

JT10

Operator's Manual



Overview



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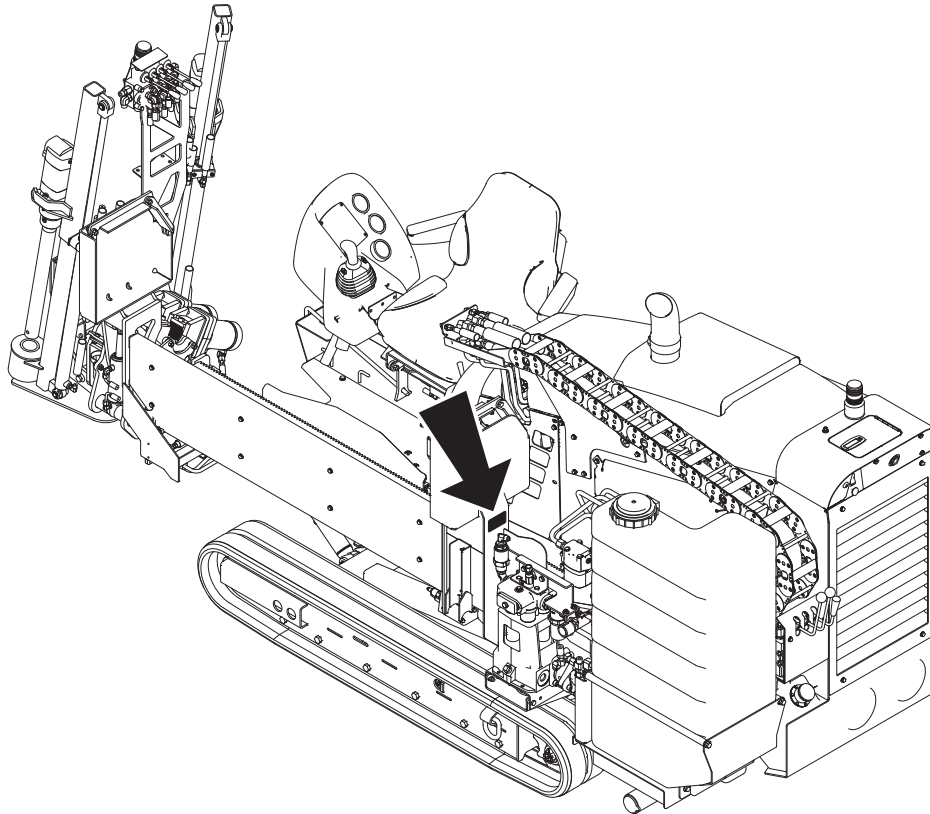
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Serial Number Location

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



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

Intended Use



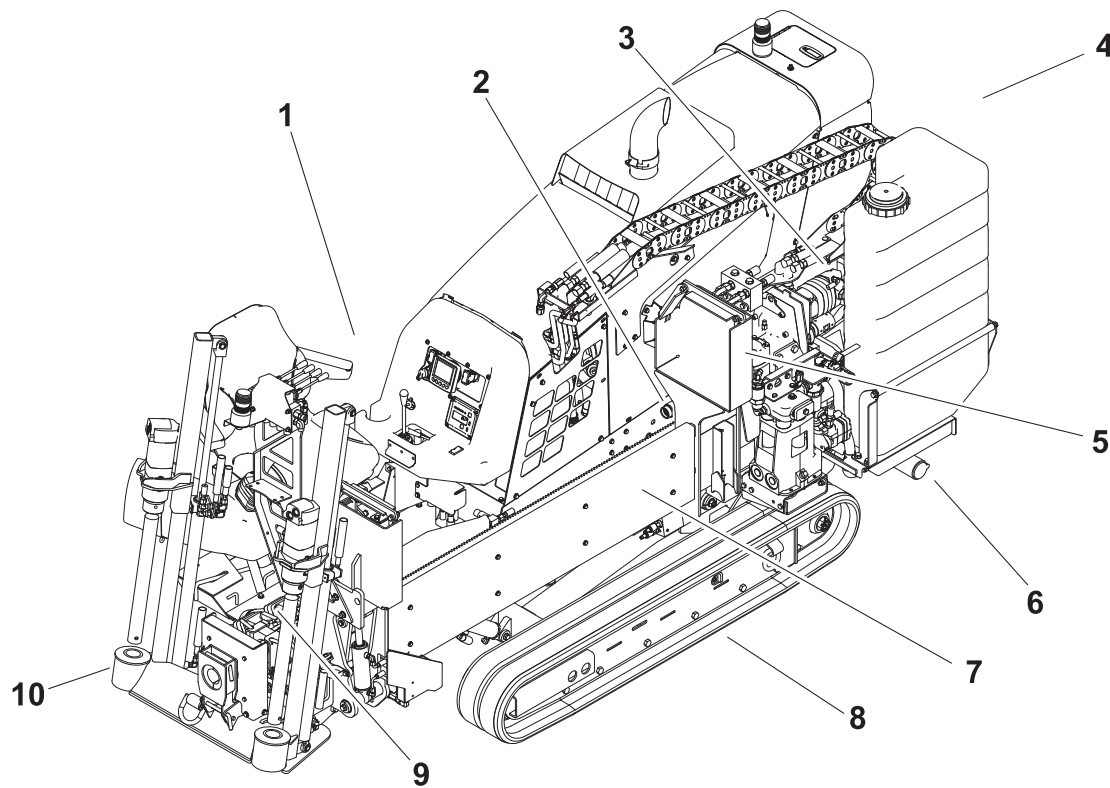
The JT10 is a self-contained horizontal directional drilling unit designed to install buried cable and pipe at distances to 300' (90 m) depending on soil conditions and is intended for operation in ambient temperatures from 0° to 115°F (-18° to 46°C). Use in any other way is considered contrary to the intended use.

The JT10 can be used with Ditch Witch® drilling fluid units and Subsite® Electronics locating equipment. It should be operated, serviced, and repaired only by persons familiar with its particular characteristics and acquainted with the relevant safety procedures.

Equipment Modification

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

Unit Components



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- | | |
|-----------------------|----------------------|
| 1. Operator's station | 6. Stabilizer |
| 2. Spindle | 7. Drill frame |
| 3. Carriage | 8. Tracks |
| 4. Set-up console | 9. Vise wrenches |
| 5. Drill pipe box | 10. Anchoring system |

FCC Statement - Internal Transmitter



U.S.

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

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

Canada

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

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



N 16819

RF Exposure Statement

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

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

Reorient or relocate the receiving antenna.

Increase the separation between the equipment and the receiver.

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

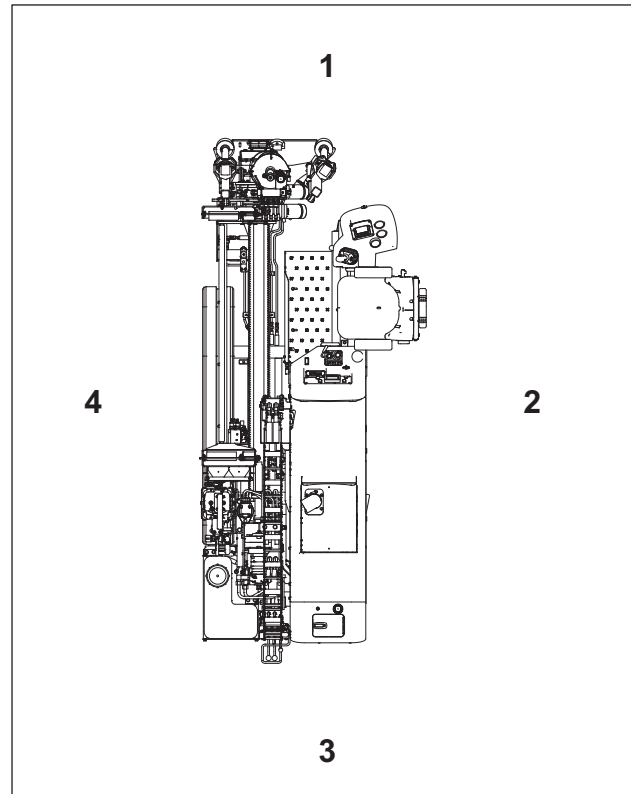
Consult the dealer or an experienced radio/TV technician for help.

This device complies with Health Canada's Safety Code. The installer of this device should ensure that RF radiation is not emitted in http://hc-sc.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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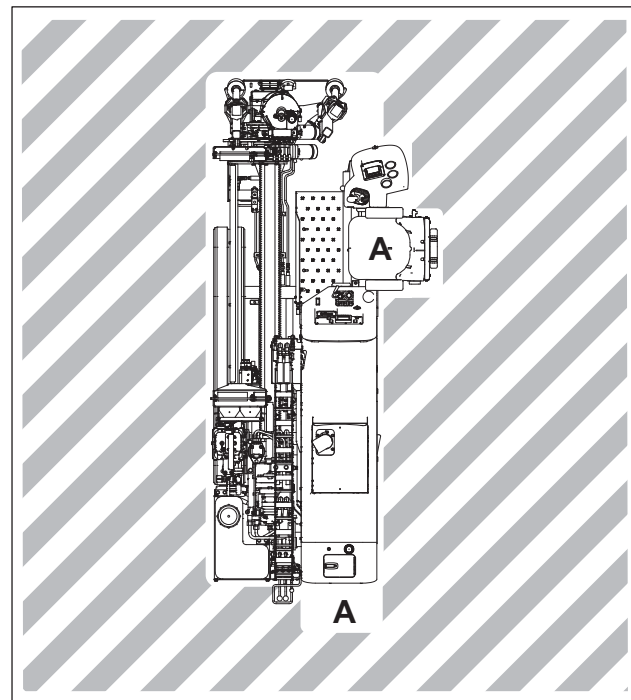
Operating Area

IMPORTANT: Top view of unit is shown.

The operating area (A) is:

- at the rear of the machine, behind the set-up console
- on the operator seat

Any other area less than 6 ft (2 m) from the machine is a danger area. Stay away.



j61om003h.eps

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.



JT10 Operator's Manual

This manual covers the following models: JT10 Tier 4 / JT10 Tier 4i

Issue number 1.0/OM-10/16

Part number 053-2965

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This product and its use may be covered by one or more patents at <http://patents.charlesmachine.works>.

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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

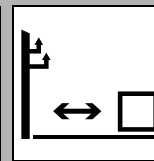
Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.



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.

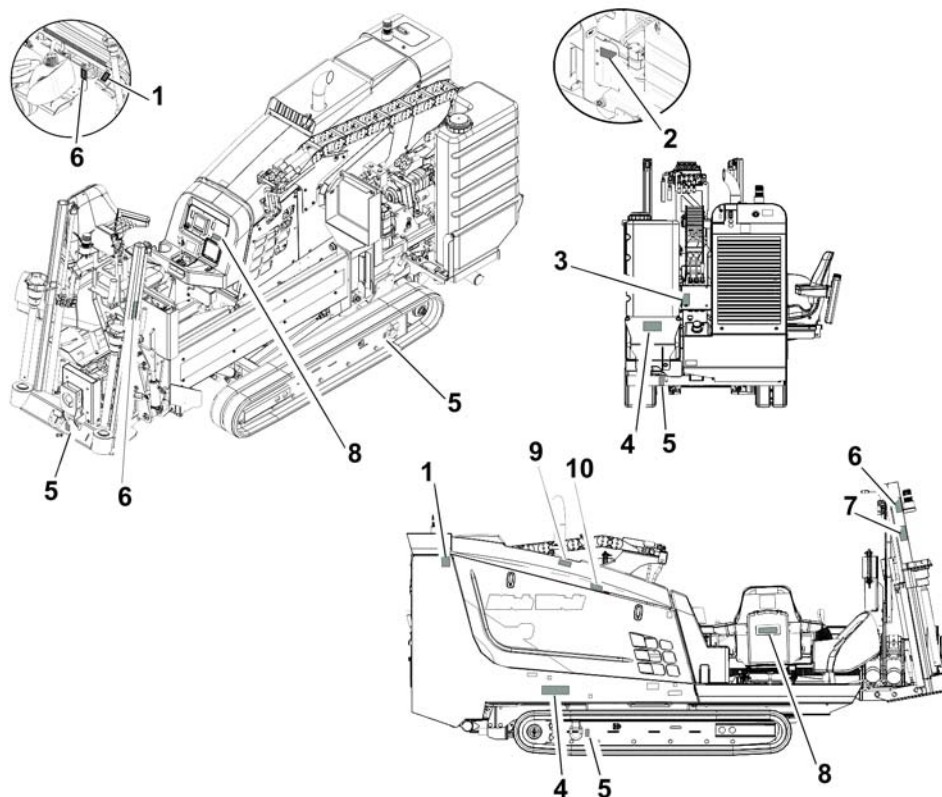
Watch for two other words: **NOTICE** and **IMPORTANT**.

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.

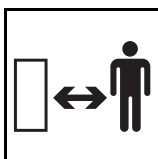
Machine Safety Alerts

JT10 T4



Decal_JT9t4

1

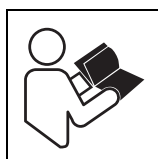


WARNING

275-184, 273-546

Moving parts could cut off hand or foot. Stay away.

2

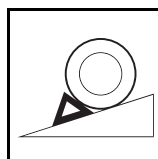


WARNING

270-6035

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

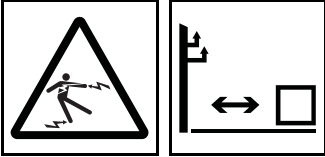
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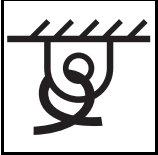


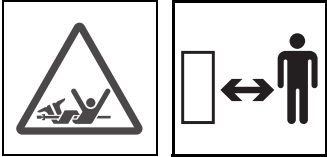
WARNING

275-383

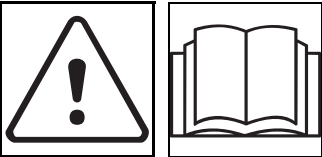
Do not park machine on slope unless chocked or blocked.

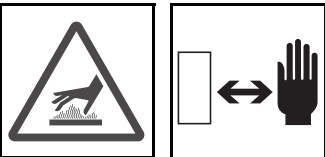
4		 DANGER Electric shock will cause death or serious injury. Stay away. 274-049
---	---	---

5		Tiedown location. See Transport chapter for more information.
---	---	---

6		 DANGER Rotating shaft will cause death or serious injury. Stay away. 270-1506, 275-197
---	---	---

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

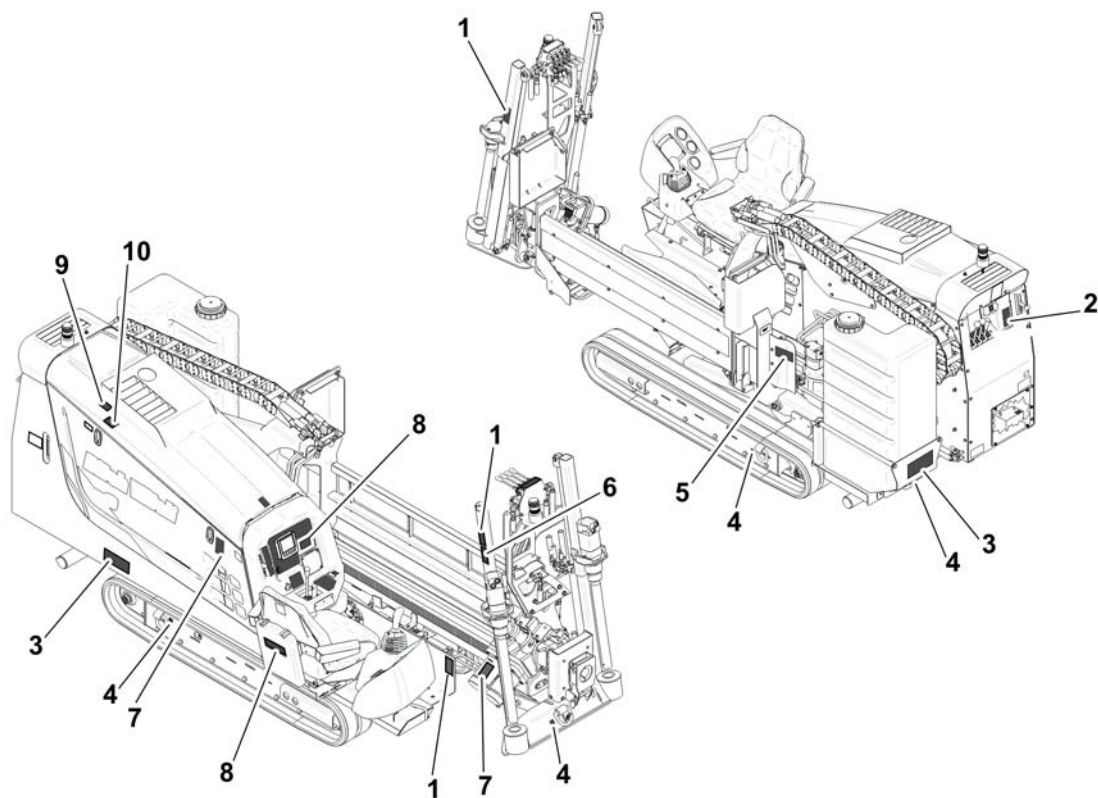
8		 WARNING Read operator's manual. Follow safety rules and know how to use all controls. Your safety is at stake. 273-475
---	--	---

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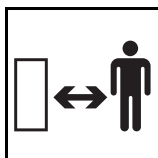


JT10 T4i



Decal_JT9T4i

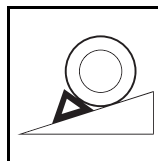
1



⚠ DANGER

Rotating shaft will cause death or serious injury.
Stay away. 270-1506, 275-197

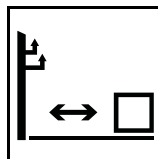
2



⚠ WARNING

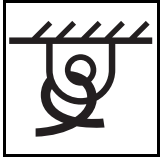
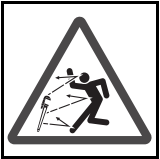
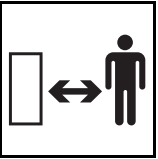
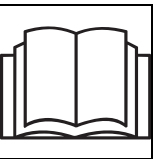
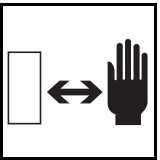
Do not park machine on slope unless chocked or
blocked. 275-383

3



⚠ DANGER

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

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|---|---|---|
| 4 |  | Tiedown location. See Transport chapter for more information. |
|---|---|---|
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|---|---|--|
| 5 |   | ⚠ WARNING Pressurized fluid or air could pierce skin and cause severe injury. Refer to operator's manual for proper use. 270-6035 |
|---|---|--|
-
- | | | |
|---|---|--|
| 6 |   | ⚠ DANGER Moving tools will kill or injure. Never use pipe wrenches on drill string. 273-278 |
|---|---|--|
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- | | | |
|---|---|---|
| 7 |   | ⚠ WARNING Moving parts could cut off hand or foot. Stay away. 275-184, 273-546 |
|---|---|---|
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|---|---|---|
| 8 |   | ⚠ WARNING Read operator's manual. Follow safety rules and know how to use all controls. Your safety is at stake. 273-475 |
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- | | | |
|---|---|--|
| 9 |   | ⚠ CAUTION Hot parts may cause burns. Do not touch until cool or wear gloves. 275-355 (2-P), 273-423 (2-P) |
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- | | | |
|----|---|---|
| 10 |   | ⚠ WARNING Fire or explosion possible. Do not use starter fluid. 273-459 (2P), 274-206 (2P), 700-206 (2P) |
|----|---|---|
-



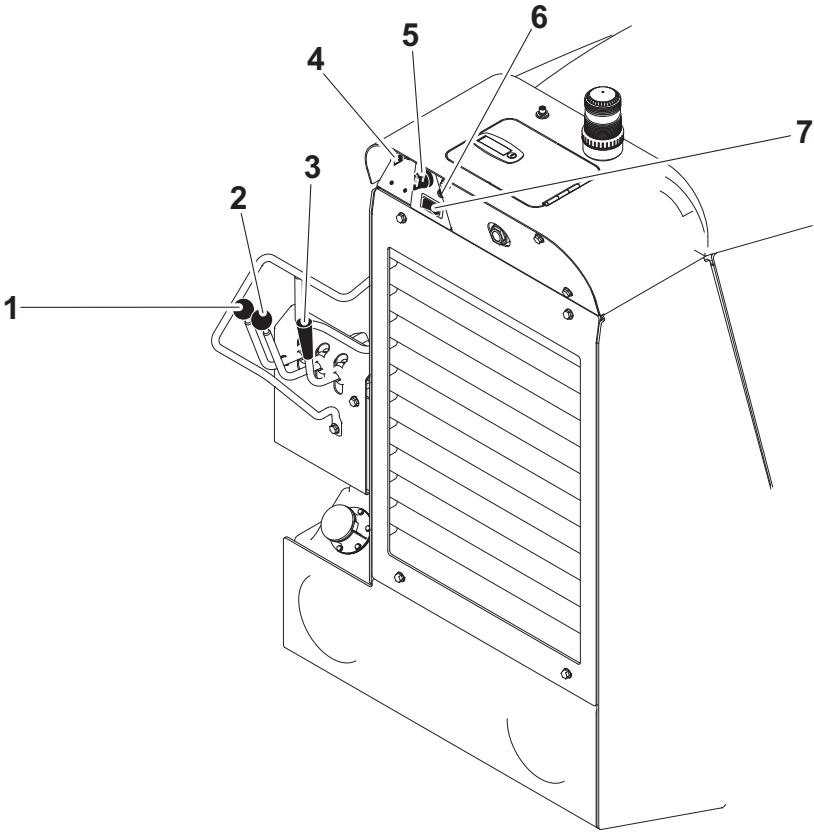
Controls

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Seat/Armrest 40
Battery 41
ESID 42



Set-Up Console



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1. Left track control

2. Right track control

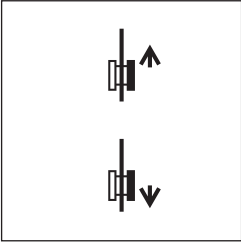
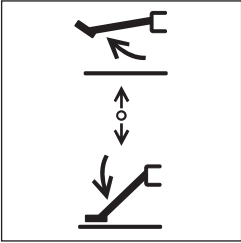
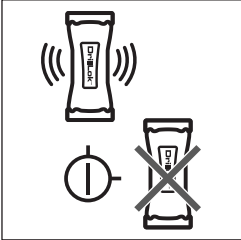
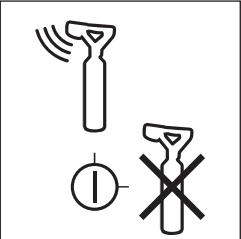
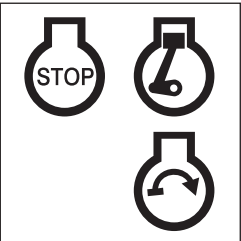
3. Stabilizer and frame tilt control

4. DrillLok™ key
5. Ignition switch

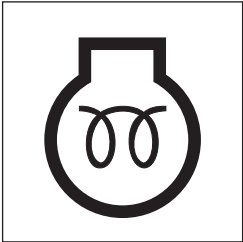
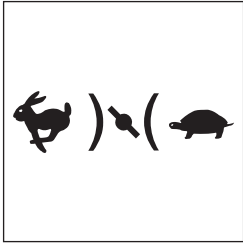
6. Cold start wait indicator

7. Engine throttle control

Item	Description	Notes
1. Left track control c00ic147h.eps	To move forward, push. To move backward, pull. To stop, move to center.	

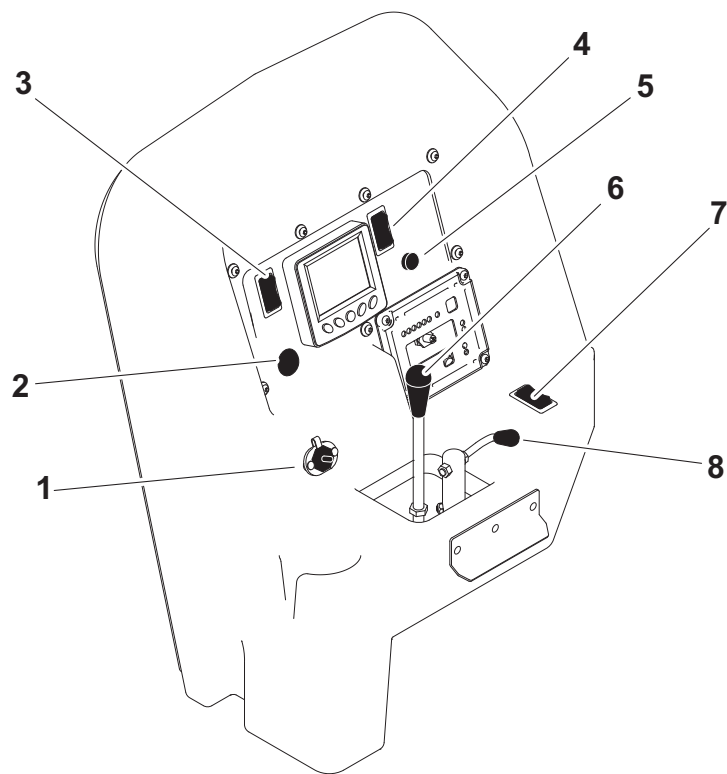
Item	Description	Notes
2. Right track control  c00ic148h.eps	To move forward, push. To move backward, pull. To stop, move to center.	
3. Stabilizer and frame tilt control  c00ic030h.eps	To raise stabilizer and increase frame tilt, push. To lower stabilizer and decrease frame tilt, pull.	IMPORTANT: Stabilizer control lowers the front of the drill frame along with the stabilizer.
4. DrillLok™ key  c00ic122w.eps  c00ic063h.eps	To allow tracker operator to stop thrust and rotation, move key to enable position (up). To override DrillLok mode, move key to override position (right).	IMPORTANT: Remove key and keep in tracker operator's possession. For more information about using DrillLok key, see "DrillLok™" on page 108.
5. Ignition switch  c00ic065h.eps	To start engine, insert key and turn clockwise. To stop engine, turn key counterclockwise.	



