543	NOx limits exceeded due to Insufficient Reagent Quality	Condition Exists		X
4096	31	3547	Aftertreatment Diesel Exhaust Fluid Tank Empty	Condition Exists	X	X
4185	31	1427	Overspeed Shutdown Relay Driver Diagnostic has detected an error	Condition Exists	X	X
4186	31	1428	Low Oil Pressure (LOP) Shutdown Relay Driver Diagnostic has detected an error	Condition Exists	X	X
4187	31	1429	High Engine Temperature (HET) Shutdown Relay Driver Diagnostic has detected an error	Condition Exists	X	X
4188	31	1431	Pre-Low Oil Pressure Indicator Relay Driver	Pre-Low Oil Pressure Warning Relay Driver Diagnostic has detected an error , Condition Exists	X	X
4223	31	1432	Pre-High Engine Temperature Warning Relay Driver	Pre-High Engine Temperature Warning Relay Driver Diagnostic has detected an error , Condition Exists	X	X
4334	2	3596	Aftertreatment 1 Diesel Exhaust Fluid Pressure Sensor	Data erratic, intermittent or incorrect	X	X
4334	3	3571	Aftertreatment 1 Diesel Exhaust Fluid Pressure Sensor	Voltage above normal, or shorted to high source	X	X
4334	4	3572	Aftertreatment 1 Diesel Exhaust Fluid Pressure Sensor	Voltage below normal, or shorted to low source	X	X
4334	16	3575	Aftertreatment 1 Diesel Exhaust Fluid Pressure Sensor	Data Valid But Above Normal Operating Range	X	X
4334	18	3574	Aftertreatment 1 Diesel Exhaust Fluid Pressure Sensor	Data Valid But Below Normal Operating Range	X	X
4337	10	4249	Aftertreatment 1 Diesel Exhaust Fluid Dosing Temperature	Abnormal Rate of Change	X	X

J1939_SPN	J1939_FMI	Cummins Fault Code	Circuit	Cummins Detailed Description	JT25/JT30	JT60/JT100
4340	3	3237	Aftertreatment 1 Diesel Exhaust Fluid Line Heater 1 Circuit	Voltage above normal, or shorted to high source	X	X
4340	4	3238	Aftertreatment 1 Diesel Exhaust Fluid Line Heater 1 Circuit	Voltage below normal, or shorted to low source	X	X
4340	5	3258	Aftertreatment 1 Diesel Exhaust Fluid Line Heater 1 Circuit	Current below normal or open circuit	X	X
4342	3	3239	Aftertreatment 1 Diesel Exhaust Fluid Line Heater 2 Circuit	Voltage above normal, or shorted to high source	X	X
4342	4	3241	Aftertreatment 1 Diesel Exhaust Fluid Line Heater 2 Circuit	Voltage below normal, or shorted to low source	X	X
4342	5	3261	Aftertreatment 1 Diesel Exhaust Fluid Line Heater 2 Circuit	Current below normal or open circuit	X	X
4344	3	3422	Aftertreatment Diesel Exhaust Fluid Line Heater 3 Circuit	Voltage above normal, or shorted to high source	X	X
4344	4	3423	Aftertreatment Diesel Exhaust Fluid Line Heater 3 Circuit	Voltage below normal, or shorted to low source	X	X
4344	5	3425	Aftertreatment Diesel Exhaust Fluid Line Heater 3 Circuit	Current below normal or open circuit	X	X
4360	0	3229	Aftertreatment 1 SCR Intake Temperature	Data valid but above normal operational range , Most Severe Level	X	X
4360	2	3144	Aftertreatment 1 SCR Intake Temperature Sensor	Data erratic, intermittent or incorrect	X	X
4360	3	3142	Aftertreatment 1 SCR Intake Temperature Sensor Circuit	Voltage above normal, or shorted to high source	X	X
4360	4	3143	Aftertreatment 1 SCR Intake Temperature Sensor Circuit	Voltage below normal, or shorted to low source	X	X
4360	15	3164	Aftertreatment 1 SCR Intake Temperature	Data Valid But Above Normal Operating Range , Least Severe	X	X
4360	16	3231	Aftertreatment 1 SCR Intake Temperature	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
4363	0	3165	Aftertreatment 1 SCR Outlet Temperature	Data valid but above normal operational range , Most Severe	X	X
4363	2	3148	Aftertreatment 1 SCR Outlet Temperature Sensor	Data erratic, intermittent or incorrect	X	X
4363	3	3146	Aftertreatment 1 SCR Outlet Temperature Sensor Circuit	Voltage above normal, or shorted to high source	X	X
4363	4	3147	Aftertreatment 1 SCR Outlet Temperature Sensor Circuit	Voltage below normal, or shorted to low source	X	X
4363	16	3235	Aftertreatment 1 SCR Outlet Temperature	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
4364	18	3582	Aftertreatment SCR Catalyst Conversion Efficiency	Data Valid But Below Normal Operating Range , Moderately Severe Level	X	X
4376	3	3577	Aftertreatment Diesel Exhaust Fluid Return Valve	Voltage above normal, or shorted to high source	X	X
4376	4	3578	Aftertreatment Diesel Exhaust Fluid Return Valve	Voltage below normal, or shorted to low source	X	X
4376	7	4157	Aftertreatment Diesel Exhaust Fluid Return Valve	Mechanical system not responding or out of adjust	X	X
4765	2	3315	Aftertreatment 1 Diesel Oxidation Catalyst Intake Temperature	Data erratic, intermittent or incorrect	X	X
4765	3	3314	Aftertreatment 1 Diesel Oxidation Catalyst Intake Temperature Sensor Circuit	Voltage above normal, or shorted to high source	X	X
4765	4	3313	Aftertreatment 1 Diesel Oxidation Catalyst Intake Temperature Sensor Circuit	Voltage below normal, or shorted to low source	X	X
4765	16	3251	Aftertreatment 1 Diesel Oxidation Catalyst Intake Temperature	Data Valid But Above Normal Operating Range	X	X
4766	0	5387	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Gas Temperature	Data Valid But Above Normal Operating Range , Most Severe Level	X	X
4766	2	5386	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Gas Temperature	Data Erratic, Intermittent, or Incorrect	X	X
4766	3	4533	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Gas Temperature Sensor Circuit	Voltage above normal, or shorted to high source	X	X
4766	4	4534	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Gas Temperature Sensor Circuit	Voltage below normal, or shorted to low source	X	X
4766	15	5389	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Gas Temperature	Data Valid But Above Normal Operating Range , Least Severe Level	X	X
4766	16	5388	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Gas Temperature	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
4792	7	3751	Aftertreatment SCR Catalyst System	Mechanical system not responding or out of adjustment	X	X
4792	14	4585	Aftertreatment 1 SCR Catalyst System	Special Instructions	X	X
4794	31	3151	Aftertreatment 1 SCR Catalyst System Missing	Condition Exists	X	X
4796	31	1664	Aftertreatment 1 Diesel Oxidation Catalyst Missing	Condition Exists	X	X
5018	11	2637	Aftertreatment 1 Diesel Oxidation Catalyst Face Plugged	Root Cause Not Known	X	X
5018	14	5617	Aftertreatment 1 Diesel Oxidation Catalyst System	Special Instructions	X	X
5024	10	3649	Aftertreatment 1 Intake NOx Sensor Heater	Abnormal rate of change	X	X
5031	10	3583	Aftertreatment 1 Outlet NOx Sensor Heater	Abnormal rate of change	X	X
5125	3	3419	Sensor Supply 7 Circuit	Voltage above normal, or shorted to high source	X	X