Item	Description	Notes
6. Cold start wait indicator  c00ic180h.eps	Lights when intake air pre-heater is operating. Wait until light goes off before starting engine.	
7. Engine throttle control  c00ic744h.eps	To increase engine speed, press  To decrease engine speed, press 	

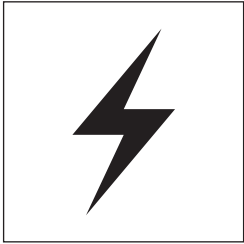
Left Control Console

Drilling/Operation Controls

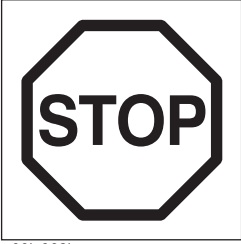
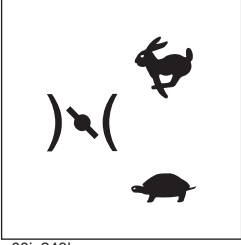
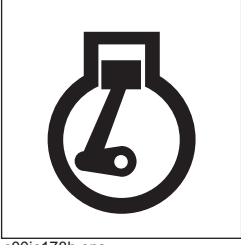
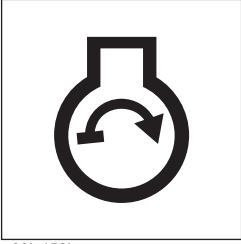


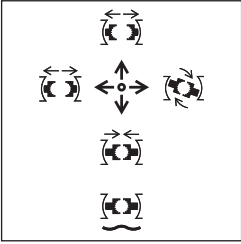
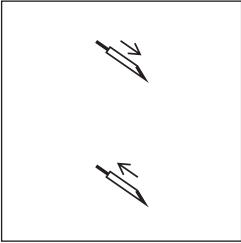
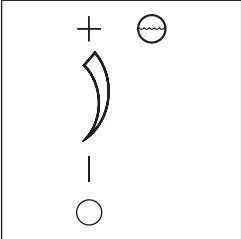
j610m004h.eps

1. Auxiliary outlet
2. Engine stop
3. Engine throttle control
4. Engine shutdown override switch
5. Remote engine start switch
6. Wrench control
7. Rear home/front home switch
8. Fluid flow control

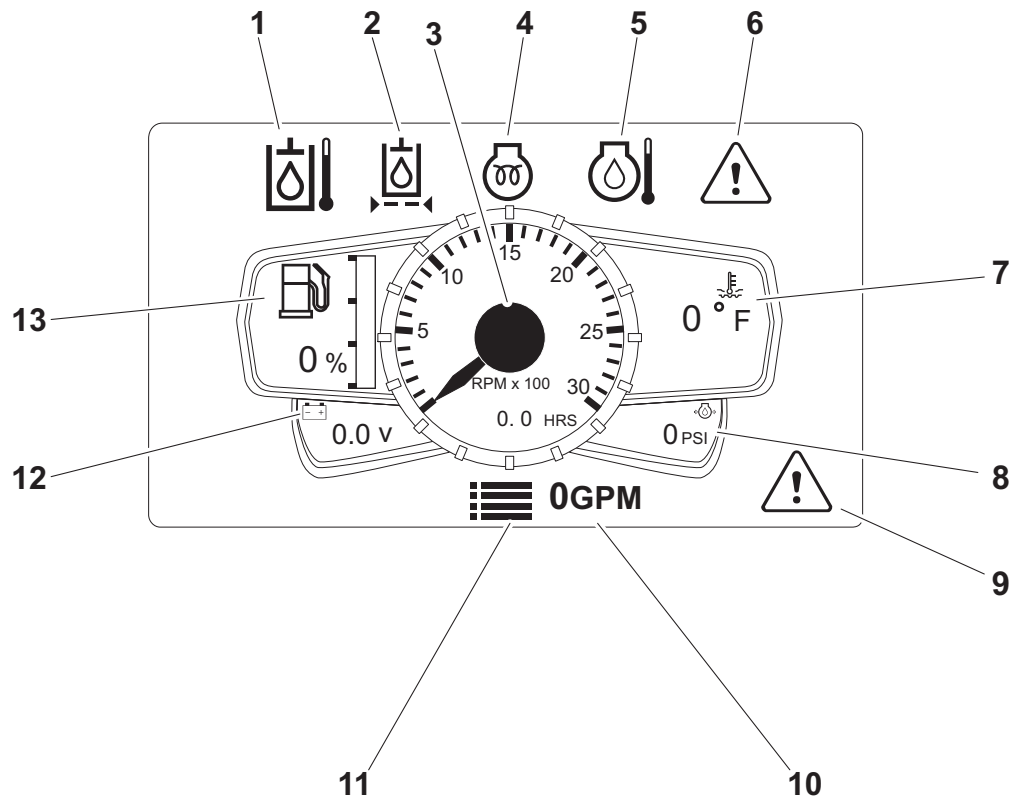
Item	Description	Notes
1. Auxiliary outlet 	Provides power for other equipment.	Power output is 12V, 5A.

c00ic448h.eps

Item	Description	Notes
2. Engine stop  c00ic062h.eps	To stop engine, press. To restart engine, turn ignition off and then back to start.	IMPORTANT: - If this switch is used to stop drilling unit, turn ignition switch off if machine will be left unattended for long periods of time. Battery discharge can occur. - If wrenches are engaged when engine stop button is pressed, wrenches will remain engaged but could gradually open.
3. Engine throttle control  c00ic243h.eps	To increase engine speed, press  To decrease engine speed, press 	
4. Engine shutdown override switch  c00ic178h.eps	If engine shutdown indicator comes on, press to delay engine shutdown for 30 seconds.	NOTICE: After 30 seconds, engine will shut down unless fault condition has been cleared on diagnostic gauge.
5. Remote engine start switch  c00ic152h.eps	To start engine from operator's station, press. Release when engine starts.	IMPORTANT: This switch only operates if the following conditions are met: - key is inserted in ignition key at set-up console; - operator is in seat; - battery disconnect switch is closed.

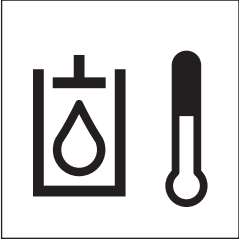
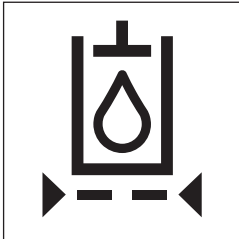
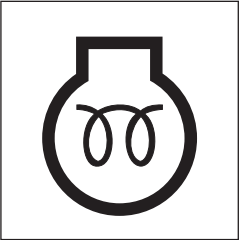
Item	Description	Notes
6. Wrench control  c00ic454h.eps	To clamp front wrench and shut off drilling fluid, move toward pipe box. To unclamp front wrench, move away from pipebox. To clamp and rotate rear (rotating) wrench, move toward engine compartment. To unclamp rear (rotating) wrench, move toward seat.	
7. Rear home/ front home switch  c00ic572h.eps	To move carriage to front of drill frame, press top. To move carriage to rear of drill frame, press bottom.	
8. Fluid flow control  c00ic675h.eps	To increase flow, turn counterclockwise. To decrease flow, turn clockwise. To stop flow, turn all the way clockwise.	



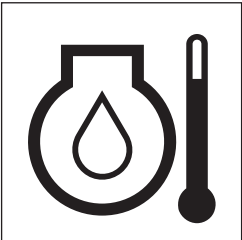
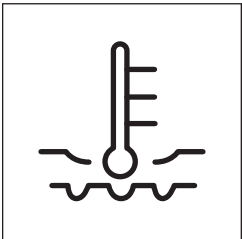
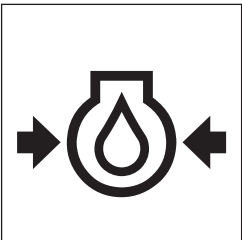
Engine Display

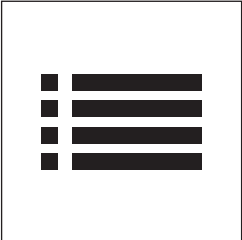
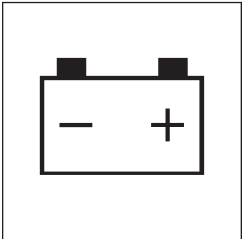
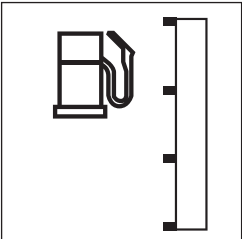
j610m005h.eps

- | | |
|--|----------------------------------|
| 1. Hydraulic fluid temperature indicator | 7. Engine temperature indicator |
| 2. Hydraulic filter service indicator | 8. Engine oil pressure indicator |
| 3. Hourmeter | 9. Diagnostics menu indicator |
| 4. Cold start wait indicator | 10. Flow rate indicator |
| 5. High temperature indicator | 11. Settings menu indicator |
| 6. Engine shutdown indicator (Tier 4)
Diagnostic message indicator (Tier 4) | 12. Voltmeter display |
| | 13. Fuel gauge |

Item	Description	Notes
1. Hydraulic fluid temperature indicator  c00ic023h.eps	Indicates hydraulic fluid is overheating.	- Check hydraulic fluid level. - Check cooler for debris.
2. Hydraulic filter service indicator  c00ic024h.eps	Indicates hydraulic fluid filter needs replacing.	Change filter when indicator lights continuously.
3. Hourmeter  c00ic019h.eps	Displays engine operating time.	Use engine operating times to schedule service.
4. Cold start wait indicator  c00ic180h.eps	Lights when intake air pre-heater is operating. Wait until light goes off before starting engine.	



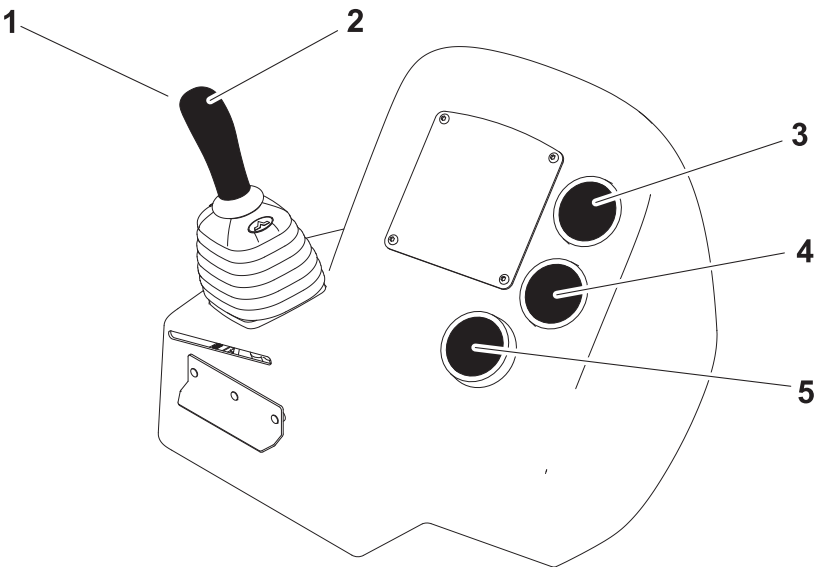
Item	Description	Notes
5. High temperature indicator  c00ic232h.eps	Indicates engine is overheating.	IMPORTANT: Alarms will sound when engine overheats. Stop engine and service unit.
6. Engine shutdown indicator (Tier 4i) Diagnostic message indicator (Tier 4)  c00ic123w.eps	Tier 4i: Indicates the engine shutdown relay has been activated due to low engine oil pressure. Tier 4: Indicates a Diagnostic Trouble Code.	
7. Engine temperature indicator  c00ic004w.eps	Lights when engine coolant temperature is too high.	Tier 4i: Will flash when temperature is over 275°F (135°C). Tier 4: Will flash when temperature is over 230°F (110°C). Stop engine and service unit.
8. Engine oil pressure indicator  c00ic119h.eps	Indicates engine oil pressure is too low.	IMPORTANT: Alarms will sound when engine oil pressure is too low. Stop engine and check oil level.

Item	Description	Notes
9. Diagnostics menu indicator  c00ic123w.eps	Use soft key directly below icon to access diagnostics menu.	
10. Flow rate indicator	Shows flow rate for fluid pump.	
11. Settings menu indicator  c00ic678h.eps	Use soft key directly below icon to access main menu.	
12. Voltmeter display  c00ic008w.eps	Shows system voltage.	
13. Fuel gauge  c00ic677h.eps	Displays fuel level in tank.	NOTICE: Use low sulfur or ultra low sulfur fuel only. Refer to engine operator's manual for cold weather fuel recommendations.



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

Right Control Console



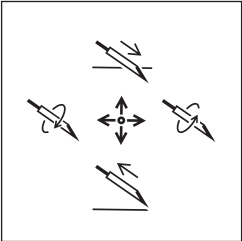
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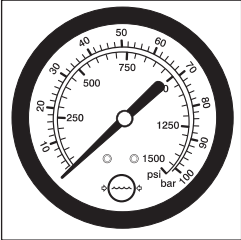
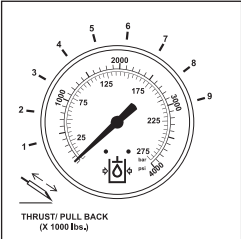
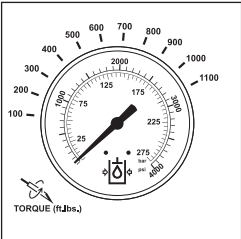
1. Carriage control

2. Pipe lubricator button (optional)

3. Drilling fluid pressure gauge
4. Thrust pressure gauge

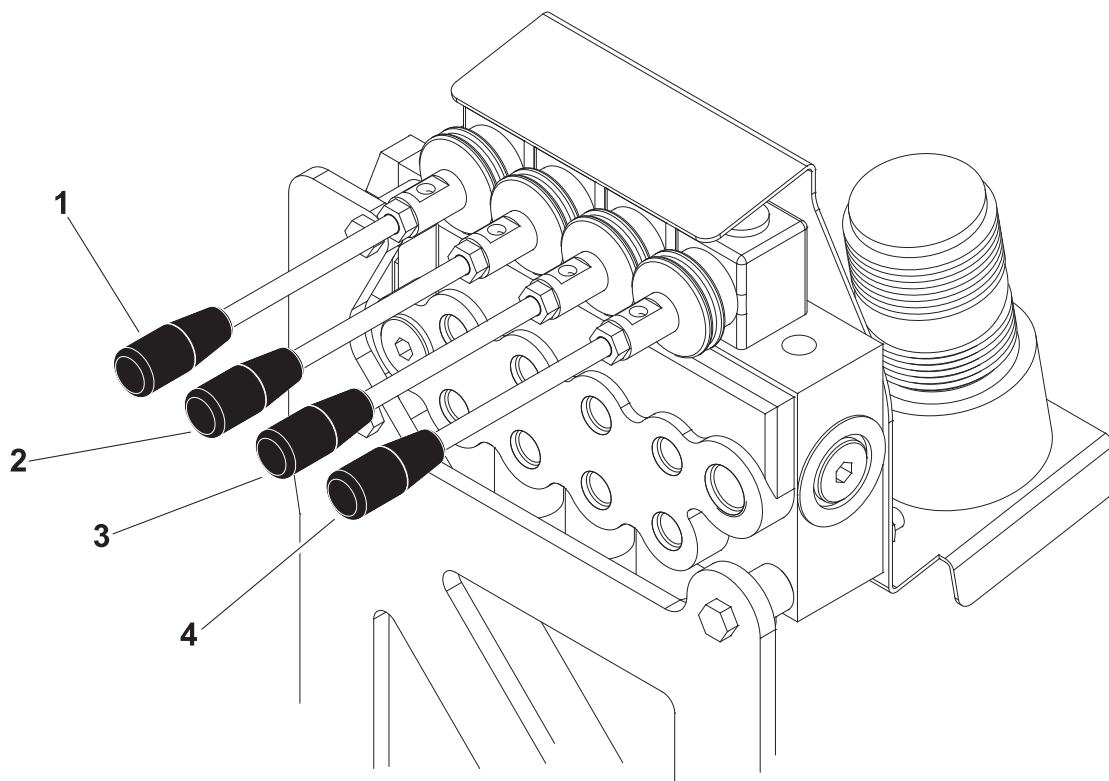
5. Rotation pressure gauge

Item	Description	Notes
1. Carriage control  c00ic452h.eps	To move carriage forward, push. To move carriage backward, pull. To rotate spindle counterclockwise (breakout), move right. To rotate spindle clockwise (makeup), move left.	

Item	Description	Notes
2. Pipe lubricator button (optional)	To apply joint compound to threads at wrenches, press button.	
3. Drilling fluid pressure gauge  c00ic157h.eps	Displays drilling fluid pressure supplied by drilling fluid pump.	
4. Thrust pressure gauge  c00ic450h.eps	Displays hydraulic fluid pressure to thrust motor during thrust and pullback. Estimates thrust and pullback force on lines outside gauge.	
5. Rotation pressure gauge  c00ic451h.eps	Displays hydraulic fluid pressure to rotation motor when spindle is turned clockwise. Estimates rotational torque on lines outside gauge.	

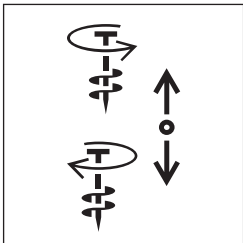


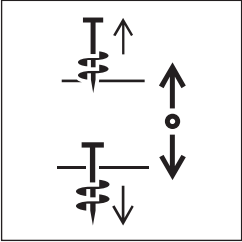
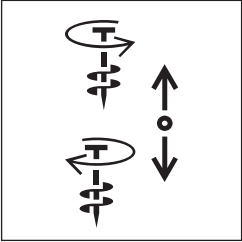
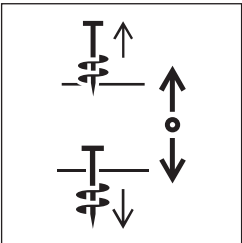
Anchoring System Console



j21om008h.eps

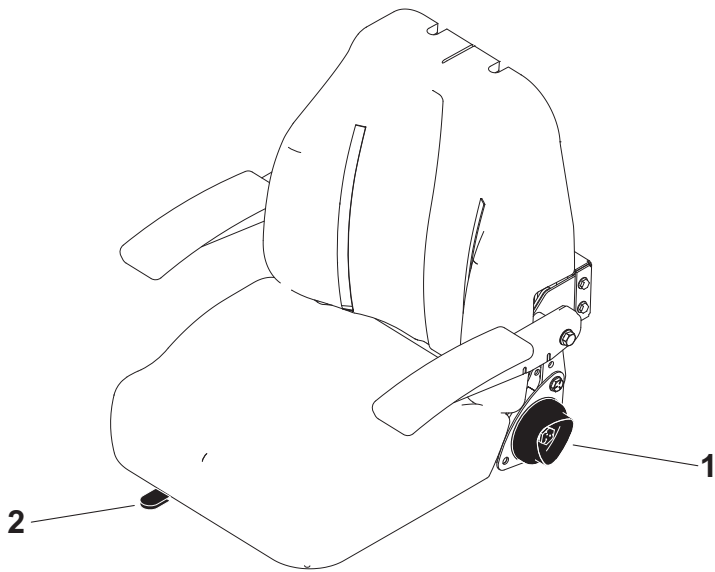
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|--------------------------|---------------------------|
| 1. Left rotation control | 3. Right rotation control |
| 2. Left thrust control | 4. Right thrust control |

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

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

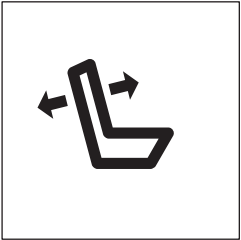


Seat/Armrest

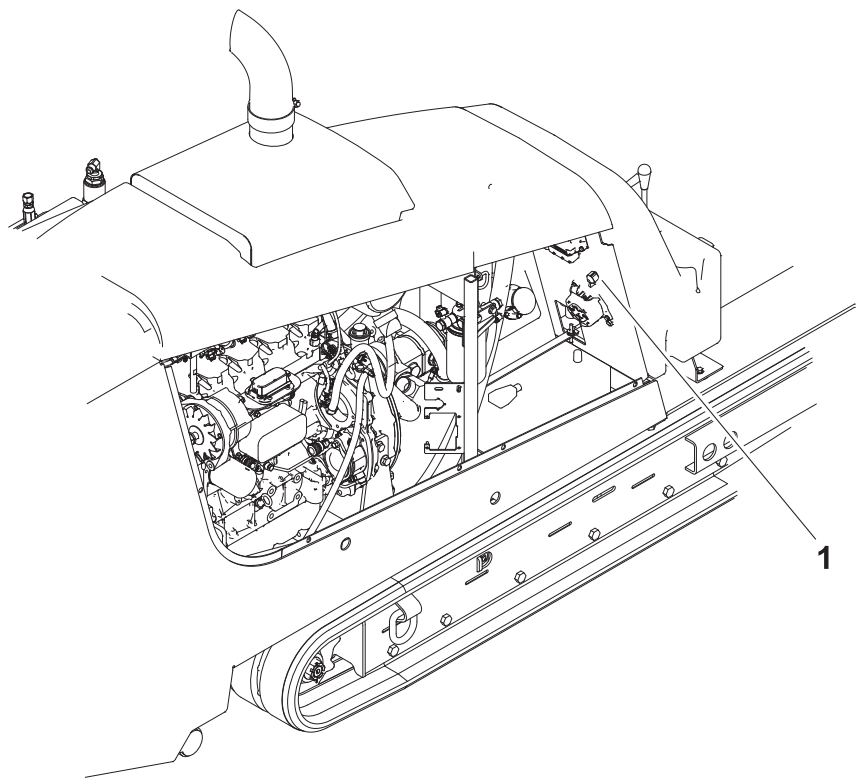


j610m006h.eps

1. Seat recline control
2. Seat slide control

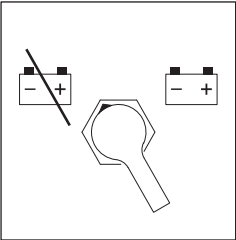
Item	Description	Notes
1. Seat recline control  c00ic096h.eps	To recline or raise backrest, turn.	
2. Seat slide control  c00ic095h.eps	To slide forward or backward, pull. To set position, release.	

Battery

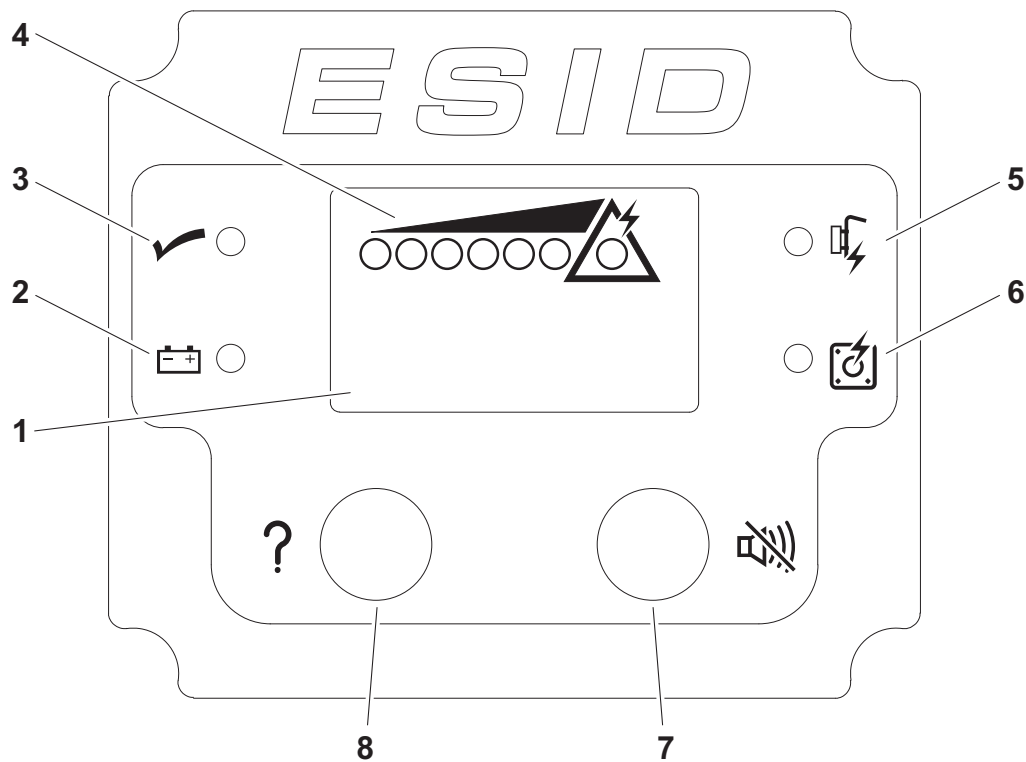


j42om011h.eps

1. Battery disconnect switch

Item	Description	Notes
1. Battery disconnect switch  c00ic097h.eps	To disable battery power, move switch to the disconnect position. To enable battery power, move switch to the connect position.	