5125	4	3421	Sensor Supply 7 Circuit	Voltage below normal, or shorted to low source	X	X
5245	31	4863	Aftertreatment SCR Operator Inducement Active	Condition Exists	X	X
5246	0	3712	Aftertreatment SCR Operator Inducement	Data valid but above normal operational range , Most Severe level	X	X

J1939_SPN	J1939_FMI	Cummins' Fault Code	Circuit	Cummins Detailed Description	JT25/JT30	JT60/JT100
5298	18	1691	Aftertreatment 1 Diesel Oxidation Catalyst Conversion Efficiency	Data Valid But Below Normal Operating Range , Moderately Severe Level	X	X
5394	2	3755	Aftertreatment Diesel Exhaust Fluid Dosing Valve	Data erratic, intermittent or incorrect	X	X
5394	5	3567	Aftertreatment Diesel Exhaust Fluid Dosing Valve	Current below normal or open circuit	X	X
5394	7	3568	Aftertreatment Diesel Exhaust Fluid Dosing Valve	Mechanical system not responding or out of adjustment	X	X
5484	3	3633	Engine Fan Clutch 2 Control Circuit	Voltage above normal, or shorted to high source	X	X
5484	4	3634	Engine Fan Clutch 2 Control Circuit	Voltage below normal, or shorted to low source	X	X
5491	3	3562	Aftertreatment Diesel Exhaust Fluid Line Heater Relay	Voltage above normal, or shorted to high source	X	X
5491	4	3563	Aftertreatment Diesel Exhaust Fluid Line Heater Relay	Voltage below normal, or shorted to low source	X	X
5571	0	3741	High Pressure Common Rail Fuel Pressure Relief Valve	Data valid but above normal operational range	X	X
5571	3	4262	High Pressure Common Rail Fuel Pressure Relief Valve	Voltage Above Normal, or Shorted to High Source		X
5571	4	4263	High Pressure Common Rail Fuel Pressure Relief Valve	Voltage below normal, or shorted to low source		X
5571	7	3727	High Pressure Common Rail Fuel Pressure Relief Valve	Mechanical system not responding or out of adjustment	X	X
5571	15	5585	High Pressure Common Rail Fuel Pressure Relief Valve	Data Valid But Above Normal Operating Range , Least Severe Level	X	X
5571	31	4867	High Pressure Common Rail Fuel Pressure Relief Valve	Condition Exists		X
5603	9	3843	Cruise Control Disable Command	Abnormal update rate		X
5603	31	3845	Cruise Control Disable Command	Condition Exists		X
5605	31	3844	Cruise Control Pause Command	Condition Exists		X
5742	3	4161	Aftertreatment Diesel Particulate Filter Temperature Sensor Module	Voltage Above Normal, or Shorted to high source	X	X
5742	4	4162	Aftertreatment Diesel Particulate Filter Temperature Sensor Module	Voltage below normal, or shorted to low source	X	X
5742	9	4151	Aftertreatment Diesel Particulate Filter Temperature Sensor Module	Abnormal update rate	X	X
5742	12	4158	Aftertreatment Diesel Particulate Filter Temperature Sensor Module	Bad intelligent device or component	X	X
5742	16	4163	Aftertreatment Diesel Particulate Filter Temperature Sensor Module	Data Valid But Above Normal Operating Range	X	X
5743	3	4164	Aftertreatment Selective Catalytic Reduction Temperature Sensor Module	Voltage Above Normal, or Shorted to high source	X	X
5743	4	4165	Aftertreatment Selective Catalytic Reduction Temperature Sensor Module	Voltage below normal, or Shorted to low source	X	X
5743	9	4152	Aftertreatment Selective Catalytic Reduction Temperature Sensor Module	Abnormal update rate	X	X