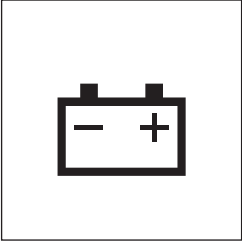
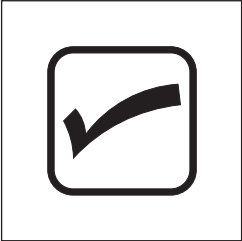
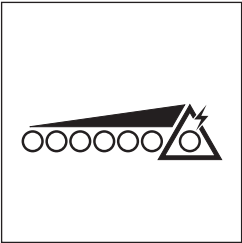
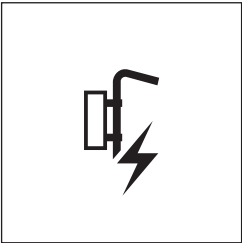
ESID



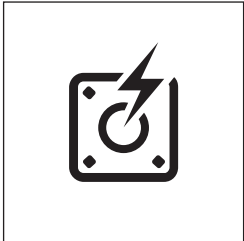
ESID.eps

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

Item	Description	Notes
1. LCD display	Displays the amount of current and voltage being detected as a percentage of a strike condition. Displays status icons during certain error conditions. The line with the "V" shows voltage reading and the line with the "A" shows current reading.	See "Diagnostic Icons" on page 102.

Item	Description	Notes
2. Electrical power supply indicator  c00ic081h.eps	Green light means control box has sufficient electrical power for operation. Strike system is ready to operate if OK indicator is also on.	
3. OK indicator  c00ic056h.eps	Green light means system self test detected no problems. Strike system is ready to operate.	
4. Strike indicator  c00ic077h.eps	The indicator bubbles are filled as strike percent readings increase. A filled indicator bubble in the triangle represents a strike warning condition and will trigger the alarm(s) and strobe(s). Remember that the system can go from one or two indicator bubbles to an electric strike immediately.	NOTICE: The ESID does not indicate proximity to electric lines. System will activate only when voltage and/or amperage detected at the drilling unit are above threshold minimum limits.
5. Voltage problem indicator  c00ic078h.eps	Blinking red light indicates a voltage problem.	See "Troubleshoot Strike System" on page 99.



Item	Description	Notes
6. Current problem indicator  c00ic080h.eps	Blinking red light indicates a current problem.	See "Troubleshoot Strike System" on page 99.
7. Alarm interrupt button  c00ic078h.eps	To turn off strike alarm at drilling unit, press.	
8. Self test button  c00ic075h.eps	Press to start a manual self test. Press and hold to reset the system after a strike has been detected.	Checks all systems and circuits. NOTICE: See "If an Electric Line is Damaged" on page 16.

Operation Overview

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Plan

1. Gather information about jobsite. See page 50.
2. Inspect jobsite. See page 51.
3. Classify jobsite. See page 53.
4. Plan bore path. See page 56.
5. Check supplies and prepare equipment. See page 63.
6. Load equipment. See page 72.

Set Up at Jobsite

1. Prepare jobsite. See page 62.
2. Unload drilling unit from trailer. See page 74.
3. Position drilling unit and frame. See page 78.
4. Assemble strike system. See page 97.
5. Anchor drilling unit. See page 95.
6. Calibrate tracker with beacon that will be installed in beacon housing. See tracker operator's manual.

Drill

1. Start system. See page 78.
2. Prime drilling fluid pump. See page 78.
3. Engage DrillLok™ if desired. See page 108.
4. Assemble drill string. See page 81.
5. Drill first pipe. See page 84.
6. Record bore path. See page 87.
7. Add pipe. See page 85.
8. Drill remaining pipes in pipe box.
 - Correct direction. See page 86.
9. Surface drill head. See page 88.

Backream

1. Assemble backream string. See page 89.
2. Start drilling unit and adjust throttle.
3. Set drilling fluid flow. Check that fluid flows through all nozzles.
4. Remove pipe from bore. See page 91.
5. Remove pullback device. See page 92.

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.



Leave Jobsite

1. Remove anchors. See page 96.
2. Rinse unit and down-hole tools. See page 123.
3. Disassemble strike system and disconnect from fluid system. See page 125.
4. Stow tools. See page 125.
5. Load unit onto trailer. See page 72.

Store Equipment

1. For cold weather storage, antifreeze drilling unit. See page 122.
2. For long-term storage, disconnect battery disconnect switch.

Prepare

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- Examine Pullback Material 50
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- Prepare Entry Point 62

Check Supplies and Prepare Equipment 63

- Check Supplies 63
- Prepare Equipment 64
- Assemble Accessories 65



Gather Information

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

Review Job Plan

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

Notify One-Call Services

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

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

Examine Pullback Material

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

Arrange for Traffic Control

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

Plan for Emergency Services

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

Inspect Site

Identify Hazards

Inspect jobsite before transporting equipment. Check for the following:

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



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

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

Select Start and End Points

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

Slope

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

Traffic

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

Space

Check that starting and ending points allow enough space for gradual pipe bending. See "Minimum Setback" on page 60.

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.

To help avoid injury:

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

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



Select a Classification

Jobsites are classified according to underground hazards present.

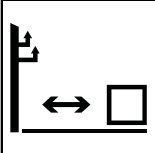
If working . . .	then classify jobsite as . . .
within 10' (3 m) of a buried electric line	electric
within 10' (3 m) of a natural gas line	natural gas
in concrete, sand or granite which is capable of producing crystalline silica (quartz) dust	crystalline silica (quartz) dust
within 10' (3 m) of any other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

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

Apply Precautions

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

Electric Jobsite Precautions



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

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

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

Natural Gas Jobsite Precautions

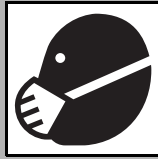


⚠ WARNING Fire or explosion possible. Fumes could ignite and cause burns. No smoking, no flame, no spark.

In addition to using a directional drilling system and positioning equipment upwind from gas lines, use one or both of these methods.

- Expose lines by careful hand digging or soft excavation. Use beacon to track bore path. Have someone observe clearance between drill head and backreamer when crossing a line.
- Have gas shut off while work is in progress. Have gas company test lines before returning them to service.

Crystalline Silica (Quartz) Dust Precautions



CAUTION

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

To help avoid injury:

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

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

Other Jobsite Precautions

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



Plan Bore Path

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

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

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

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

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

IMPORTANT: See the following pages for more information about these measurements. If not using Trac Management System Plus, see "Bore Path Calculator" on page 61 and use these measurements to help plan your bore.

Recommended Bend Limits

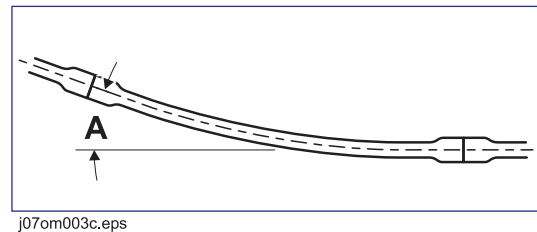
Ditch Witch® drill pipes are designed to bend slightly during operation. Slight bending allows for steering and correcting direction. Bending beyond recommended limits will cause damage that might not be visible. This damage adds up and will later lead to sudden drill pipe failure.

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

Pipe Pitch

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

Make sure pitch (A) changes no more than 7.3% over the full length of each Power Pipe® HD pipe and no more than 6.2% for Power Pipe Forged pipe.



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



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

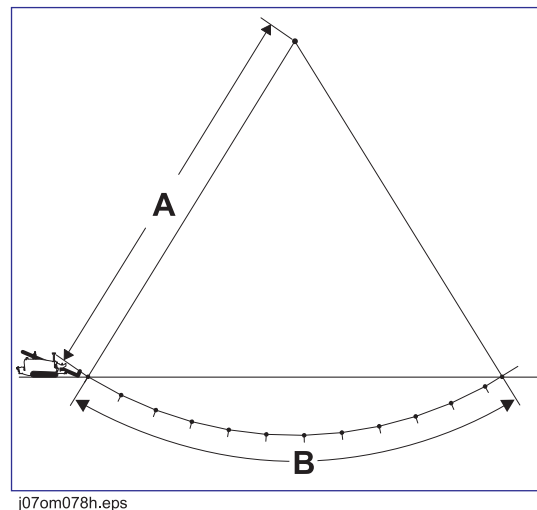
Bend Radius

Power Pipe® HD drill pipes have a tested minimum bend radius of 82' (25 m). This means that a 90-degree bend in the bore path:

- has a radius (A) of 82' (25 m)
- requires approximately 132' (40.2 m) of drill pipe (B).

Power Pipe® Forged drill pipes have a tested minimum bend radius of 96' (29.3 m). This means that a 90-degree bend in the bore path:

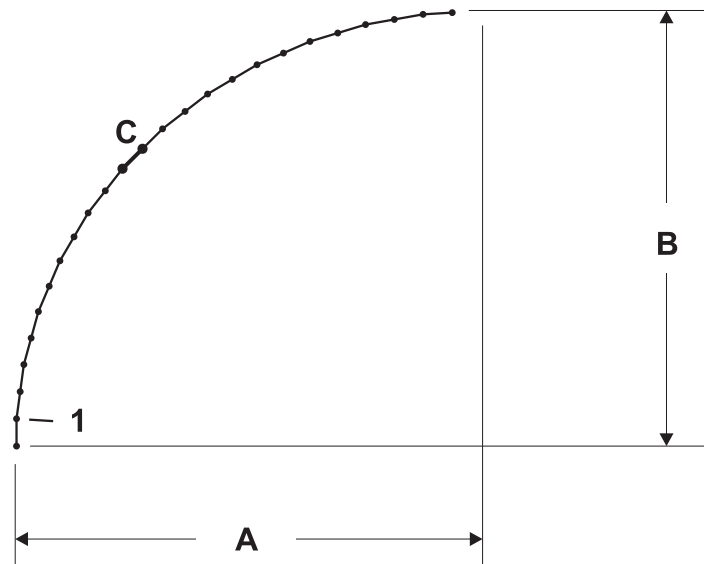
- has a radius (A) of 96' (29.3 m)
- requires approximately 151' (46 m) of drill pipe (B).



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

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

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

Pipe-By-Pipe Bend Limits


PlanBorePath.eps

Power Pipe® HD

Pipe (C)	Forward (B)	Deflection (A)	Pipe (C)	Forward (B)	Deflection (A)
1	5 ft 11 in (1.8 m)	0 ft 2.6 in (0.07 m)	12	63 ft 1 in (19.2 m)	29 ft 8 in (9 m)
2	11 ft 11.5 in (3.6 m)	0 ft 10.5 in (0.27 m)	13	66 ft 9 in (20.3 m)	34 ft 5 in (10.5 m)
3	17 ft 10 in (5.4 m)	1 ft 11.6 in (0.6 m)	14	70 ft 1 in (21.4 m)	39 ft 5 in (12 m)
4	23 ft 8 in (7.2 m)	3 ft 6 in (1.1 m)	15	73 ft 0 in (22.2 m)	44 ft 7.5 in (13.6 m)
5	29 ft 4 in (8.9 m)	5 ft 5 in (1.6 m)	16	75 ft 6 in (23 m)	50 ft 1 in (15.3 m)
6	34 ft 10 in (10.6 m)	7 ft 9 in (2.4 m)	17	77 ft 8 in (23.7 m)	55 ft 8 in (16.9 m)
7	40 ft 2 in (12.3 m)	10 ft 6 in (3.2 m)	18	79 ft 4.5 in (24.2 m)	61 ft 5 in (18.7 m)
8	45 ft 4 in (13.8 m)	13 ft 8 in (4.2 m)	19	80 ft 8 in (24.6 m)	67 ft 3 in (20.5 m)
9	50 ft 2 in (15.3 m)	17 ft 2 in (5.2 m)	20	81 ft 6 in (24.8 m)	73 ft 2.5 in (22.3 m)
10	54 ft 9.5 in (16.7 m)	23 ft 0 in (6.4 m)	21	81 ft 11 in (24.9 m)	79 ft 2 in (24.1 m)
11	59 ft 1 in (18 m)	25 ft 2 in (7.7 m)	22	82 ft 0 in (25 m)	82 ft 0 in (25 m)

Power Pipe® Forged

Pipe (C)	Forward (B)	Deflection (A)	Pipe (C)	Forward (B)	Deflection (A)
1	6 ft 0 in (1.8 m)	0 ft 2 in (0.06 m)	14	73 ft 8 in (22.5 m)	34 ft 6 in (10.5 m)
2	12 ft 0 in (3.6 m)	0 ft 9 in (0.23 m)	15	77 ft 5 in (23.6 m)	39 ft 2 in (11.4 m)
3	17 ft 11 in (5.5 m)	1 ft 8 in (0.51 m)	16	80 ft 9 in (24.6 m)	44 ft 2 in (13.5 m)
4	23 ft 9 in (7.2 m)	3 ft 0 in (0.91 m)	17	83 ft 10 in (25.6 m)	49 ft 3 in (15 m)
5	29 ft 6 in (9 m)	4 ft 8 in (1.4 m)	18	86 ft 7 in (26.4 m)	54 ft 7 in (16.6 m)
6	35 ft 2 in (10.7 m)	6 ft 8 in (2 m)	19	89 ft 0 in (27.1 m)	60 ft 1 in (18.3 m)
7	40 ft 8 in (12.4 m)	9 ft 0.5 in (2.8 m)	20	91 ft 1 in (27.8 m)	65 ft 9 in (20 m)
8	46 ft 0 in (14 m)	11 ft 9 in (3.6 m)	21	92 ft 10 in (28.3 m)	71 ft 6 in (21.8 m)
9	51 ft 2 in (15.6 m)	14 ft 9.5 in (4.5 m)	22	94 ft 2 in (28.7 m)	77 ft 4 in (23.6 m)
10	56 ft 2 in (17.1 m)	18 ft 2 in (5.5 m)	23	95 ft 2 in (29 m)	83 ft 3 in (25.4 m)
11	60 ft 11 in (18.6 m)	21 ft 10 in (6.6 m)	24	95 ft 9 in (29.2 m)	89 ft 2.5 in (27.2 m)
12	65 ft 5 in (19.9 m)	25 ft 9 in (7.9 m)	25	96 ft 0 in (29.3 m)	95 ft 2 in (29 m)
13	69 ft 8 in (21.2 m)	30 ft 0 in (9.1 m)	26	96 ft 0 in (29.3 m)	96 ft 0 in (29.3 m)



Entry Pitch

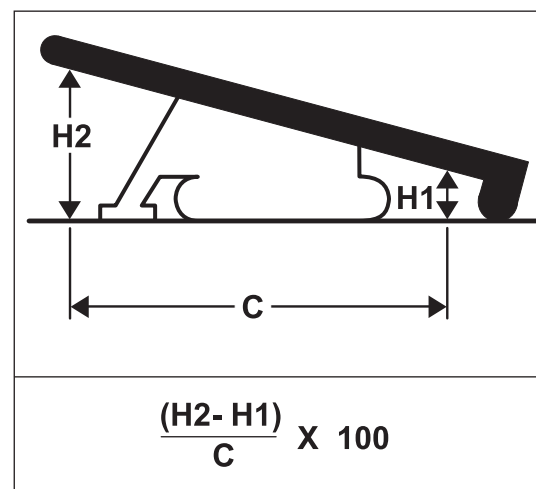
Entry pitch is the slope of the drill frame compared with the slope of the ground. Determine entry pitch one of two ways:

1. With Pitch Beacon

- Lay pitch beacon on the ground and read pitch.
- Lay pitch beacon on drill frame and read pitch.
- Subtract ground pitch from drilling unit pitch.

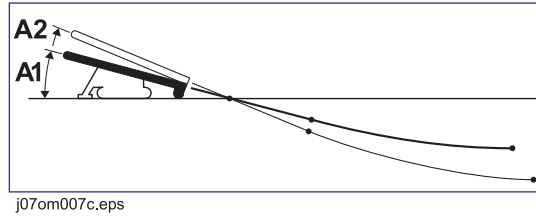
2. With Measurements

- Measure from the ground to front end of drill frame (H1).
- Measure from the ground to back end of frame (H2).
- Subtract (H1) from (H2). Record this number.
- Measure the distance between front and back points (C).
- Divide (H2-H1) by (C), then multiply by 100. This is your pitch.



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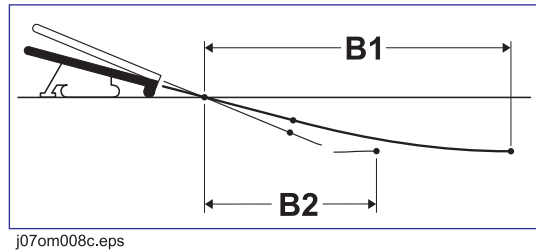
IMPORTANT: A shallow entry pitch (A1) allows you to reach horizontal sooner and with less bending. Increasing entry pitch (A2) makes bore path longer and deeper.



Minimum Setback

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

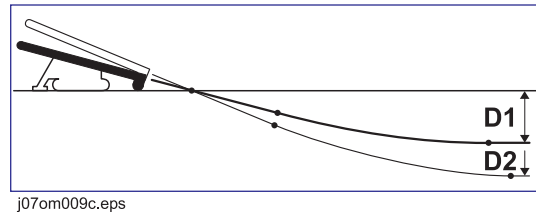
NOTICE: If setback is too small (B2), you will exceed bend limits and damage the pipe.



Minimum Depth

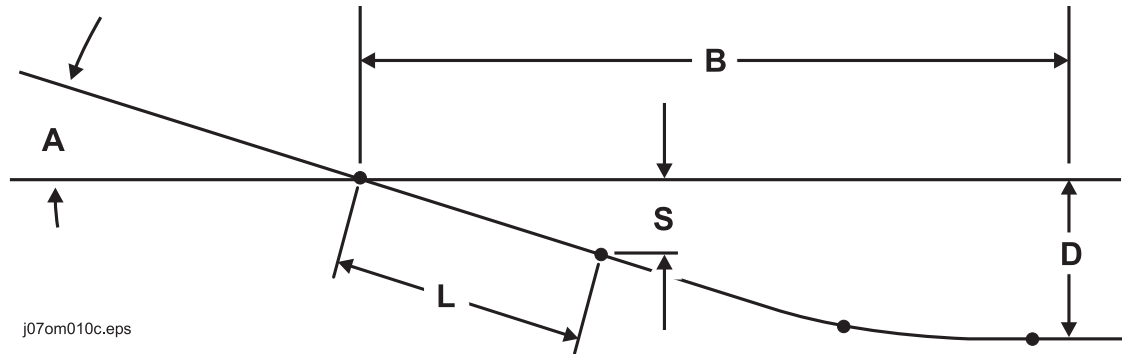
Because you must bend pipe gradually, entry pitch and bend limits determine how deep the pipe will be when it becomes horizontal. This is called the **minimum depth**.

- 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.



Power Pipe® HD



Minimum depth (D)	Entry pitch (A)	Setback (B)	Depth to begin steering (S)
2 ft 9 in (0.89 m)	-18%	22 ft 5 in (6.8 m)	1 ft 6 in (0.46 m)
3 ft 2 in (0.96 m)	-20%	23 ft 11 in (7.3 m)	1 ft 7 in (0.48 m)
3 ft 8 in (1.12 m)	-22%	25 ft 6 in (7.8 m)	1 ft 9 in (0.53 m)
4 ft 2 in (1.27 m)	-24%	26 ft 11 in (8.2 m)	1 ft 11 in (0.58 m)
4 ft 5 in (1.34 m)	-25%	27 ft 9 in (8.5 m)	2 ft 0 in (0.61 m)

Power Pipe Forged

Minimum depth (D)	Entry pitch (A)	Setback (B)	Depth to begin steering (S)
3 ft 0 in (0.91 m)	-18%	24 ft 11 in (7.6 m)	1 ft 6 in (0.46 m)
3 ft 6 in (1.07 m)	-20%	26 ft 8 in (8.1 m)	1 ft 7 in (0.48 m)
4 ft 0 in (1.22 m)	-22%	28 ft 6 in (8.7 m)	1 ft 9 in (0.53 m)
4 ft 7 in (1.40 m)	-24%	30 ft 3 in (9.2 m)	1 ft 11 in (0.58 m)
4 ft 10 in (1.47 m)	-25%	31 ft 1 in (9.5 m)	2 ft 0 in (0.61 m)

IMPORTANT: Numbers in table based on **82'/25 m (Power Pipe HD) or 96'/29.3 m (Power Pipe Forged) minimum bend radius**, beacon housing, EZ-Connect, connector, transition sub, and 1/3 of first drill pipe (L, totaling 8' [2.4 m]) in the ground before steering.

Prepare Jobsite



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

To help avoid injury:

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

Mark Bore Path

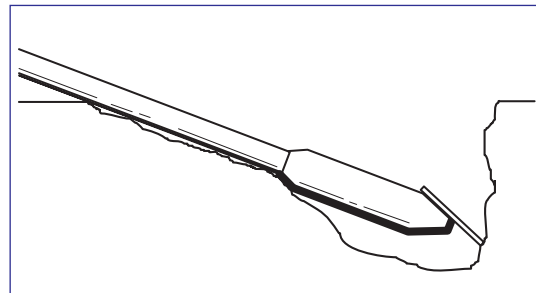
Mark your planned bore path and all located utility lines with flags or paint.

Prepare Entry Point

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

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

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



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Check Supplies and Prepare Equipment

Check Supplies

- receiver/transmitter or tracker with spare batteries
- extra batteries for DrillLok™ remote, if equipped
- beacons with new and spare batteries
- two-way radios with new and spare batteries
- quick wrench
- transition sub
- anchoring equipment and accessories
- bits, screens, nozzles
- adapters, pipe, beacon housings
- marking flags or paint
- water and additional hoses
- fuel (Use low sulfur or ultra low sulfur fuel only.)
- drilling fluid additives
- spare fuses
- keys
- backreamers, swivels, pulling devices
- wash down hose and spray gun
- duct tape
- spray lubricant
- tool joint compound
- electrically insulating boots and gloves
- personal protective equipment, such as hard hat and safety glasses
- notepad and pencil



Prepare Equipment

Fluid Levels

- fuel (Use low sulfur or ultra low sulfur fuel only.)
- hydraulic fluid
- battery charge
- engine oil

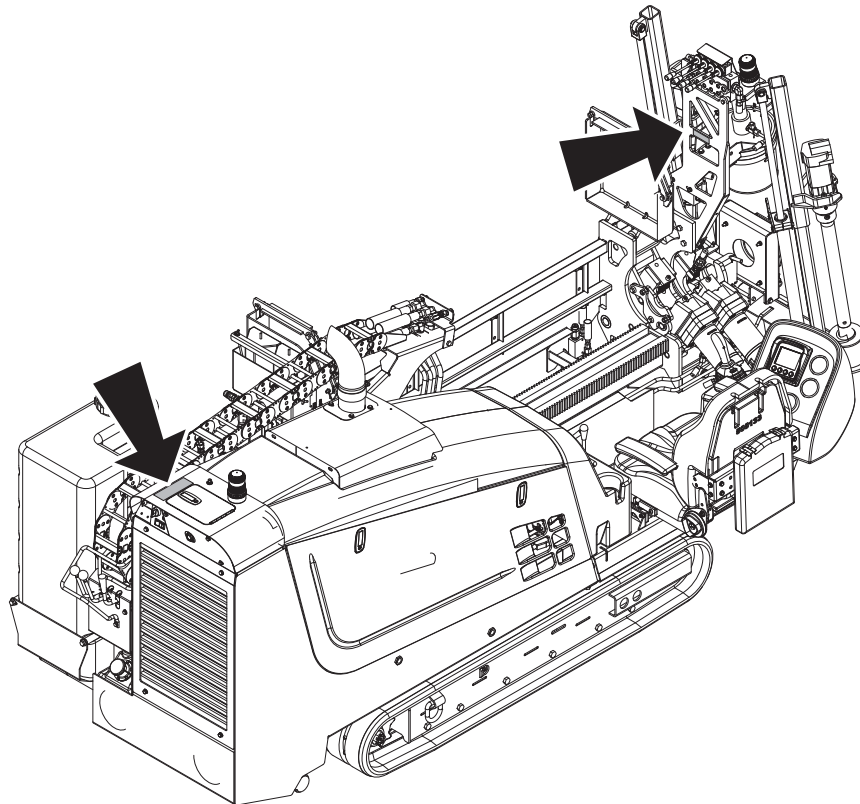
Condition and Function

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

Assemble Accessories

Fire Extinguisher

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.



Drive

Chapter Contents

Start Unit 68

Steer Unit 68

Shut Down Unit 69



Start Unit

1. Insert key.
2. Turn key clockwise.
3. Run engine at low throttle for 5 minutes.

Steer Unit

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

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, move one control to reverse and one control to forward to turn in the desired direction. Tracks will counter-rotate and turn drilling unit in a tight circle.

Tips to Reduce Track Wear

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

Wash tracks daily to remove foreign objects and abrasive soil from sprockets and idler rollers. Drive slowly and make wide turns when possible. Regularly check undercarriage components (sprocket, rollers, idler) for wear and damage. Maintain proper track tension. (See "Check Track Tension and Condition" on page 154.)

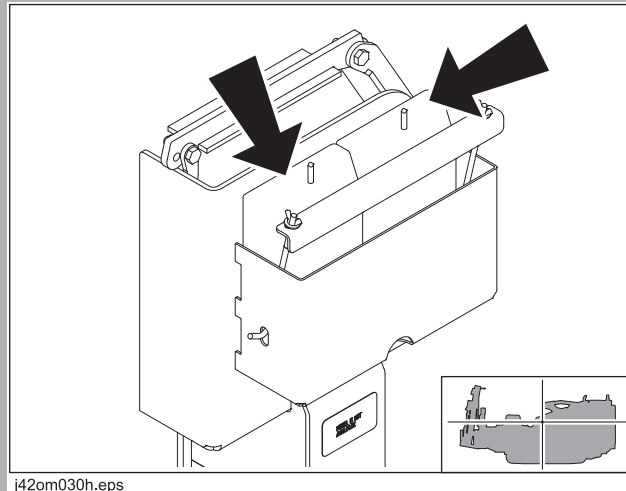
To prevent premature wear, avoid the following:

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

Shut Down Unit

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

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



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



Transport

Chapter Contents

Lift 72
Haul 72
• Load72
• Tie Down72
• Unload74
Retrieve 75

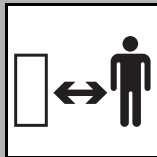


Lift

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

Haul

Load



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

To help avoid injury:

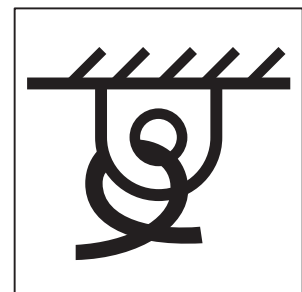
- Load and unload trailer on level ground.
- Verify that trailer wheels are blocked.
- Incorrect loading can cause trailer swaying.
- Attach trailer to vehicle before loading or unloading.
- Ten to fifteen percent of total vehicle weight (equipment plus trailer) must be on tongue to help prevent trailer sway.

1. Start drilling unit engine.
2. Move drilling unit to rear of trailer and align with ramps.
3. Slow engine to low throttle and slowly drive unit onto trailer.
4. Lower stabilizer and drill frame to trailer floor.
5. Stop engine when unit is safely positioned on trailer bed.
6. Attach tiedowns to drilling unit where indicated on page 72.

Tie Down

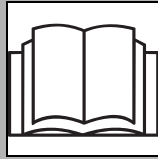
Points

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



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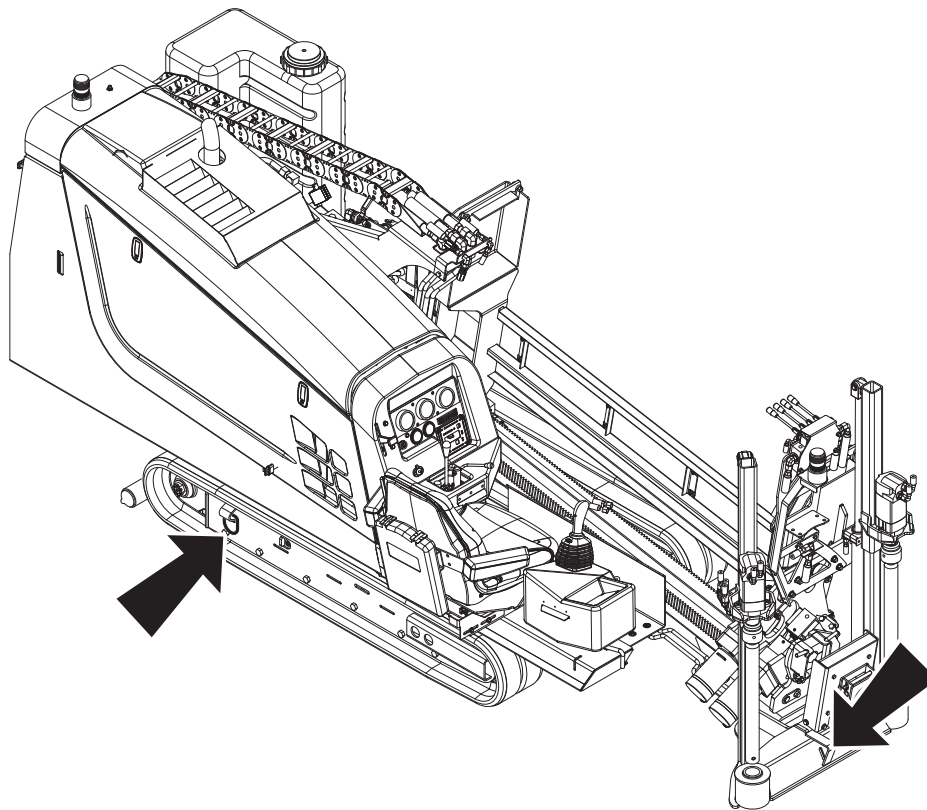
Procedure



WARNING

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

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

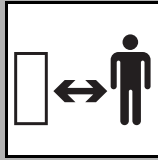


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Attach chains at front and rear tie-down points (shown). Make sure chains are tight before transporting unit.

IMPORTANT: Drill frame must be lowered to trailer floor before attaching chains.

Unload



Crushing weight could cause death or serious injury. 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 ramps.
2. Remove tiedowns.
3. Start drilling unit engine.
4. Raise stabilizers.
5. Raise drill frame.
6. 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 retrieval is necessary:

1. Disengage track hydraulics.

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

2. Attach chains to indicated tow points facing towing vehicle.
3. Retrieve:
 - Tow for short distances at less than 1 mph (1.6 km/h).
 - Use maximum towing force of 1.5 times unit weight.
4. Engage track hydraulics.

To disengage track hydraulics:

1. Loosen locknut (B).
2. Turn screw (A) on each counterbalance valve clockwise until it stops.

IMPORTANT: Be sure to count number of turns.

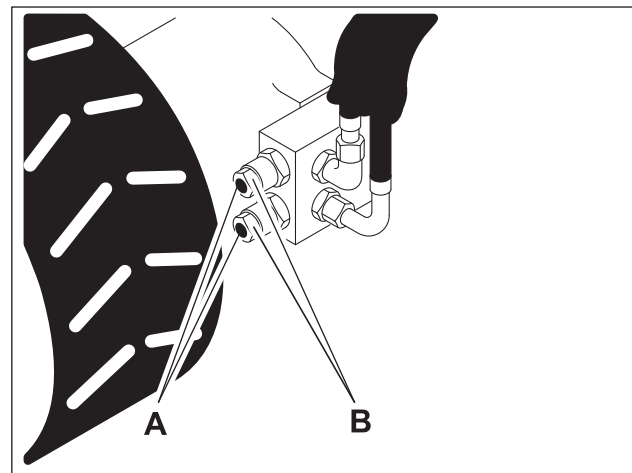
3. Repeat on other track.

To engage track hydraulics:

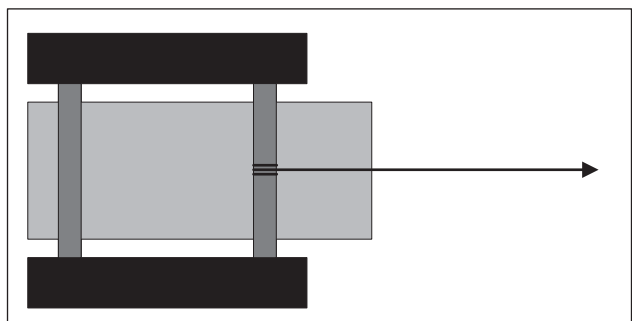
1. Turn screw (A) on counterbalance exactly same number of turns counterclockwise.
2. Tighten locknut (B).
3. Repeat on other track.

To attach chains to tow points:

1. Determine which crossmember (either front or back) faces towing vehicle.
2. Loop chains around applicable crossmember on drill frame.



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Towing.eps



Conduct a Bore



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Prime Drilling Fluid Pump 78

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- Drill Head Position87
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Remove Pipe 91

Remove Pullback Device 92

Position Equipment

1. Review bore plan and select drilling unit position and fluid unit position. See "Select Start and End Points" on page 52.

NOTICE: Do not connect to a public or private water system while drilling on an electrical job site.

2. Move equipment into selected positions.

Start System

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

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

2. Enable DrillLok™ mode if desired. See "DrillLok™" on page 108.
3. Set engine to 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

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

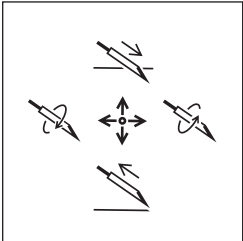
To help avoid injury: Failure to prime the drilling fluid pump will cause flow fluctuations, which will make it difficult to control the washwand.

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

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

Operate Carriage Control

The thrust/rotation control has eight positions which allow the four basic functions 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.

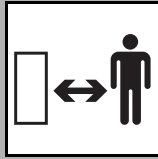


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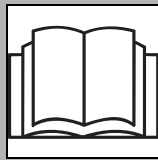
Carriage Movement	Rotation Direction	
forward	clockwise (makeup)	 ic1102a.eps
reverse	counterclockwise (breakout)	 ic1104a.eps

Clamp Pipe

**⚠ DANGER**

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

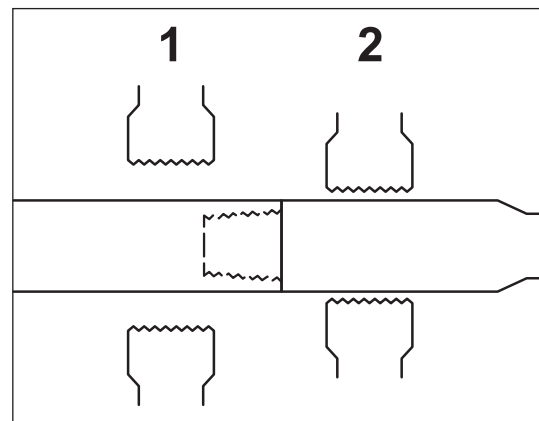
To help avoid injury: Clamping anywhere else on the pipe will weaken the pipe. Pipe can later break, even when operating under normal loads.

**⚠ WARNING**

Read operator's manual. Follow safety rules and know how to use all controls. Your safety is at stake.

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

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



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Assemble Drill String

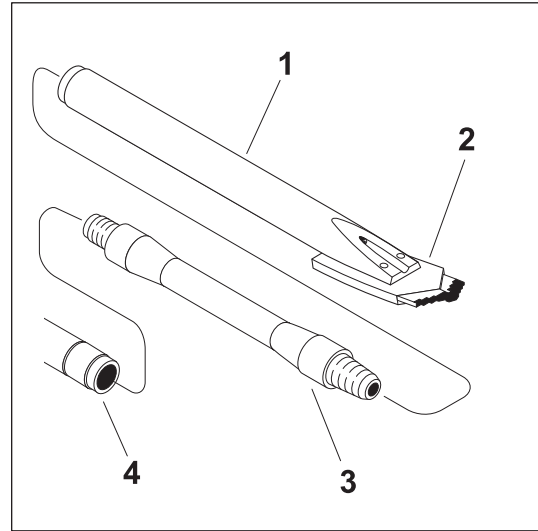


Prepare Beacon Housing

1. Select nozzles and bit.

IMPORTANT: A variety of nozzles and bits are available to suit your particular job conditions. See "Downhole Tools" on page 109 for more information, or contact your Ditch Witch® dealer.

2. Insert nozzle into beacon housing.
3. Attach bit (2) to beacon housing (1).
4. Install beacon, following beacon instructions for:
 - battery replacement
 - beacon positioning
5. Install beacon housing lid. See "Beacon Housings" on page 110.
6. Follow beacon instructions to check beacon operation.
7. Follow tracker instructions to calibrate beacon.



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Attach Transition Sub

Use either machine torque or quick wrench to attach transition sub (3) to beacon housing (1).

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.

Quick Wrench



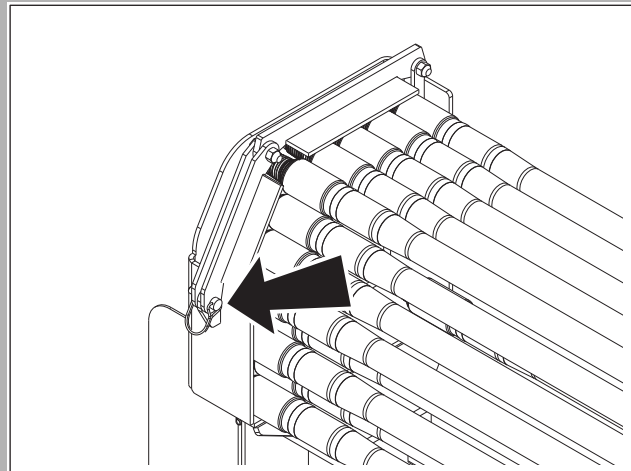
Moving tools will kill or injure. Never use pipe wrenches on drill string.

1. Lube joints with TJC.
2. Attach quick wrench to the joint in the join position and tighten joint. See “Quick Wrench” on page 114.

Connect Drill Pipe

1. Start drilling unit engine.
2. Align transition sub (3) in front wrench.
3. Clamp tool in front wrench. See "Clamp Pipe" on page 80.
4. Lift pipe box latches.

NOTICE: If drilling unit is set up in a side-slope, the rear pipe box latch should be left latched to help ensure that upper rows of drill pipe do not fall.



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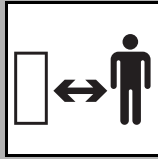
5. Load pipe (4).
 - Lubricate upper pipe threads.
 - Move pipe to spindle. Move pin end of pipe into saver sub and release pipe to rest on rear wrench. Lubricate lower threads.
6. Connect pipe.
 - Move carriage forward until saver sub nears male pipe thread.
 - Slowly rotate spindle clockwise. Carriage will move forward as threads screw together.
 - Slowly move carriage forward until pipe end touches end of transition sub.
 - To screw pipes together and fully torque joint, slowly rotate drill pipe until spindle stops turning.
 - Open wrench.

NOTICE: Do not handle pipe while rotating.

7. Close guides.



Drill First Pipe

**⚠ DANGER**

Rotating shaft will cause death or serious injury. 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.

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 62.
4. Slowly move carriage forward. See "Prepare Entry Point" on page 62. Take care to steer to drill straight in line with drilling unit. Drill in downhole tools and 1/3 of first pipe before steering.
5. Monitor gauges.

Add Pipe



1. Set engine throttle to full speed.
2. Clamp pipe joint. See “Clamp Pipe” on page 80.
3. Locate drill head.
4. Engage front wrench until pipe is clamped and pressure develops.
5. Slowly rotate spindle counterclockwise. Move carriage back as threads unscrew.
6. After threads are fully unscrewed, stop rotation and move carriage to back of frame, slowing down as carriage approaches rear end.
7. Connect Pipe. See “Connect Drill Pipe” on page 83.
8. Ensure that pipe fills and fluid pressure begins to rise.
9. Rotate spindle.
10. Slowly move carriage forward. Adjust rotation speed control according to bit size and soil conditions.
11. Monitor gauges.
12. Locate drill head with tracker at least every half-length of pipe.

Correct Direction

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

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

Basic Rules

- Steering ability depends on soil condition; bit, drill head, and nozzle used; roll of drill head; and distance pushed without outer rotation.
- All corrections should be made as gradually as possible. See "Recommended Bend Limits" on page 57.
- Over correcting will cause "snaking." This can damage pipe and will make drilling and pullback more difficult. Begin to straighten out of each correction as early as possible.
- Do not push an entire piece of drill pipe into ground without rotation. This can exceed bend radius and cause pipe failure.

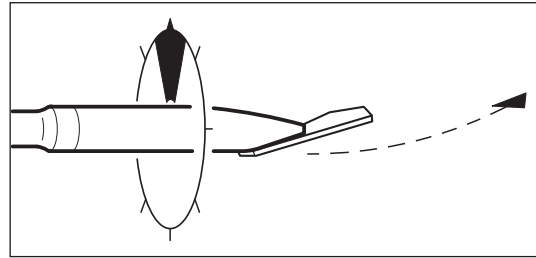
Procedure

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

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

To move forward without changing direction:

Rotate pipe into ground.

Record Bore Path

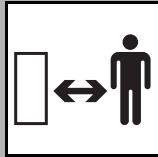
Locate drill head every half-length of pipe. As the job is completed, record the actual data for each drill pipe. List pitch and depth of each joint and a brief description of the procedure. In addition, draw a simple sketch of the site and record depth and rough location of pullback.

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

Surface Drill Head

**⚠ DANGER**

Moving tools will kill or injure. Never use pipe wrenches on drill string.

**⚠ DANGER**

Rotating shaft will cause death or serious injury. 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 57.
2. Clean area around exit point.
3. Turn fluid flow control to off position as soon as drill head emerges.
4. Allow tracker operator to turn off tracker or use DrillLok™ to disable drilling unit thrust/pullback and rotation hydraulics. Tracker operator waits at least 16 seconds for green light to enter pit and change tools.
5. Clean drill head especially around threads.
6. Disconnect EZ-Connect joint or use quick wrench to remove drill head. Keep threads clean. See "Quick Wrench" on page 114.

Assemble Backream String

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

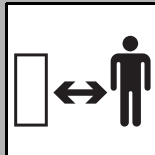
Moving tools will kill or injure. Never use pipe wrenches on drill string.



⚠ WARNING

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

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



⚠ DANGER

Rotating shaft will cause death or serious injury. 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™.
- 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.



1. Select backreaming devices. See "Backreamers" on page 111.
2. Determine fluid rate requirements and install appropriate nozzles to provide sufficient flow. See "Backream Fluid Requirements" on page 112 and "Nozzles" on page 109.
3. Attach backreamer to backream 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 110.
6. Follow beacon instructions to check beacon operation.
7. Follow tracker instructions to calibrate beacon.
8. Connect EZ-Connect joint or use quick wrench to attach backreamer/beacon housing assembly to transition sub. See "Quick Wrench" on page 114.
9. Attach swivel and additional pullback devices or product to end of backreamer/beacon housing assembly.

Remove Pipe



NOTICE: If engine is shut off during backreaming, drill pipe clamped by wrenches but not connected to saver sub can be pulled downhole as vise wrenches loosen.

1. Stop carriage when pipes are aligned in wrenches.
2. Clamp pipe in front wrench. See page 80.
3. Clamp and rotate rear wrench to break front joint.
4. Disengage rear wrench.
5. Unscrew front joint.
 - Slowly rotate spindle counterclockwise to unscrew pipe. Move carriage back slowly until threads unscrew.
 - Move carriage back until pipe is properly positioned in rear wrench.
6. Break rear joint.
 - Engage rear wrench.
 - Slowly rotate spindle counterclockwise until joint is loosened. **Do not** fully unscrew joint.
 - Disengage rear wrench.
 - Move carriage back, move seat toward pipe and grip pipe with both hands.
 - Pull pin end of pipe clear of saver sub, lift pipe and stow it in box.
7. Lube front threads.
8. Attach saver sub to next pipe.
 - Move carriage forward until saver sub touches pipe.
 - Rotate spindle to screw onto pipe. Slowly tighten joint to full machine torque.
9. 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.

1. Turn off drilling fluid.
2. Move engine throttle to low speed.
3. Turn drilling unit engine off.
4. Allow tracker operator to turn off tracker or use DrillLok™ to disable drilling unit thrust/pullback and rotation hydraulics. Tracker operator waits at least 16 seconds for green light to enter pit and change tools.
5. Clean pullback device.
6. Use quick wrench to remove pullback device. See “Quick Wrench” on page 114.

Systems and Equipment

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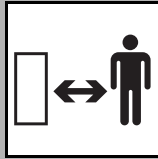
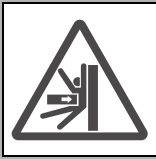
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Anchor System



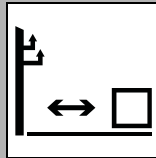
⚠ WARNING

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



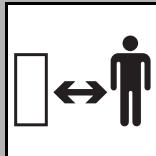
To help avoid injury:

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



⚠ DANGER

Electric shock will cause death or serious injury. Stay away.



⚠ DANGER

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

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

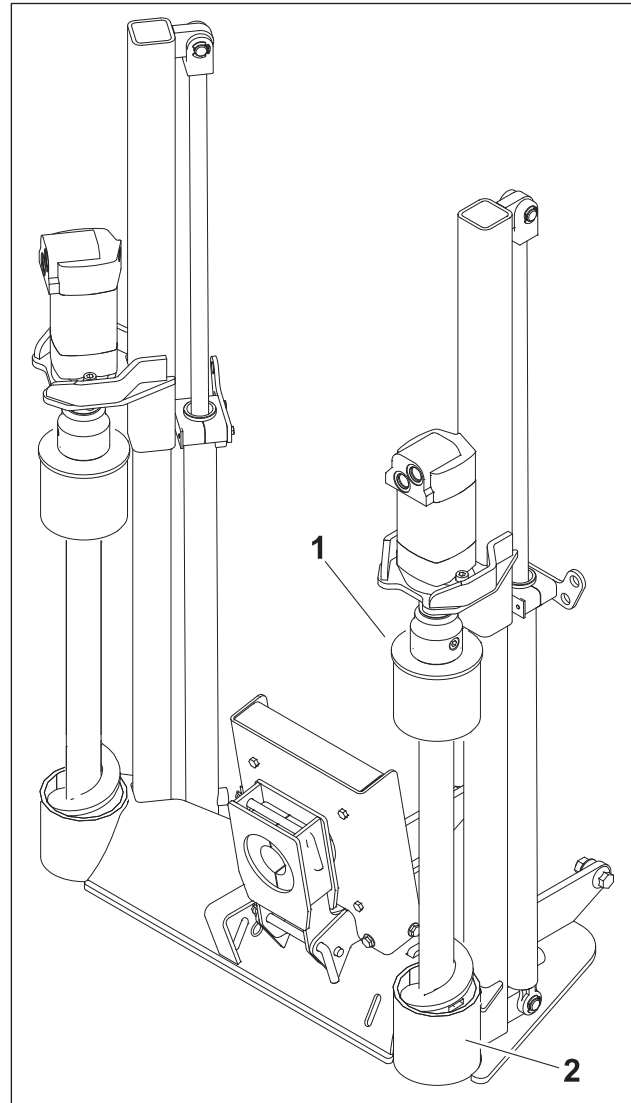
Drive Anchors

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

1. Use anchor rotation and thrust controls to drive anchor into ground.
2. Anchor is set when cap top plate (1) rests firmly on centering tube (2).
3. Repeat process for other anchor.

Remove Anchors

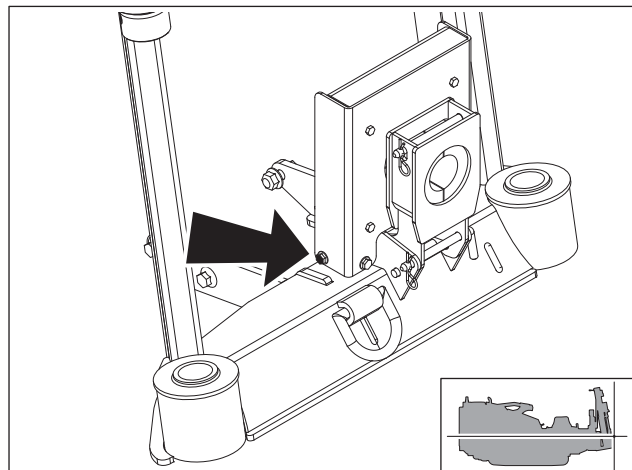
1. Use anchor rotation and thrust controls to slowly remove anchor shaft from ground.
2. Repeat process for other anchor.



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NOTICE: If anchors are not being driven to full depth, additional grounding is needed.

- Remove paint from surface and attach cable to machine where shown.
- Drive rod into ground away from machine.



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Electric Strike System

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

- Boots must have high tops and meet the electric hazard protection requirements of ASTM F2413 or ASTM F1117 when tested at 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 55. Review safety procedures before each job.