5743	11	4261	Aftertreatment Selective Catalytic Reduction Temperature Sensor Module	Root Cause Not Known	X	X
5743	12	4159	Aftertreatment Selective Catalytic Reduction Temperature Sensor Module	Bad intelligent device or component	X	X
5743	16	4166	Aftertreatment Selective Catalytic Reduction Temperature Sensor Module	Data Valid But Above Normal	X	X
5745	3	4168	Aftertreatment 1 Diesel Exhaust Fluid Dosing Unit Heater	Voltage Above Normal, or Shorted to High	X	X
5745	4	4169	Aftertreatment 1 Diesel Exhaust Fluid Dosing Unit Heater	Voltage below normal, or shorted to low source	X	X
5745	18	4171	Aftertreatment 1 Diesel Exhaust Fluid Dosing Unit Heater	Data Valid But Below Normal Operating Range	X	X
5746	3	4155	Aftertreatment 1 Diesel Exhaust Fluid Dosing Unit Heater Relay	Voltage Above Normal, or Shorted to high source	X	X
5746	4	4156	Aftertreatment 1 Diesel Exhaust Fluid Dosing Unit Heater Relay	Voltage below normal, or shorted to low source	X	X
5798	10	4251	Aftertreatment 1 Diesel Exhaust Fluid Dosing Unit Heater Temperature	Abnormal Rate of Change	X	X
6655	3	4951	Maintain ECU Power Lamp	Voltage Above Normal, or Shorted to High Source		X
6655	4	4952	Maintain ECU Power Lamp	Voltage Below Normal, or Shorted to Low Source		X
6713	9	5177	VGT Actuator Driver Circuit	Abnormal update rate		X
6713	13	4956	Variable Geometry Turbocharger Actuator Software	Out of Calibration		X
6713	31	4957	Variable Geometry Turbocharger Actuator Software	Condition Exists		X
6802	31	5278	Aftertreatment 1 Diesel Exhaust Fluid Dosing System Frozen	Condition Exists	X	X
6881	9	5653	SCR Operator Inducement Override Switch	Abnormal Update Rate	X	X
6881	13	5654	SCR Operator Inducement Override Switch	Out of Calibration	X	X
6882	3	5393	Aftertreatment Diesel Oxidation Catalyst Temperature Sensor Module	Voltage Above Normal or Shorted to High Source	X	X
6882	4	5394	Aftertreatment Diesel Oxidation Catalyst Temperature Sensor Module	Voltage Below Normal or Shorted to Low Source	X	X
6882	9	5391	Aftertreatment Diesel Oxidation Catalyst Temperature Sensor Module	Abnormal Update Rate	X	X
6882	11	5395	Aftertreatment Diesel Oxidation Catalyst Temperature Sensor Module	Root Cause Not Known	X	X
6882	12	5392	Aftertreatment Diesel Oxidation Catalyst Temperature Sensor Module	Bad Intelligent Device or Component	X	X
6882	16	5396	Aftertreatment Diesel Oxidation Catalyst Temperature Sensor Module	Data Valid But Above Normal Operating Range , Moderately Severe Level	X	X
6918	31	5632	SCR System Cleaning Inhibited Due to Inhibit Switch	Condition Exists	X	X
6928	31	5631	SCR System Cleaning Inhibited Due to System Timeout	Condition Exists	X	X

J1939_SPN	J1939_FMI	Cummins' Fault Code	Circuit	Cummins Detailed Description	JT25/JT30	JT60/JT100
520784	3	5183	Fan Blade Pitch Position Sensor Circuit	Voltage Above Normal, or Shorted to High Source	X	X
520784	4	5184	Fan Blade Pitch Position Sensor Circuit	Voltage Below Normal, or Shorted to Low Source	X	X
520784	5	5185	Fan Blade Pitch	Mechanical system not responding or out of adjustment	X	X
520808	31	5291	Engine Emergency Shutdown Switch Activated	Condition Exists		X
520809	31	5292	Excessive Time Since Last Engine Air Shutoff Maintenance Test	Condition Exists		X
524286	31	5617	Aftertreatment 1 Diesel Oxidation Catalyst System	Special Instruction	X	X