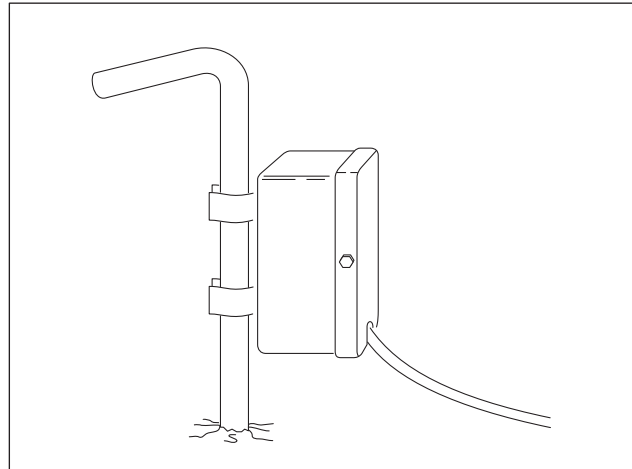
FCC Statement

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

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

Assemble Voltage Detector

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



ESS_VoltageStake.eps

Test Strike System

If system fails any part of this test, see "Troubleshoot Strike System" on page 99. Do not drill until test is completed successfully.

1. Turn on drilling unit.
2. ESID control module will perform internal tests which check everything but alarms and strobe.
3. If green OK indicator and electrical power supply indicator lights remain on, press self test button to perform a self test. During this test, alarms and strobes on all connected units should sound.
4. If this test is successful, OK indicator and electrical power supply indicator lights will remain on.
5. Use Electric Strike Simulator to test voltage and current sensors. See page 101.

Troubleshoot Strike System

When strike system detects a problem, an error icon will be displayed. Anytime this happens, press the self-test button to retest. If error icon is still displayed, have the control module checked or replaced.

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



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

Problem	Possible cause	Possible solution
Alarm on drilling unit does not work during self-test	Improper connections with control module	Check connections and wiring harness
	Defective alarm	1. Disconnect strobe and connect to external 12V power source. 2. If strobe does not work, replace it.
	Defective control module	Have control module checked or replaced
Strobe light and alarm on drilling unit do not work during self-test	Improper connections with control module	Check connections and wiring harness
	Defective control module	Have control module checked or replaced
Current problem indicator is flashing	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
Voltage problem indicator is flashing	Improper connections with control module	Check cable connection on control module
	Defective voltage limiter	Have voltage limiter checked or replaced
	Defective control module	Have control module checked or replaced

Use Electric Strike Simulator

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

Current Test



To test for current at normal levels:

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

To test for current at strike levels:

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

With two loops,

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

With three loops,

- Current should be 130-160%.
- Strike indication should be continuous.

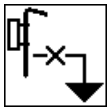
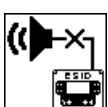
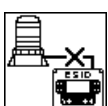
Voltage Test

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

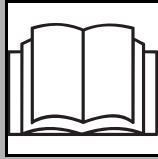
It is normal for simulator voltage levels to drift below strike level.

Diagnostic Icons

The following table lists possible icons that could be displayed on the LCD display.

Icon	Description	Resolution
	The ESID did not detect any errors during the last self-test. Note: The ESID does not perform a full system test and can only detect a handful of possible problems. Follow the "Use Electric Strike Simulator" procedure before every drilling operation.	
	The ESID is currently running an internal self-test.	
	Errors were detected during the last self-test.	Refer to the other icons for the specific error message.
	The voltage limiter was not found.	Ensure the voltage limiter is connected and functioning.
	The ESID could not detect ground continuity.	Ensure that the voltage stake is properly driven into the ground and that the voltage limiter is correctly connected.
	The coil was not found.	Ensure the current coil is properly connected to the ESID.
	A horn wiring error was detected.	Ensure that the horn is properly wired to the ESID. Start a manual self-test to verify proper operation.
	A strobe wiring error was detected.	Ensure the strobe is properly wired to the ESID. Start a manual self-test to verify proper operation.
	The ESID's real-time clock has malfunctioned.	Replace the ESID.
	The ESID failed its internal self-test or the input voltage is too low.	Ensure the system's DC supply voltage is in the proper operating range. If correcting the DC supply voltage does not resolve the error, replace the ESID.

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 protection, use these recommended Baroid® products, available from your Ditch Witch® dealer.

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

Guidelines

Match drilling fluid to soil type. This chart is meant as a guideline only. See your local Ditch Witch dealer for soil conditions and drilling fluid recommendations for your area. Also see our interactive Drilling Fluid Formulator at www.ditchwitch.com.

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 107.

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.

To help avoid injury:

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

General mixing order:

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

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

Basic Fluid Recipes

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



Drilling Fluid Requirements

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

Funnel Viscosity

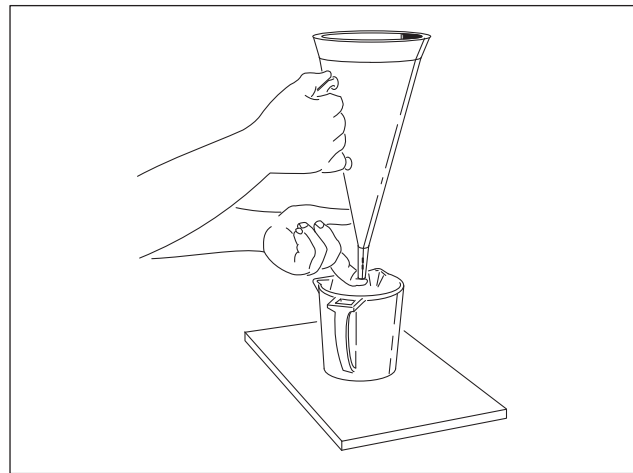
Viscosity is the measure of internal resistance of a fluid to flow; the greater the resistance, the higher the viscosity. Viscosity of drilling fluids must be controlled.

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



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

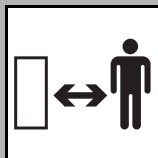
1. Using hose and a clean container, take a fresh sample of drilling fluid. The sample must be at least 1.5 qt (1.4 L).
2. With finger over bottom of funnel, fill with fluid from the container through the screen until fluid reaches the bottom of the screen.
3. Move funnel over 1 qt (.95 L) container.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



Funnel.eps

DrillLok™

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.

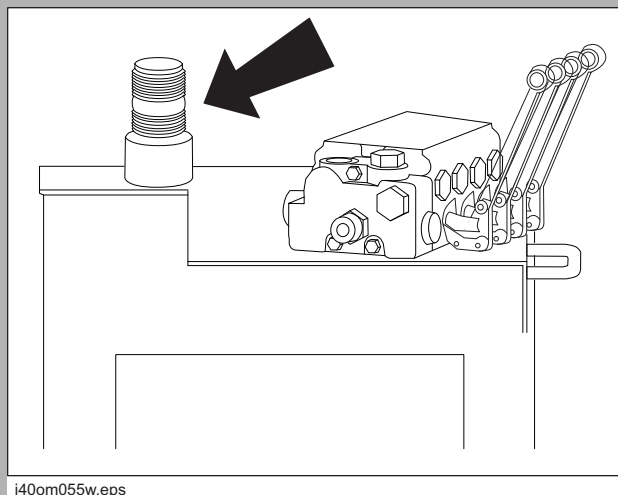
This mode allows the tracker operator to disable hydraulic power to drilling unit thrust and rotation.

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 26.



j40om055w.eps

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

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

Downhole Tools

Nozzles

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



Bits

Selection

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

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

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

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

Installation

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

Beacon Housings

Beacon Installation

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

Backreamers

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

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



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

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

Backream Fluid Requirements

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

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

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

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

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

Backream Fluid Requirements

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



Quick Wrench

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

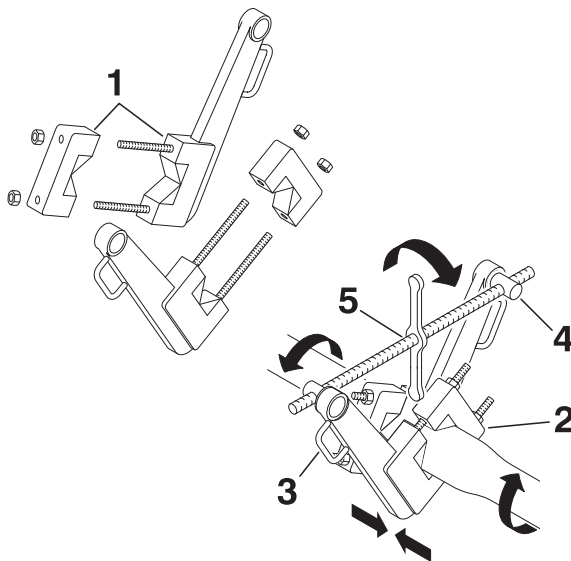


DANGER

Moving tools will kill or injure. Never use pipe wrenches on drill string.

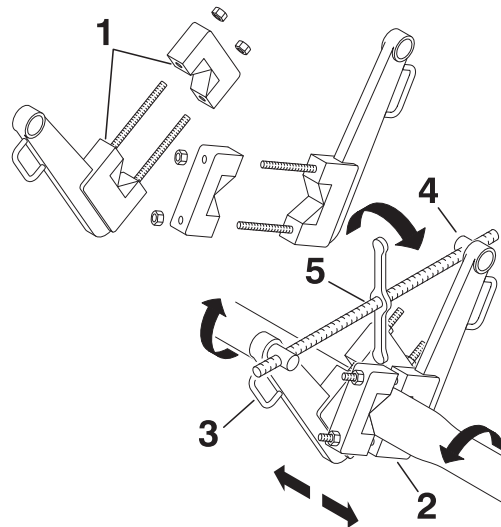
IMPORTANT: Apply TJC to threads and hand-tighten joint before attaching quick wrench components to tighten joint.

Attach quick wrench in either the join or break position.



QuickWrench_JoinBreak_Flats.eps

Join

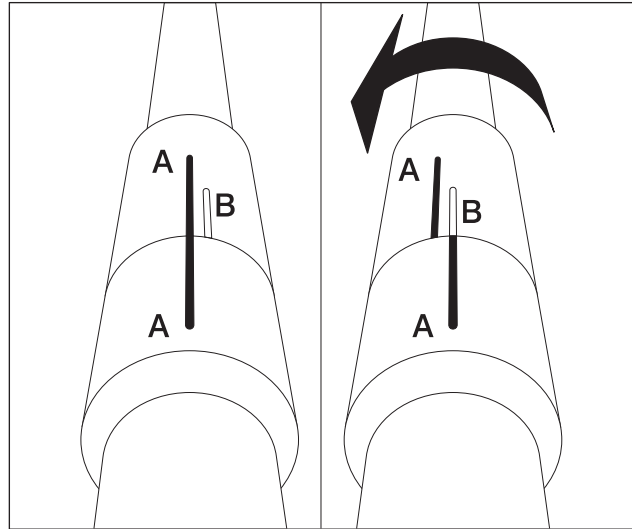


Break

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

To Join

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



To Break

1. Turn handle until joint is broken.
2. Remove quick wrench components.

Drill Pipe

Perform Regular Drill Pipe Care

Precondition New Pipe

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

1. **Hand-lubricate** entire surface of threads and shoulders of both ends of pipe with copper base tool joint compound. See page 127 for correct lubricant.
2. Join pipe and tighten joint.
3. Break joint.

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

Lubricate Joints Before Each Use

Lubricate threads and shoulders of male joints with copper base tool joint compound. This prevents rust and reduces wear on shoulders and threads. See page 127 for correct lubricant.

Clean the Threads

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

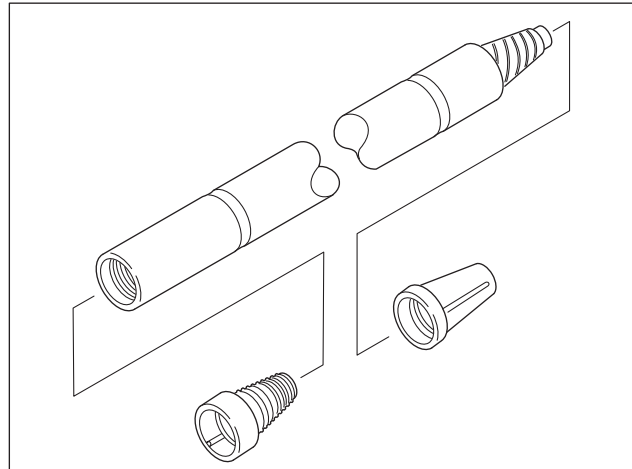
NOTICE: Do not use gasoline or other petroleum-based solvents. This prevents tool joint compound from sticking to the joints and will reduce thread life.

After cleaning, hand lubricate entire surface of threads and shoulders.

Use Caps and Plugs

Install plug on saver sub before transporting.

Cap and plug male and female ends of drill pipe during prolonged storage.



DrillPipe_Caps.eps



Replace Worn Saver Sub

Because each pipe comes in contact with the saver sub, check saver sub regularly for wear. Replace it when it is worn, or it will damage your drill pipe. See page 155 for replacement procedure.

Precondition a new saver sub the same way you do new pipe. See "Precondition New Pipe" on page 116.

Rotate Pipe Order

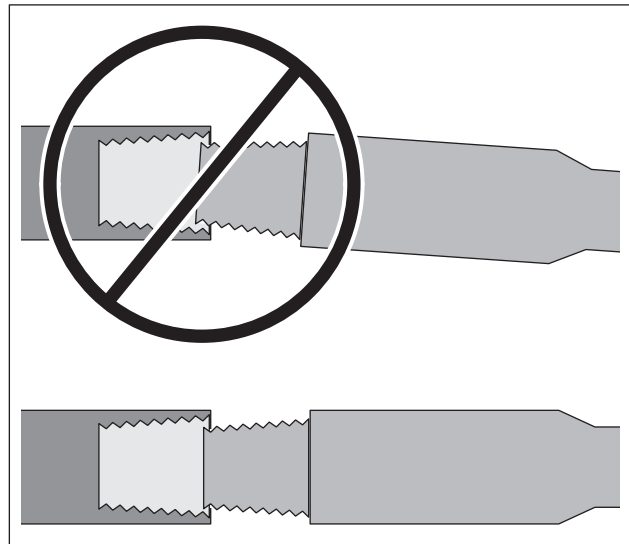
Because the lead drill pipe is in the ground longer, it is subjected to higher shock loads and experiences more wear. To help spread this wear evenly over all pipe, move the lead pipe from the previous job out of the first position.

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.

IMPORTANT: The first pipe drilled must be in a straight line with the unit. A misaligned pipe can damage threads on each pipe that is added.

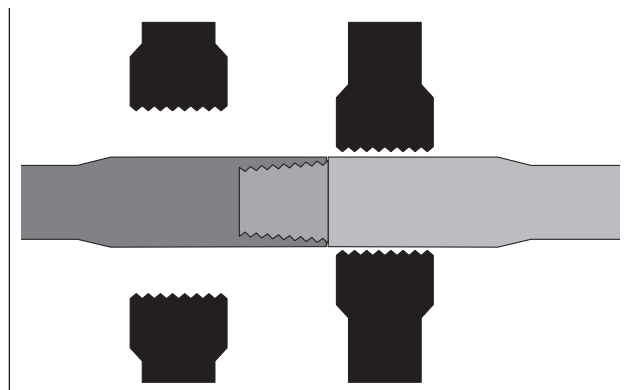


DrillPipe_Align.eps

Clamp Pipe Correctly

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

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



DrillPipe_Clamp.eps

See "Clamp Pipe" on page 80 for more information.

Make Up and Break Out Joints Correctly

- **Make up and break out joints slowly.** Do not ram pipes together during makeup or force them apart during breakout. Carefully time rotation with carriage travel speed, and always connect and disconnect joints slowly and deliberately. This will help prevent thread crossing, galling, and shoulder swelling.
- **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 “Recommended Bend Limits” on page 57. Do not oversteer.

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

Complete the Job

Chapter Contents

Antifreeze Drilling Unit 122

- Add Antifreeze122
- Reclaim Antifreeze123

Rinse Equipment 123

Disconnect 125

Stow Tools 125

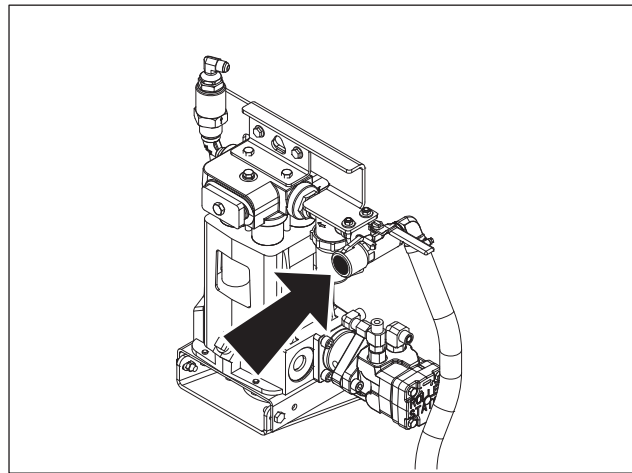


Antifreeze Drilling Unit

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

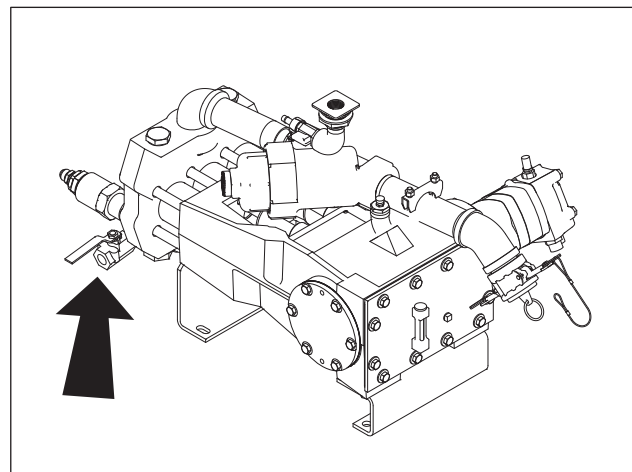
Add Antifreeze

1. Drain remaining water from the onboard tank.
2. Pour 3 gal (11 L) of approved antifreeze into the onboard tank.
3. Move carriage to front of drill frame.
4. Position 3-gal (11-L) bucket under spindle.
5. Install plug at quick coupler for drilling fluid pump (shown).
6. Open valve between antifreeze tank and head of drilling fluid pump.
7. Turn drilling fluid valve clockwise to zero position.
8. Start unit and set throttle to slow position.
9. Slowly turn drilling fluid valve counterclockwise until pump runs slowly.
10. Run drilling fluid pump until antifreeze comes out of spindle.
11. Turn drilling fluid valve clockwise to zero position.
12. Open valve below operator's console (shown).
13. Slowly turn drilling fluid potentiometer clockwise until pump runs slowly.
14. Close valve below console when antifreeze runs out of valve below console.
15. Turn drilling fluid potentiometer counterclockwise to zero position.



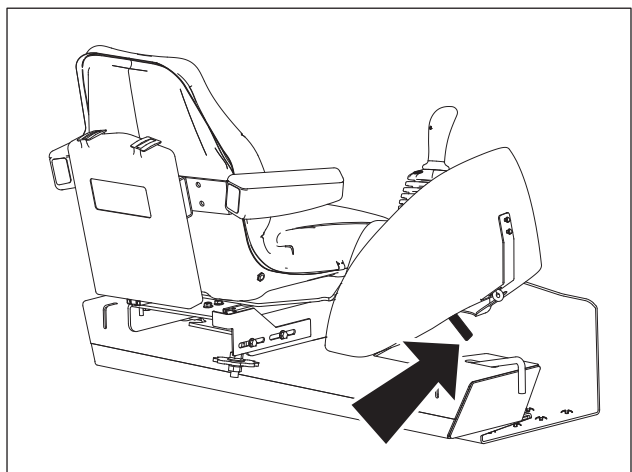
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13 and 16-gal pumps



j61om007h.eps

20-gal pump



j42om003h.eps

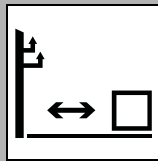
Reclaim Antifreeze

1. Start drilling unit and run at low throttle.
2. Move carriage to front of drill frame.
3. Position 3-gal (11-L) bucket under spindle.
4. Turn drilling fluid pump on low speed.
5. Turn drilling fluid pump off when drilling fluid comes out of spindle.
6. Pour antifreeze into onboard tank.



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

Rinse Equipment



DANGER

Electric shock will cause death or serious injury. Stay away.

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



WARNING

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

To help avoid injury:

- Never use high flow when using washwand.
- Do not point wash wand spray at persons.
- 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.

NOTICE: Water can damage electronics.

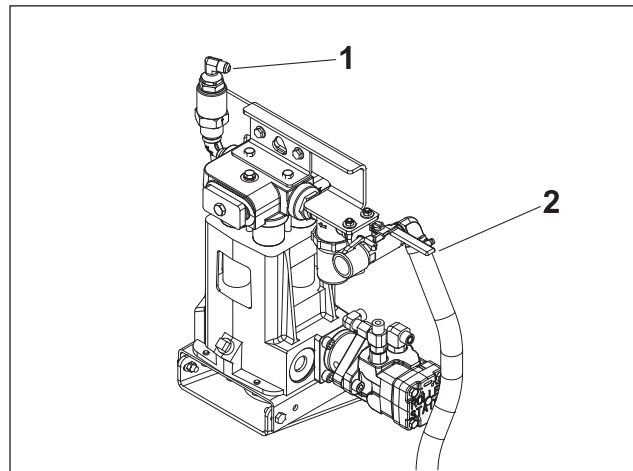
- Do not spray water onto operator's console. Wipe down instead.

Rinse equipment

1. Prime drilling fluid pump. See "Prime Drilling Fluid Pump" on page 78.
2. Operate pump at low flow.
3. If equipped, connect optional washwand. See "Connect Washwand (Optional)" on page 124.
4. Spray water onto equipment to remove dirt and mud. If necessary, slightly increase pressure to remove dried mud from wrench area.

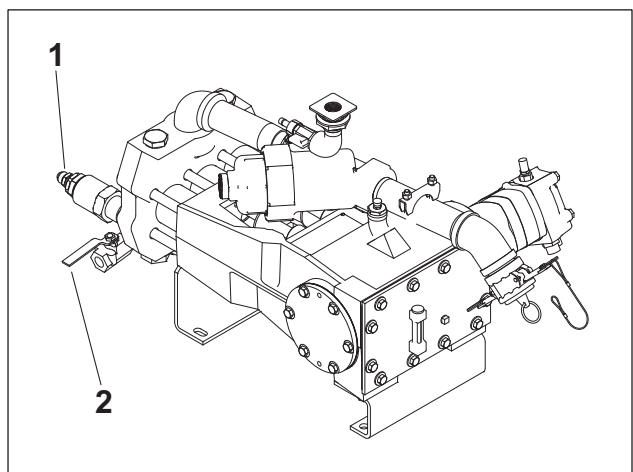
Connect Washwand (Optional)

1. Connect washwand at quick connect (1).
2. Open valve (2) to start water flow.
3. Close valve (2) to stop water flow.



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13 and 16-gal pumps



j61om010h.eps

20-gal pump

Disconnect

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

- electric strike system voltage stake
- fluid hose

Stow Tools

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



Service

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Service Precautions 128

Recommended Lubricants/Service Key 130

Startup/10 Hour 134

50 Hour 141

250 Hour 147

500 Hour 148

750 Hour 151

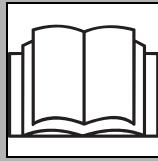
1000 Hour 152

2000 Hour 152

As Needed 153



Service Precautions



Read operator's manual. Follow safety rules and know how to use all controls. Your safety is at stake.

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.

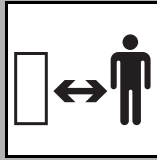
- Disconnect battery to prevent damage to battery. Do not turn off battery disconnect switch with engine running, or alternator and other electronic devices may be damaged.
- Connect welder ground clamp close to welding point and make sure no electronic components or bearings are in the ground path.

Washing Precaution

NOTICE: Water can damage electronics.

- When cleaning equipment, do not spray electrical components with water.

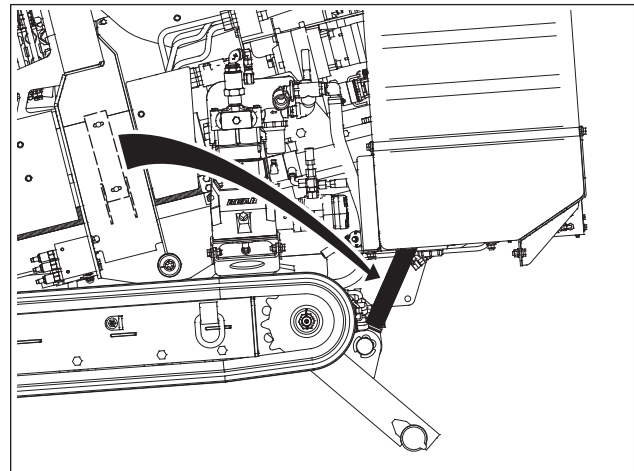
Working Under Drilling Unit



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

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

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



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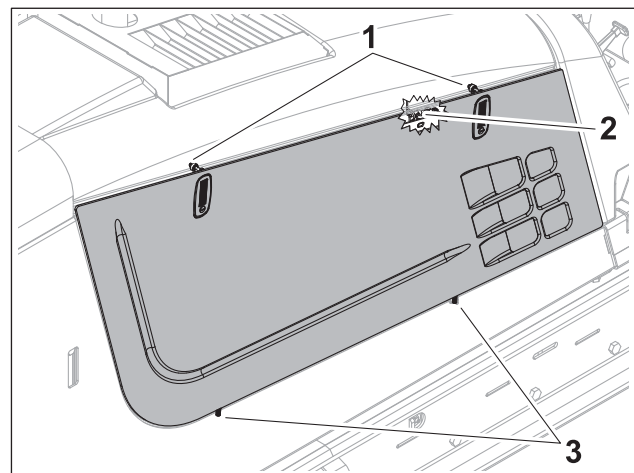
Opening/Closing Front Hood

To open:

1. Unlock hood at outside latches (1).
2. Press key lock buttons to release latches and tip hood toward you.
3. Release inside latch (2).
4. Lift hood to remove.

To close:

1. Align pins (3) with designated holes.
2. Secure inside latch (2).
3. Secure latches (1). Lock if necessary.



j21om065h.eps

Recommended Lubricants/Service Key

Item	Description		
 DEO (Tier 4)	Diesel engine oil meeting or exceeding Deutz® specification DQC III- LA. See "Approved Engine Oil" on page 131.		
 DEO (Tier 4i)	Diesel engine oil meeting API service classification CF-4 or E1-96 and SAE viscosity recommended by engine manufacturer (SAE 15W40). See "Approved Engine Oil" on page 131.		
 NDO	SAE 30 Non-detergent oil		
 MPG	Multipurpose grease. Use polyurea based NLGI GC-LB Grade 1.5 or lithium based NLGI GC-LB Grade 2.		
 EPG	Extreme pressure grease meeting ASTM D217 and NLGI 5		
 EPS	Extreme pressure spray lubricant		
 MPL	Multipurpose gear oil meeting API service classification GL-5 (SAE 80W90)		
 THF	Tractor hydraulic fluid, similar to Phillips 66® HG, Mobilfluid® 423, Chevron® Tractor Hydraulic Fluid, Texaco® TDH Oil, or equivalent		
 TJC	Tool joint compound: Ditch Witch® standard (p/n 259-858) or summer grade (p/n 256-031)		
 DEAC	Low silicate, nitrite free, fully formulated diesel engine antifreeze/coolant meeting Deutz specification DQC CB-14. See "Approved Coolant" on page 133.		
	Check level of fluid or lubricant		Check condition
	Filter		Change, replace, adjust, service or test

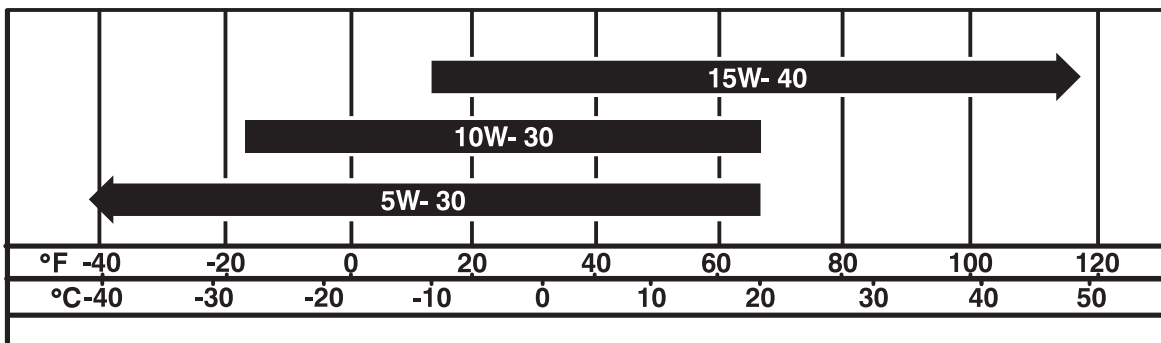
Proper lubrication and maintenance protects Ditch Witch® equipment from damage and failure. Service intervals listed are for minimum requirements. In extreme conditions, service machine more frequently. Use only genuine Ditch Witch parts, filters, approved lubricants, TJC, and approved coolants to maintain warranty. Fill to capacities listed in "Specifications" on page 161.

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

IMPORTANT: Use the "Service Record" on page 171 to record all required service to your machine.

Approved Engine Oil

Tier 4 Units



j10om073h.eps

Temperature range anticipated before next oil change

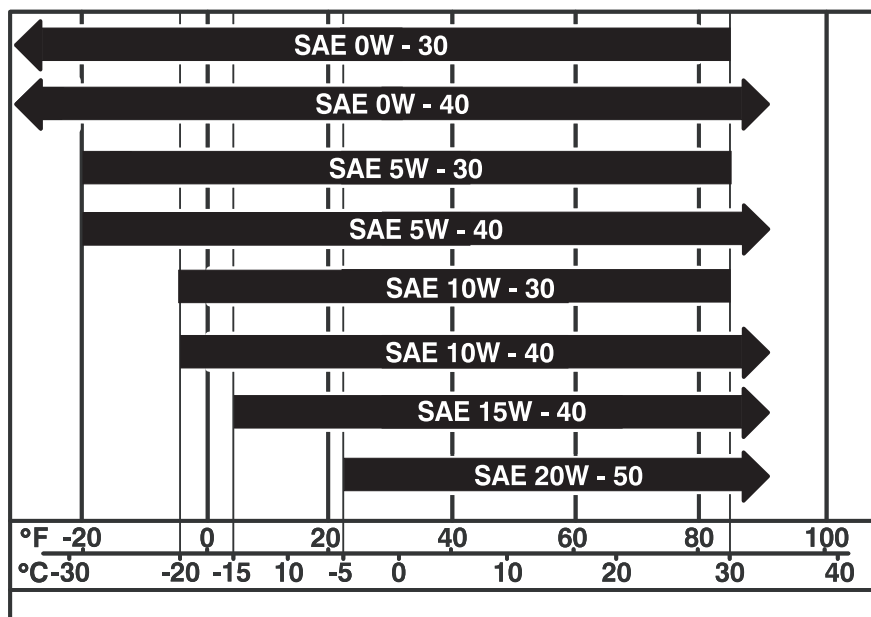


Tier 4 units are shipped from the factory with API CJ-4 DEO meeting Deutz specification DQC II-LA.

NOTICE: Incorrect oil or service will damage the engine.

- Change oil initially at 250 hours. See viscosity chart to select oil.
- Only use low SAPS (sulfated ash, phosphorous, and sulfur) oil.
- If oils meeting only API CJ-4 or ACEA E6/E9 are used, reduce service interval to 250 hours.

Tier 4i Units



t11om076c.eps

Temperature range anticipated before next oil change

Approved Fuel

**⚠ WARNING**

Ultra Low Sulfur Diesel (ULSD) poses a greater static ignition hazard than earlier diesel formulations. Fire or explosion can cause death or serious injury.

To help avoid injury:

- Avoid static electricity when fueling.
- 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. For more information, see engine manual..

IMPORTANT:

Tier 4: The engine in this product is certified to operate on Ultra Low Sulfur Diesel (ULSD) fuel with a sulfur content of 15 ppm (15mg/kg) or less. Using fuels with higher sulfur content will cause damage to the engine and affect exhaust emissions. Such action is a violation of the US Clean Air Act and US EPA regulations and will result in fines.

Tier 4i: The engine in this product is certified to operate on low sulfur diesel fuel (LSD). Fuel sulfur content should be less than 5000 ppm (0.5%). Worldwide fuel sulfur regulations vary widely. Fuel used should always comply with local regulations. Prior to shipping, Tier 4i units were filled with API CJ-4 DEO. If operating fuel with sulfur content above 500 ppm (500mg/kg), change oil initially at 100 hours.

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

Approved Coolant

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

NOTICE: Incorrect coolant will damage engine.

- Use only pre-diluted or concentrated coolant mixed with distilled water. Do not use tap water.
- Do not use water or high-silicate automotive-type coolant.
- Do not mix heavy-duty diesel engine coolant and automotive-type coolant.



Startup/10 Hour

Location	Task	Notes
DRILLING UNIT	Check engine coolant level	DEAC, Tier 4 only
	Check engine air filter service indicator	
	Check engine oil level	DEO
	Check hydraulic hoses	
	Check hydraulic fluid level	THF
	Check pipe lube applicator	
	Check pipe auto lubricator spray nozzle	
	Check pipe auto lubricator TJC level	TJC
	Check drilling fluid filter	

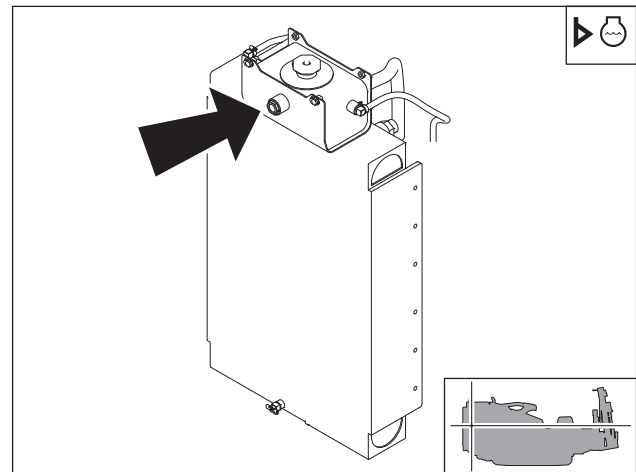
Drilling Unit

Check Engine Coolant Level (Tier 4)

Check coolant level at expansion tank before startup and every 10 hours of operation.

IMPORTANT: See "Approved Coolant" on page 133 for information on approved coolants.

1. Wait for engine to cool.
2. Ensure coolant level is at halfway point on sight glass.
3. If low, add pre-diluted coolant to maintain proper freeze protection.



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Check Engine Air Filter Service Indicator

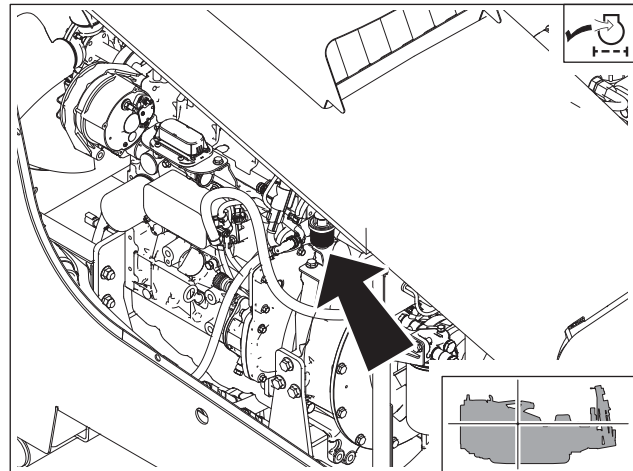
Check air filter service indicator before startup and every 10 hours of operation.

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

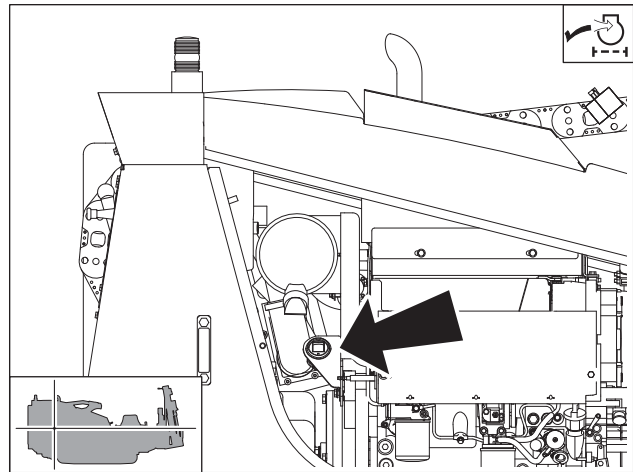
- Only open the air filter canister when air restriction is indicated.
- Change the elements. Do not attempt to clean them.

If red flag pops up:

1. Change filter element. See "Change Air Filter" on page 155.
2. Reset air filter service indicator.



Tier 4



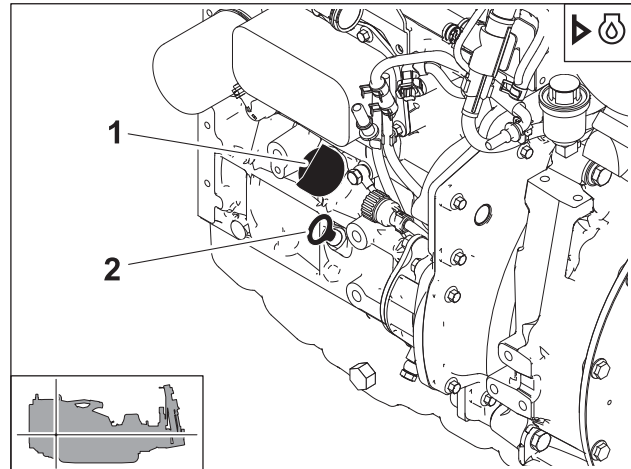
Tier 4i



Check Engine Oil Level

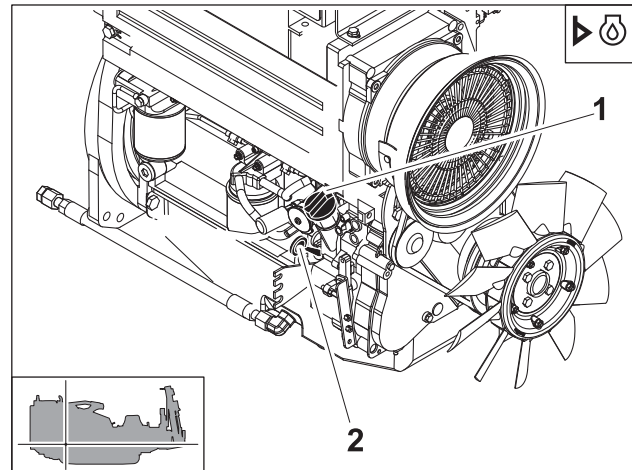
Check engine oil level before startup and every 10 hours of operation.

1. While engine oil is warm, check oil level at dipstick (1).
2. Add DEO at fill (2) as necessary to keep oil level at highest line on dipstick.



j42om013h.eps

Tier 4

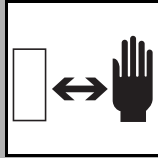


j21om014h.eps

Tier 4i

Check Hydraulic Hoses

Check hydraulic hoses for leaks and hydraulic connections for tightness before each use and every 10 hours. Replace any damaged part.



⚠ WARNING

Fluid under pressure can pierce skin and cause death or serious injury.

To help avoid injury:

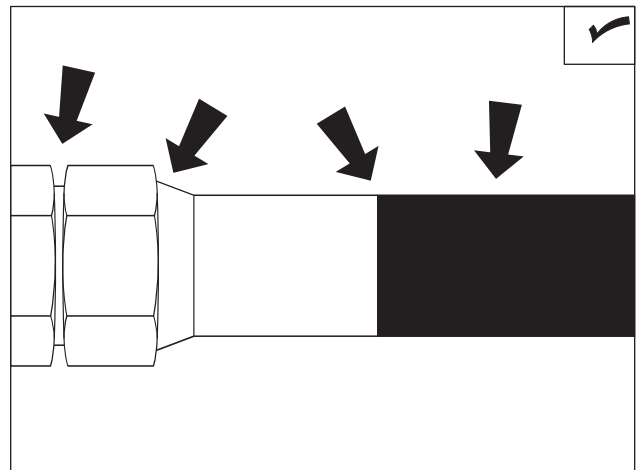
- Do not use hands to search for leaks. Use a piece of cardboard or wood.
- Wear the necessary personal protective equipment, including gloves and safety glasses.

If you are injured, seek immediate medical attention from a doctor familiar with this type of injury.



To replace parts from the hydraulic system:

1. Turn engine off.
2. To release pressure, operate all controls.
3. If there is a raised component, lower, block or support with a hoist.
4. Use appropriate container to collect all fluid.
5. Cover connection with heavy cloth.
6. To release remaining pressure, loosen connector nut slightly.
7. Replace the damaged part.
8. Reconnect to the correct torque.



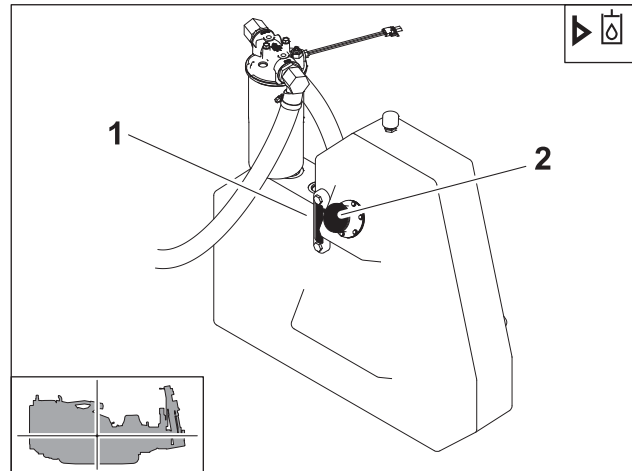
CheckHoses.eps

Check Hydraulic Fluid Level

Check hydraulic fluid level before startup and every 10 hours of operation.

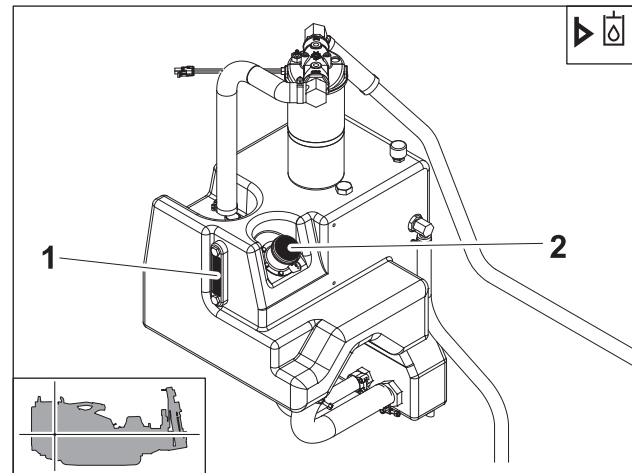
IMPORTANT: If hydraulic system must be opened for repair, install new filter (p/n 153-791) for first 50 hours of operation. If this filter becomes plugged in fewer than 20 hours, replace with clean filter. After 50 hours of normal operation, replace with clean filter (p/n 153-792).

1. Shut down engine. Wait until fluid is cool.
2. Ensure fluid level is at halfway point on sight glass (2).
3. Add THF at hydraulic fluid fill (1) as necessary.



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Tier 4



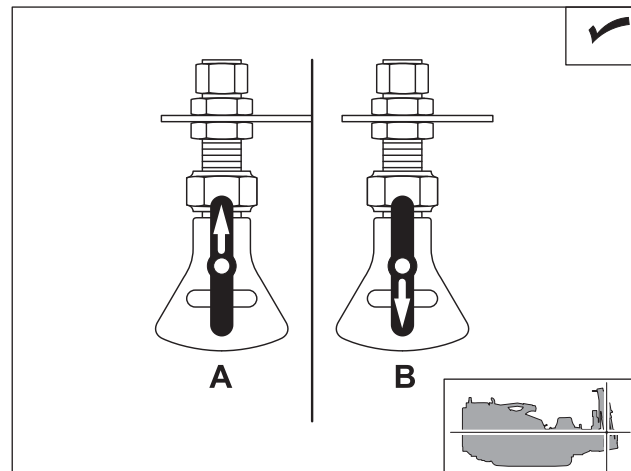
j21om018h.eps

Tier 4i

Check Pipe Auto Lubricator Spray Nozzle (Optional)

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 130 for more information.



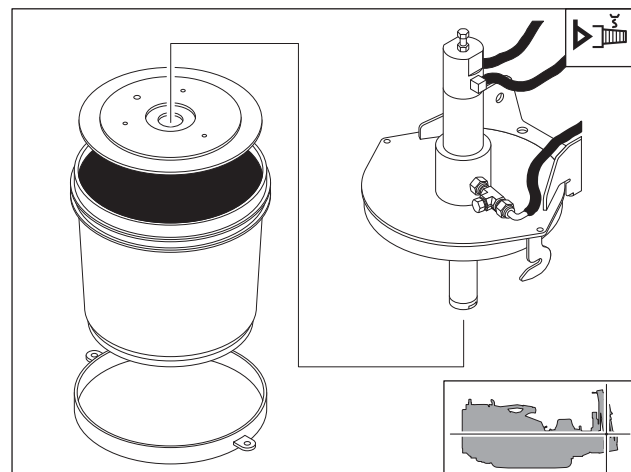
To clean:

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

Check Pipe Auto Lubricator TJC Level (Optional)

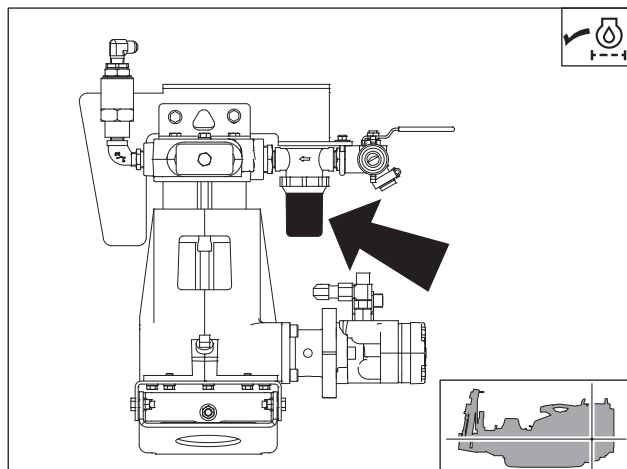
Check pipe auto lubricator TJC level before startup and every 10 hours of operation. Change pail as needed. See "Drilling Unit" on page 153 for procedure.

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 130 for more information.

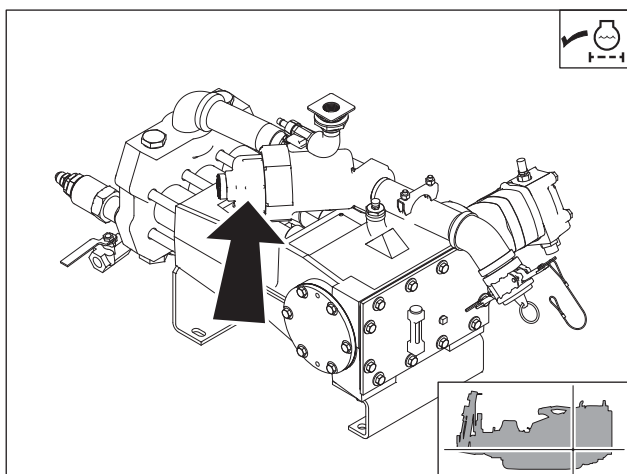


Clean Drilling Fluid Filter

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



j42om015h.eps

13 and 16-gal pumps

j61om008h.eps

20-gal pump

50 Hour

Location	Task	Notes
DRILLING UNIT	Check rotation gearbox oil level	MPL
	Change fluid pump oil level (initial)	Initial service, NDO
	Check oil cooler	
	Change hydraulic filter	Initial service
	Check ground drive gearbox oil level	2 gearboxes, MPL
	Inspect thrust rollers	
	Lubricate rotation gearbox sliding output shaft	EPS
	Check and adjust belt tension	Tier 4i only
	Clean alternator cooler turbine	Tier 4i only
	Clean radiator	Tier 4 only

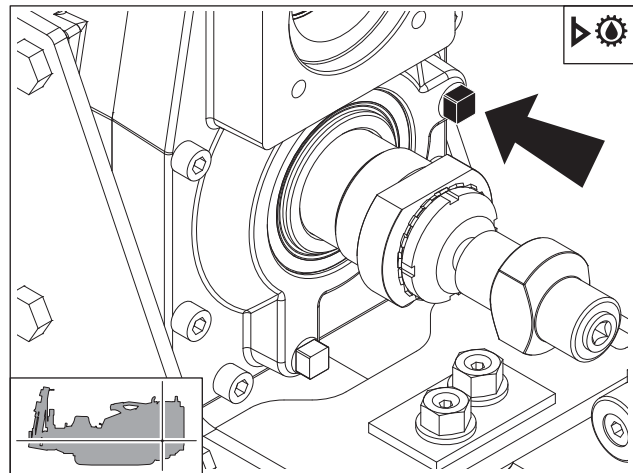


Drilling Unit

Check Rotation Gearbox Oil Level

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

IMPORTANT: Drill frame must be level for accurate reading.

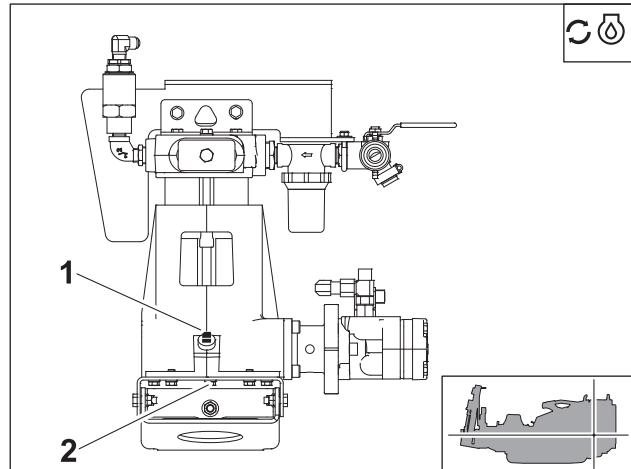


j210m027h.eps

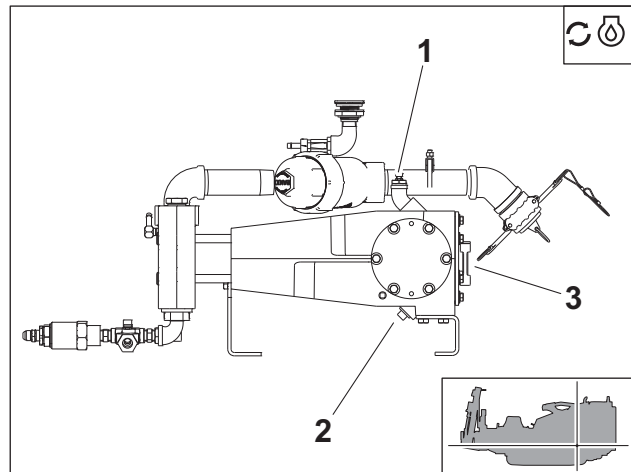
Change Fluid Pump Oil (Initial Service)

Change fluid pump oil after first 50 hours and every 750 hours thereafter.

1. Drain at plug (2).
2. Add SAE 30 at fill plug (1).
3. Maintain fluid level:
 - at fill plug (1) for 13 and 16-gal pumps
 - at sight glass (3) for the 20-gal pump



j42om016h.eps

13 and 16-gal pumps

j61om009h.eps

20-gal pump

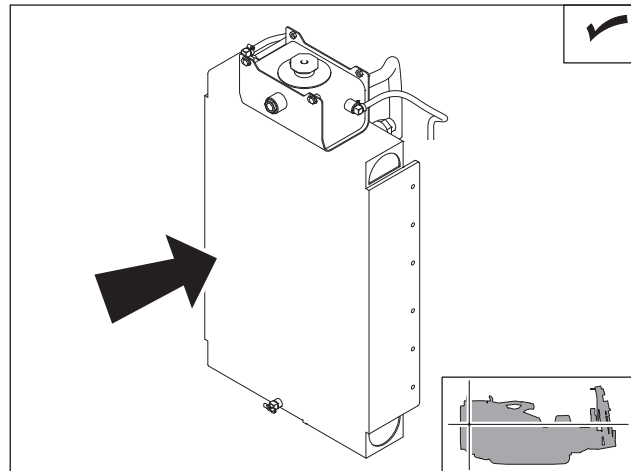
Check Oil Cooler

Check oil cooler for dirt, grass, and other foreign matter every 50 hours. Check more often if operating in dusty or grassy conditions. Clean as needed.

To clean:

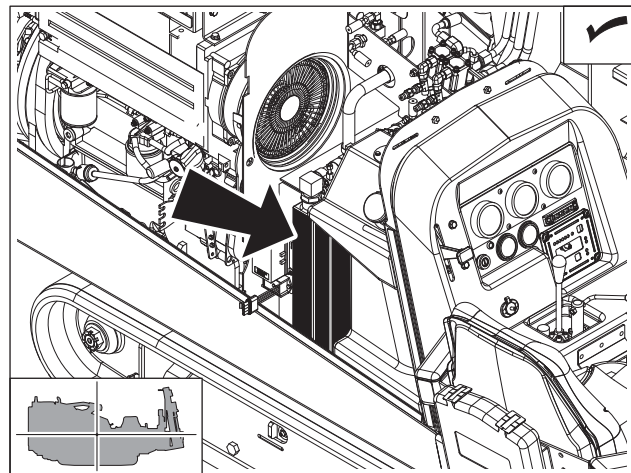
- Clean fins with compressed air or spray wash.
- Spray through oil cooler toward hydraulic tank.
- If grease and oil are present on oil cooler, spray with solvent and allow to soak overnight.

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



j42om017h.eps

Tier 4



j21om020h.eps

Tier 4i

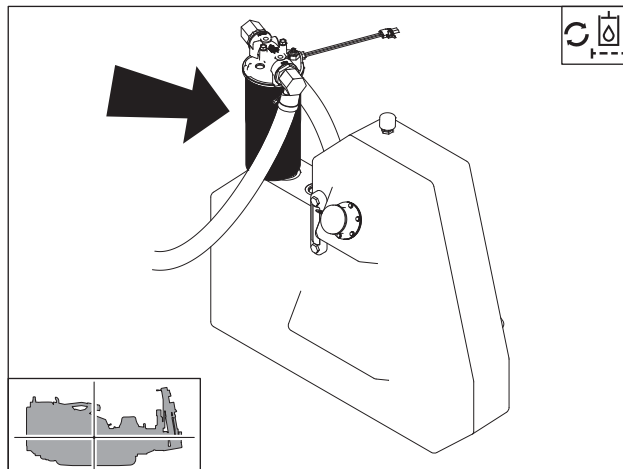


Change Hydraulic Filter (Initial Service)

NOTICE: (Tier 4 only) Disconnect battery before removing hydraulic filter.

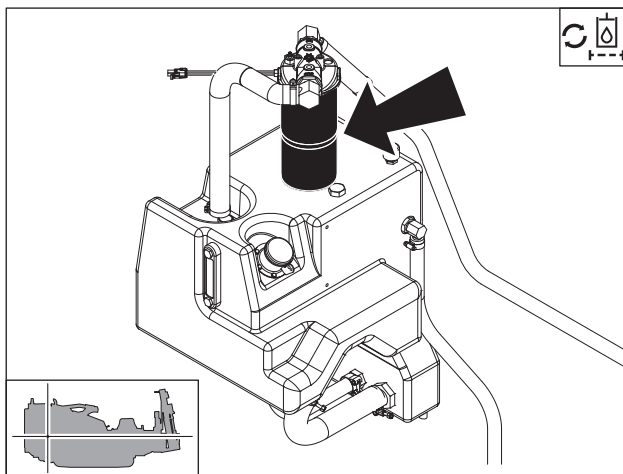
Change hydraulic filter after first 50 hours. Replace filter every 500 hours thereafter. Change filter more often if indicated by filter indicator.

IMPORTANT: If hydraulic system must be opened for repair, install new filter (p/n 153-791) for first 50 hours of operation. If this filter becomes plugged in fewer than 20 hours, replace with new filter. After 50 hours of normal operation, replace with new filter (p/n 153-792).



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Tier 4

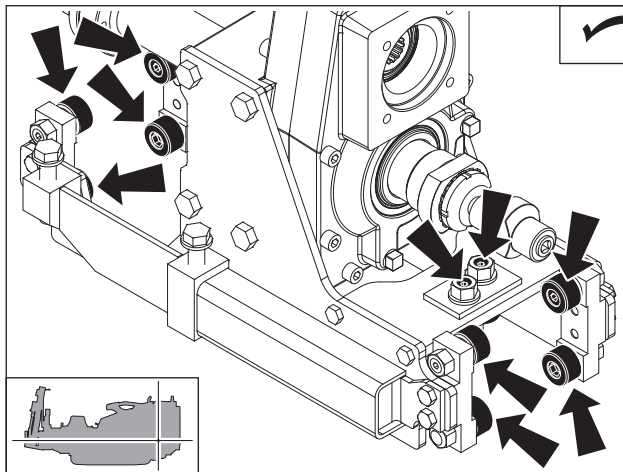


j21om019h.eps

Tier 4i

Inspect Thrust Rollers

Inspect thrust rollers every 50 hours. Clean or replace if they do not turn freely.



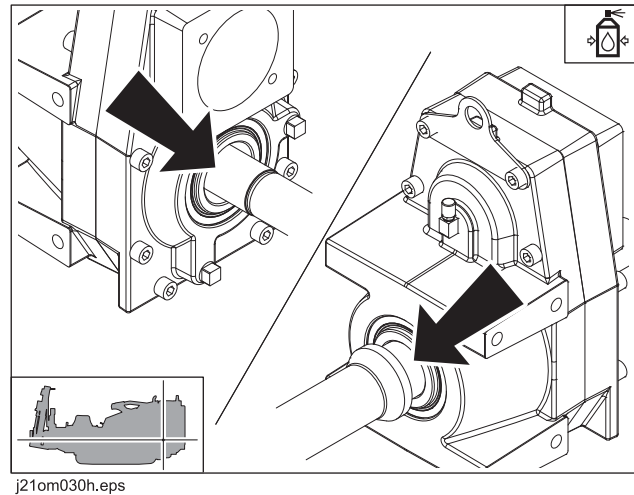
j21om028h.eps

Lubricate Rotation Gearbox Sliding Output Shaft

Lube rotation gearbox sliding output shaft with EPS every 50 hours.

To lube:

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



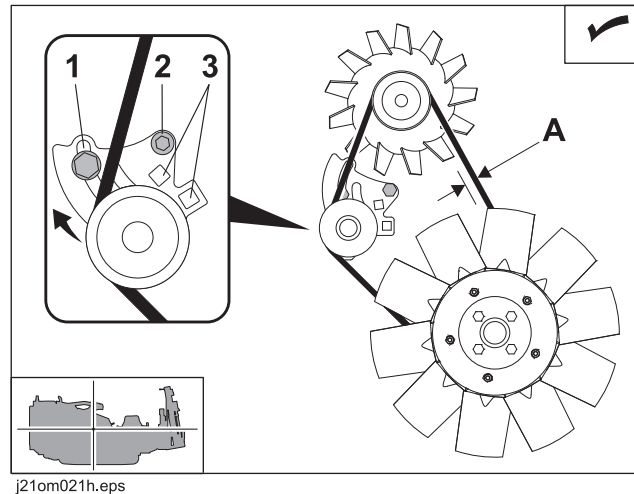
Check and Adjust Engine Belt Tension (Tier 4i)

Check belt tension every 50 hours. Belt is properly tensioned when it moves about 3/8" (10 mm) when pushed at the long span (A).

To adjust belt, move tensioner pulley:

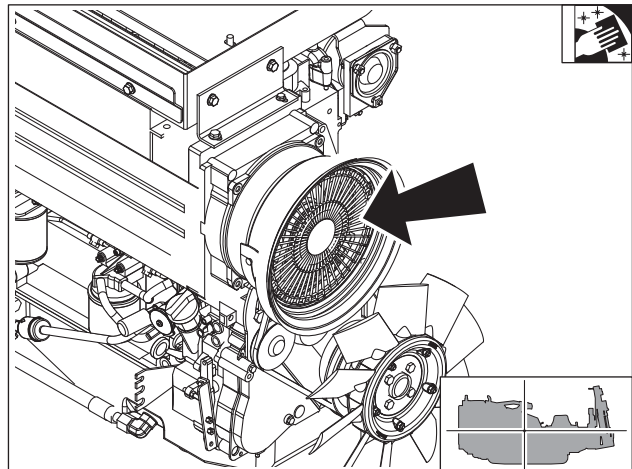
Note: Bolt heads are hidden. Use an 8 mm hex wrench, 17 mm open end wrench, and a 1/2" prybar for this procedure.

1. Loosen socket bolt (2) and bolt (1).
2. Use a prybar in slots (3) to move pulley.
3. Tighten socket bolt (2) and bolt (1).
4. Check tension.



**Clean Alternator Cooler Turbine
(Tier 4i)**

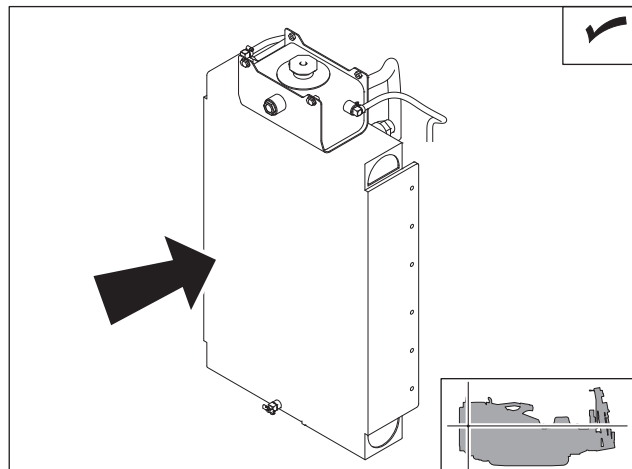
Clean the alternator cooler turbine every 50 hours. Remove side panel and use compressed air to blow dirt and debris from fins (shown).



j21om022h.eps

Clean Radiator (Tier 4)

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.



j42om017h.eps

250 Hour

Location	Task	Notes
DRILLING UNIT	Change engine oil and filter	Tier 4 only
	Inspect air intake system	

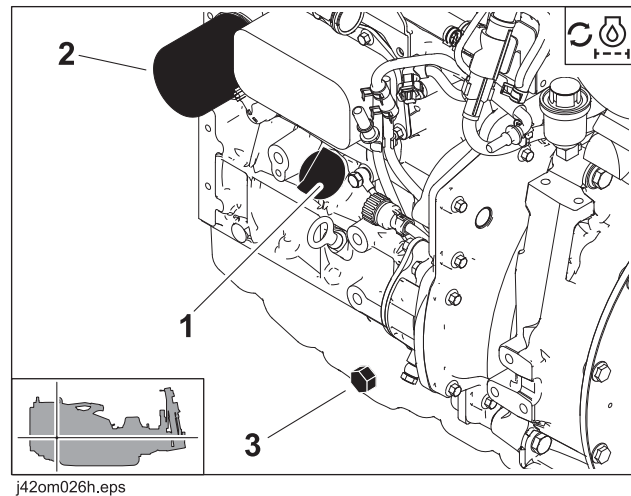
Drilling Unit

Engine Oil and Filter Change (Tier 4)

NOTICE: Regular engine oil and filter change is 250 hours. See "Recommended Lubricants/Service Key" on page 130 for more information.

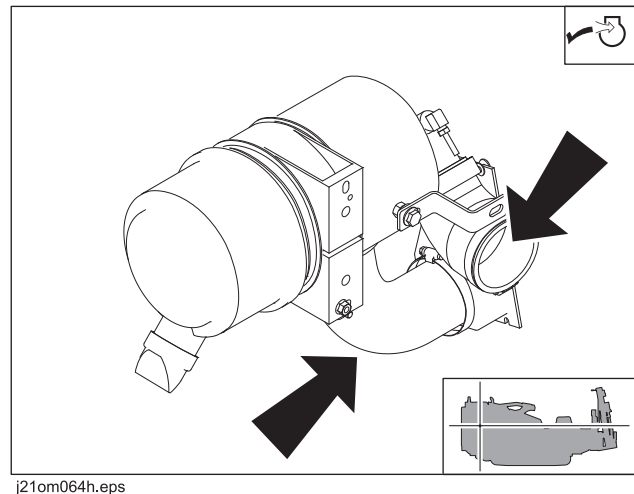
To change:

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



Inspect Air Intake System

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



500 Hour

Location	Task	Notes
DRILLING UNIT	Check fuel filter strainer	Tier 4i only
	Change fuel filter	
	Change hydraulic fluid and filter	Normal conditions

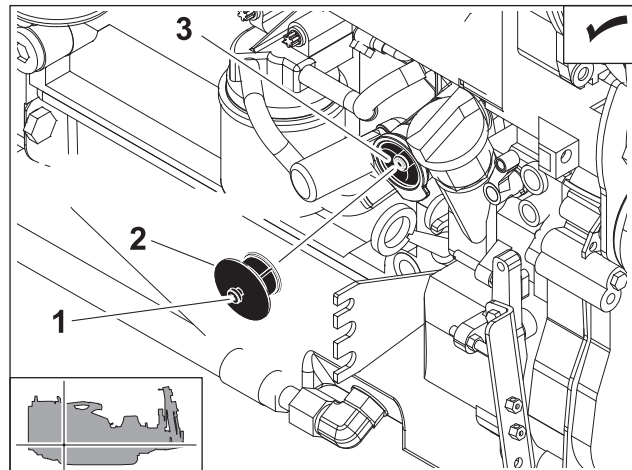
Drilling Unit

Check Fuel Filter Strainer (Tier 4i)

Check fuel filter strainer every 10 hours.

Clean fuel filter strainer:

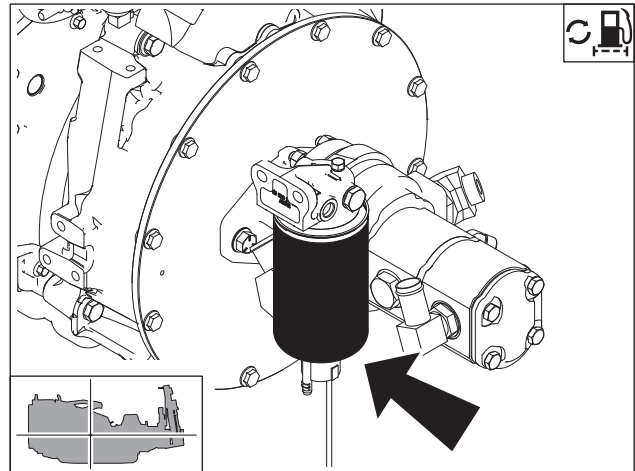
1. Close fuel shut-off valve.
2. Unscrew nut (1).
3. Remove fuel strainer cover (2).
4. Clean fuel strainer (2) with diesel fuel. Replace if necessary.
5. Place seal (3) in position.
6. Mount fuel strainer cover (2). Tighten screw (1).
7. Check for leaks.



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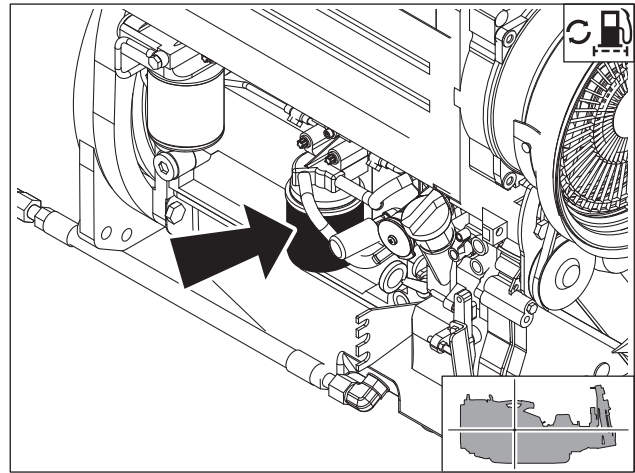
Change Fuel Filter

Change fuel filter every 500 hours.



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Tier 4



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Tier 4i

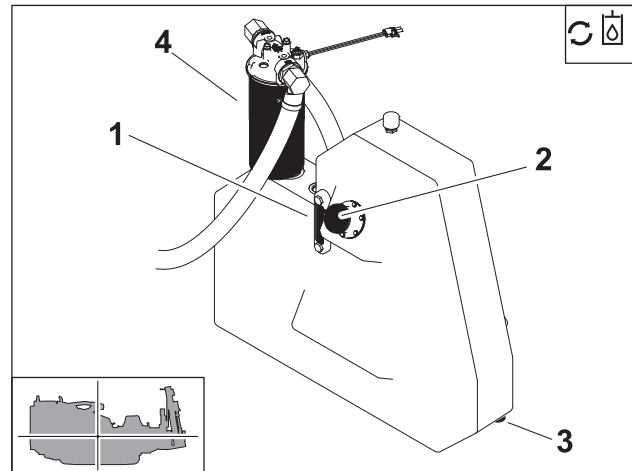


Change Hydraulic Fluid and Filter

Change hydraulic fluid and filter every 500 hours.

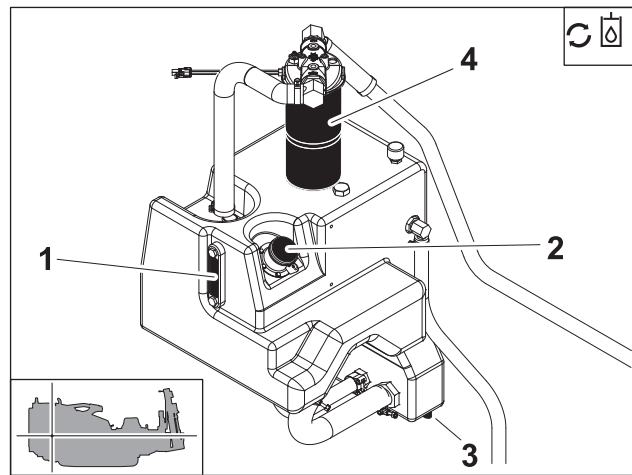
1. Drain hydraulic fluid at drain plug (3).
2. Change filter (4).
3. Add THF at hydraulic fluid fill (2).
4. Check level at sight glass (1).

IMPORTANT: If hydraulic system must be opened for repair, install new filter (p/n 153-791) for first 50 hours of operation. If this filter becomes plugged in fewer than 20 hours, replace with new filter. After 50 hours of normal operation, replace with new filter (p/n 153-792).



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Tier 4



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Tier 4i

750 Hour

Drilling Unit

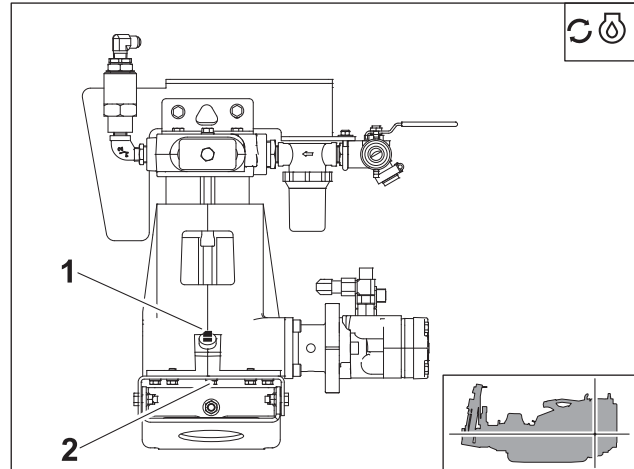
Change Fluid Pump Oil

Change fluid pump oil every 750 hours.

Oil capacities:

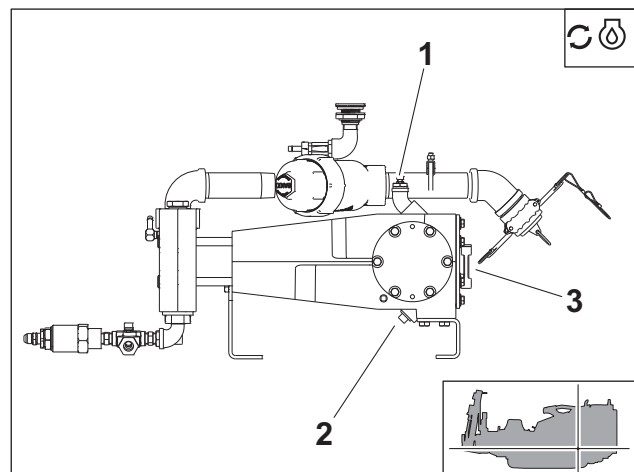
- 13-gal pump: 32 oz
- 16-gal pump: 32 oz
- 20-gal pump: 72 oz

1. Drain at plug (2).
2. Add NDO oil at fill plug (1).
3. Maintain fluid level:
 - at fill plug (13 and 16-gal pumps)
 - at sight glass (20-gal pump)



j42om016h.eps

13 and 16-gal pumps



j61om009h.eps

20-gal pump



1000 Hour

Drilling Unit

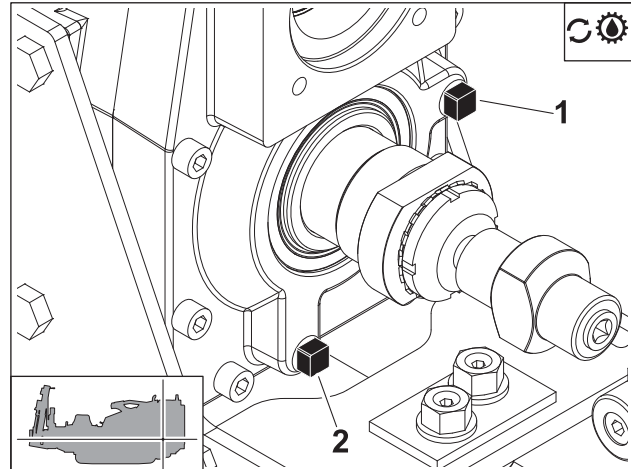
Change Rotation Gearbox Oil

Change rotation gearbox oil every 1000 hours.

1. Drain oil at drain plug (2).
2. Install drain plug (2).
3. Add MPL at fill plug (1).

IMPORTANT: Drill frame must be level for accurate reading.

4. Install fill plug (1).



j21om029h.eps

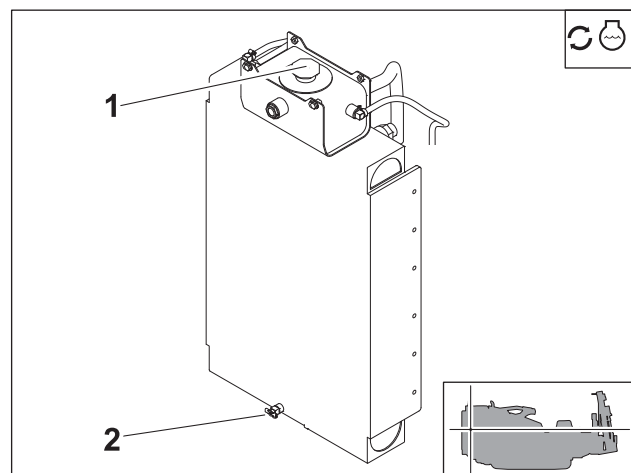
2000 Hour

Drilling Unit

Change Engine Coolant (Tier 4)

Change engine coolant every two years or 2000 hours.

1. Drain coolant at drain plug (2).
2. Install drain plug (2).
3. Add approved coolant at fill (1).



j42om002h.eps

As Needed

Location	Task	Notes
DRILLING UNIT	Clean engine cooling system	
	Change pipe auto lubricator pail	TJC
	Change hydraulic filter	Any time system is opened
	Check front pipe guide inserts	
	Check track tension and condition	
	Change air filter	
	Check saver sub	
	Inspect muffler	
	Replace fuses	
	Check battery	
	Charge battery	



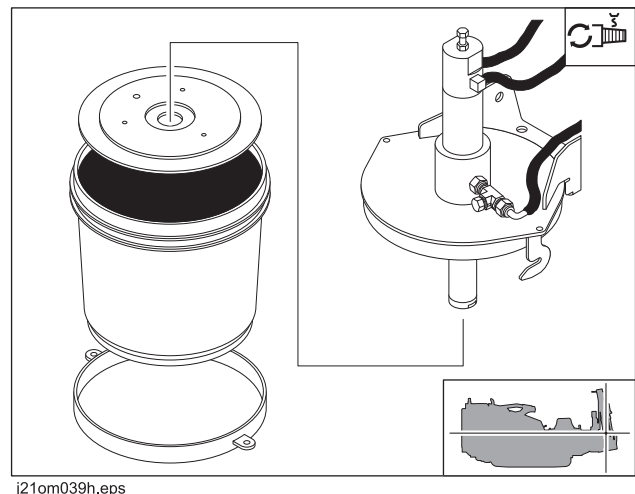
Drilling Unit

Change Auto Lubricator TJC Pail

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

To change pail:

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



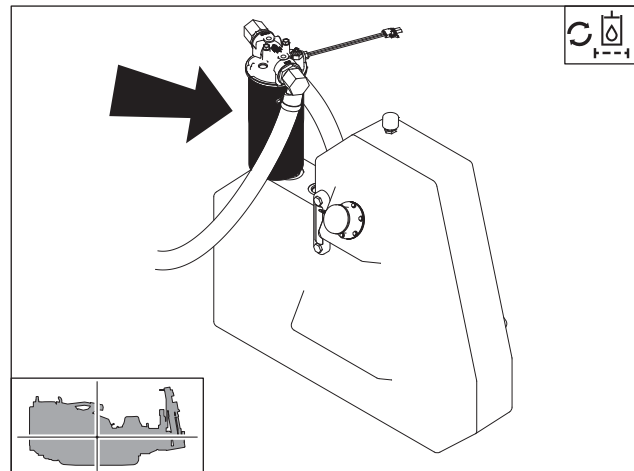
j21om039h.eps

NOTICE: Use only genuine Ditch Witch® tool joint compound to maintain warranty. See "Recommended Lubricants/Service Key" on page 130 for more information.

Change Hydraulic Filter (Anytime System Opened)

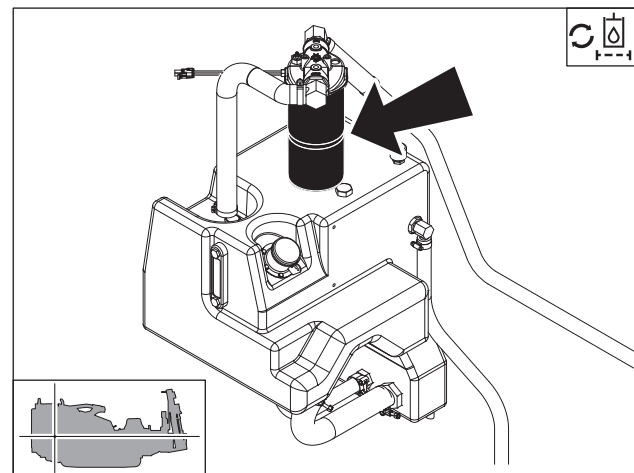
Change hydraulic filter anytime system is opened for repair. Change filter and add THF at hydraulic oil fill.

IMPORTANT: If hydraulic system must be opened for repair, install new filter (p/n 153-791) for first 50 hours of operation. If this filter becomes plugged in fewer than 20 hours, replace with new filter. After 50 hours of normal operation, replace with new filter (p/n 153-792).



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Tier 4



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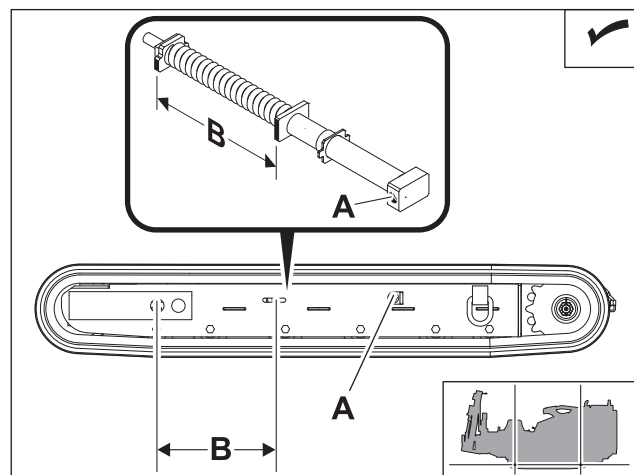
Tier 4i

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 the length of the compressed spring, dimension (B), is 15.25" (387.35 mm).
2. Drive straight forward one machine length and check tension again.

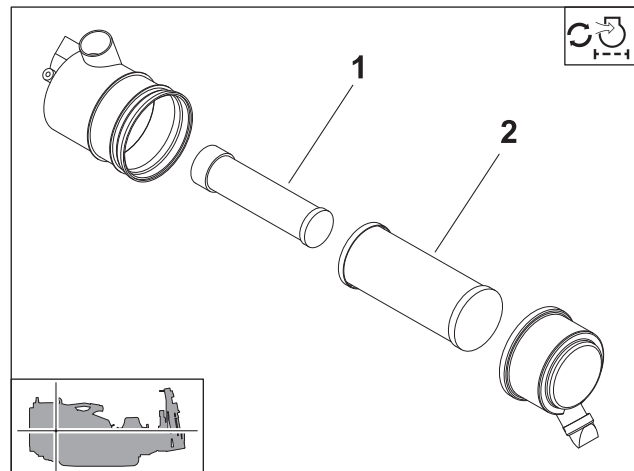


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Change Air Filter

To change:

1. Remove air filter cover (4) and remove primary (3) and secondary (2) elements.
2. Wipe inside of housing (1) and wash cover.
3. Insert new elements.
4. Replace cover with dust evacuator valve at the 6 o'clock position.
5. Reset air filter service indicator.



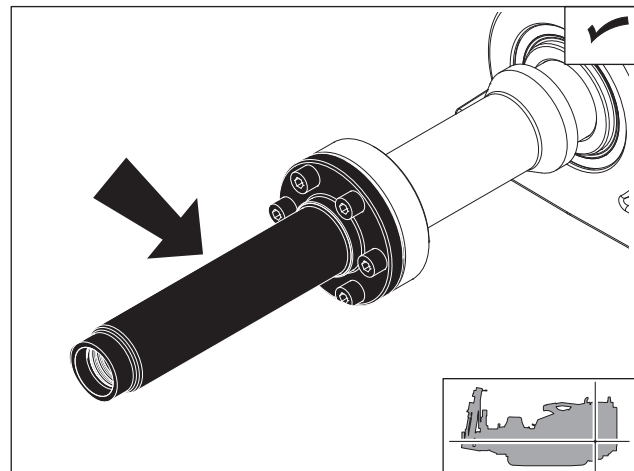
Check Saver Sub

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

IMPORTANT: Saver sub must mate up to every drill pipe. Check sub for thread wear. If saver sub threads are more worn than pipe threads, saver sub is damaging the drill pipe.

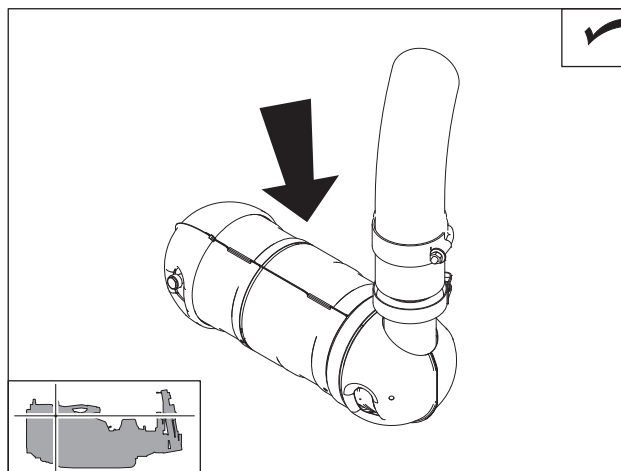
To replace

1. Remove eight bolts (shown) that attach saver sub to spindle. Do not remove indexing dowels from spindle.
2. Remove and replace o-ring, if necessary.
3. Install in reverse order and tighten eight bolts in a cross pattern to 55 ft•lb (74.6 N•m). Apply Loctite® 242 to bolts before installation.



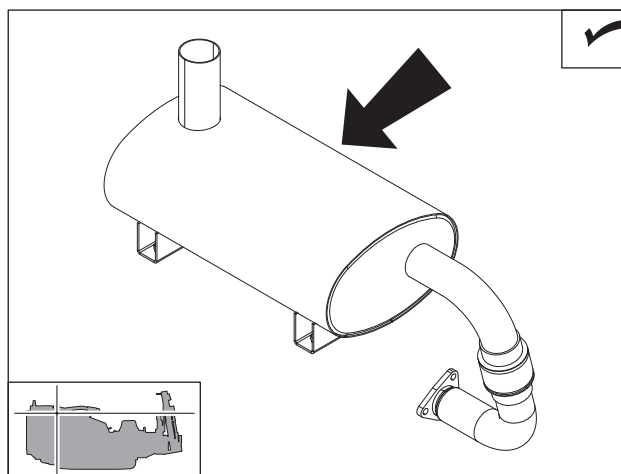
Inspect Muffler

Inspect muffler for looseness as needed.



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Tier 4

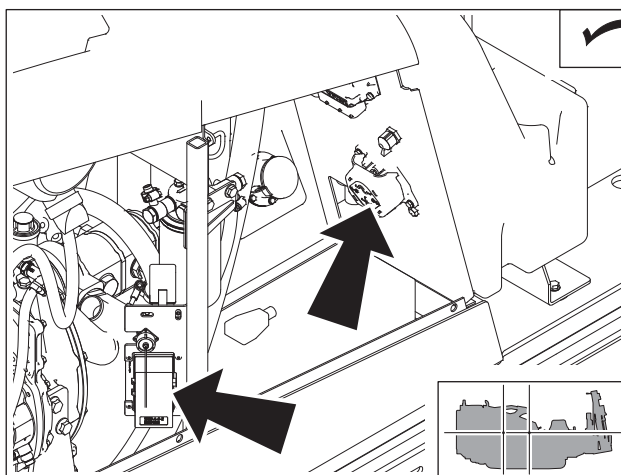


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Tier 4i

Replace Fuses

Change fuses as needed. Refer to decal inside panels to identify fuses.



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Check Battery

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



WARNING Explosion possible. Serious injury or equipment damage could occur.

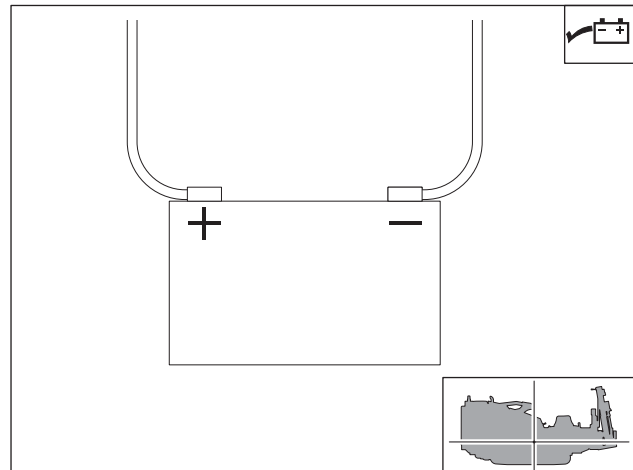
To help avoid injury:

- Keep heat, sparks, flames and other ignition sources away.
- Connect and disconnect battery cables in the correct order.
- Do not short across battery terminals for any reason.



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.



Charge Battery



Explosion possible. Serious injury or equipment damage could occur.

To help avoid injury:

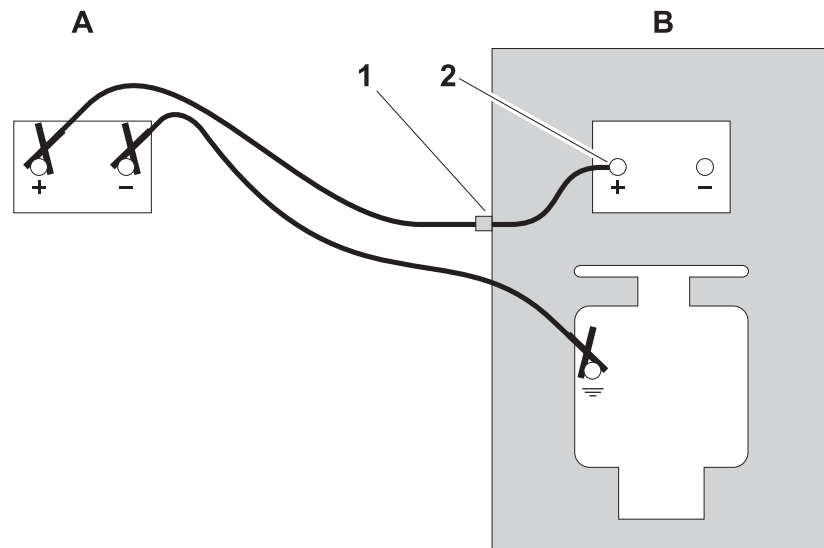
- Wear the necessary personal protective equipment, including sufficiently insulated gloves and safety glasses.
- Keep sparks, fire and other ignition sources away.
- Do not charge a battery that is leaking, bulging, heavily corroded, frozen, or otherwise damaged.
- Use a single 12V maximum source for charging. Do not connect to rapid chargers or dual batteries.
- NEVER short-circuit battery terminals for any reason or strike battery posts or cable terminals.
- NEVER lean over battery when making connections.
- Do not allow vehicles to touch when charging.
- Do not allow battery clamps to touch.

NOTICE: Electrical surge hazard.

Electronic components can be damaged during jump start procedure.

- Replace battery as an alternative to jump start procedure.
- If jump start is necessary: use quality large diameter booster cables capable of carrying high currents (400 amps or more).

To set up and check:



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CAUTION

Acid in battery is corrosive. Contact with skin will cause burns.

To help avoid injury:

- Avoid contact with battery fluid.
- Wear applicable safety glasses and gloves.
- See Material Safety Data Sheet (MSDS) for additional information.

1. Park service vehicle close to disabled equipment but do not allow vehicles to touch.
2. Engage parking brake in both vehicles.
3. Turn the ignition switch to the OFF position in both vehicles, and turn off all electrical loads. Disconnect the machine controller.
4. Inspect disabled battery (B) for signs of cracking, bulging, leaking, or other damage. If battery is damaged in any way, do not jump start. Replace battery.
5. Check for loose or corroded battery cable connections.
6. Carefully clean terminals and posts.

To connect batteries:

1. Connect red positive (+) cable clamp to positive (+) post (2) of disabled battery.

IMPORTANT: Some machines have an external positive terminal (1). In that case, connect positive clamp to external terminal.

2. Connect other red positive (+) cable clamp to positive (+) post of service vehicle battery.
3. Connect black negative (-) cable clamp to negative (-) post of service vehicle battery.
4. Connect other black negative (-) cable clamp to engine or frame ground on disabled equipment, at least 12" (305 mm) from disabled battery.

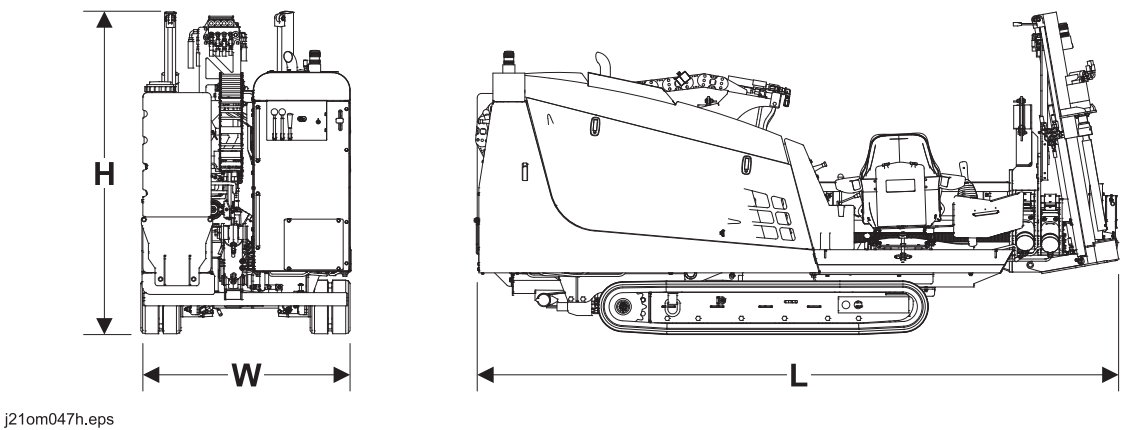
To charge disabled battery:

1. Operate service vehicle engine at 1500-2000 rpm for a few minutes.
2. Stop engine in service vehicle.

To disconnect batteries:

1. Remove black negative (-) clamp from negative post of service vehicle battery.
2. Remove black negative (-) clamp from engine or frame ground of disabled machine.
3. Remove red positive (+) clamp from positive post of service vehicle battery.
4. Remove red positive (+) clamp from external positive terminal (1) or internal positive post (2) of disabled battery.
5. Reconnect machine controller and try to start disabled machine.
6. If disabled machine does not start, replace battery.

Specifications



Dimensions	U.S.	Metric
L, overall machine length (per SAE J2022)	146 in	3.7 m
W, overall machine width (per SAE J2022)	48 in	1.2 m
H, overall machine height (per SAE J2022)	74 in	1.9 m
Entry angle (per SAE J2022)	10-14°	10-14°
Angle of approach	18°	18°
Angle of departure	18°	18°



Power Pipe [®] HD	U.S.	Metric
Length (per SAE J2022), nominal	72 in	1.8 m
Joint diameter (per SAE J2022)	2 in	51 mm
Tubing diameter (per SAE J2022)	1.6 in	40 mm
Minimum bend radius	82 ft	25 m
Weight (per SAE J2022), lined	29 lb	13 kg

Power Pipe [®] Forged	U.S.	Metric
Length (per SAE J2022), nominal	72 in	1.8 m
Joint diameter (per SAE J2022)	1.88 in	48 mm
Tubing diameter (per SAE J2022)	1.66 in	42 mm
Minimum bend radius	96 ft	29.3 m
Weight (per SAE J2022), lined	26 lb	12 kg

Operational		U.S.	Metric
Maximum spindle speed (per SAE J2022)		186 rpm	186 rpm
Maximum spindle torque (per SAE J2022)		1100 ft•lb	1491 N•m
Thrust force (per SAE J2022)		9,000 lb	40 kN
Pullback force (per SAE J2022)		10,000 lb	44.5 kN
Thrust travel speed (per SAE J2022)		188 fpm	57 m/min
Pullback travel speed (per SAE J2022)		188 fpm	57 m/min
Minimum bore diameter		3 in	76 mm
Backream diameter (soil dependent)		variable	variable
Ground travel speed			
T4	forward (per SAE J2022)	2.4 mph	3.9 km/h
	reverse (per SAE J2022)	1.5 mph	2.4 km/h
T4i	forward (per SAE J2022)	2.3 mph	3.7 km/h
	reverse (per SAE J2022)	1.5 mph	2.4 km/h
Ground bearing pressure (per SAE J1309)			
T4		5.9 psi	0.42 kg/cm ²
T4i		5.6 psi	0.39 kg/cm ²
Operating mass with 54 PPHD drill pipe			
T4	16-gal pump, water tank full (per SAE J2022)	7,526 lb	3414 kg
	16-gal pump, water tank empty	7,216 lb	3273 kg
	20-gal pump, antifreeze tank full (per SAE J2022)	7,307 lb	3315 kg
	20-gal pump, antifreeze tank empty	7,240 lb	3284 kg
T4i	13-gal pump, water tank full (per SAE J2022)	7,100 lb	3220 kg
	13-gal pump, water tank empty	6,750 lb	3060 kg

Power (Tier 4)		U.S.	Metric
Engine: Deutz® TD2.9 EPA Tier 4, EU Stage IIIB			
Fuel: diesel (ultra low sulfur fuel only)			
Cooling medium: liquid			
Injection: direct			
Aspiration: turbo charged			
Cylinders: 4			
Displacement		177 in ³	2.9 L
Bore		3.7 in	95 mm
Stroke		4.5 in	115 mm
Power			
	manufacturer's gross power rating (per SAE J1995)	66 hp	49.0 kW
	rated speed	2200 rpm	2200 rpm



Power (Tier 4i)		U.S.	Metric
Engine: Deutz® D2011L4i EPA Tier 4i, EU Stage IIIA			
Fuel: diesel			
Cooling medium: integrated oil			
Injection: direct			
Aspiration: natural			
Cylinders: 4			
Displacement		189 in ³	3.1 L
Bore		3.7 in	94 mm
Stroke		4.4 in	112 mm
Power			
	manufacturer's gross power rating (per SAE J1995)	53.5 hp	39.9 kW
	rated speed	2300 rpm	2300 rpm

Drilling Fluid System (Onboard)		U.S.	Metric
Maximum drilling fluid flow (per SAE J2022)			
T4	Standard pump	16-gal	60.6 L/min
	Optional pump	20-gal	76 L/min
T4i	Standard pump	13 gpm	49 L/min
Maximum drilling fluid pressure (per SAE J2022)			
T4	Standard pump	750 psi	52 bar
	Optional pump	1,200 psi	83 bar
T4i	Standard pump	750 psi	52 bar

Fluid Capacities Tier 4	U.S.	Metric
Fuel tank *	18 gal	68 L
Hydraulic reservoir	23 gal	87 L
Engine oil, including filter	8.5 qt	8 L

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

Fluid Capacities Tier 4i	U.S.	Metric
Fuel tank *	19 gal	72 L
Hydraulic reservoir	18 gal	68 L
Engine oil, including filter	11.6 qt	11 L

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

Battery Tier 4
SAE reserve capacity rating 195 min, 12V, negative ground, SAE cold crank rating @ 0°F (-18°C), 950 amps.

Battery Tier 4i
SAE reserve capacity rating 165 min, 12V, negative ground, SAE cold crank rating @ 0°F (-18°C), 875 amps.

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 Tier 4i

Operator ear sound pressure level is 88 dBA sound pressure per ISO 6394

Exterior sound power level is 104 dBA per ISO 6393

Noise Levels Tier 4

Operator ear sound pressure level is 91 dBA sound pressure per ISO 6394

Exterior sound power level is 107 dBA per ISO 6393

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



Support

Procedure

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

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

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

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

Resources

Publications

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



Ditch Witch® Training

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

Warranty

Ditch Witch® Equipment and Replacement Parts Limited Warranty Policy

Subject to the limitation and exclusions herein, free replacement parts will be provided at any authorized Ditch Witch dealership for any Ditch Witch equipment or parts manufactured by the 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.

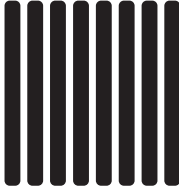
This will enable you to receive updates on this equipment as well as information on new products of interest.

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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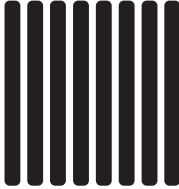
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BUSINESS REPLY MAIL
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POSTAGE WILL BE PAID BY

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



Ditch Witch® Registration Card

Please Type or Print All Information

Purchaser's Company Name		
Attention		
Street Address or P.O. Box		
City	County	
State	Zip	Nation
()		
Phone Number With Area Code		
Model	Serial Number	
Attachments/Accessories	Serial Numbers	
Attachments/Accessories	Serial Numbers	
Attachments/Accessories	Serial Numbers	
Name of Ditch Witch Dealership		
Your Signature		

Ditch Witch® Registration Card

Please Type or Print All Information

Purchaser's Company Name		
Attention		
Street Address or P.O. Box		
City	County	
State	Zip	Nation
()		
Phone Number With Area Code		
Model	Serial Number	
Attachments/Accessories	Serial Numbers	
Attachments/Accessories	Serial Numbers	
Attachments/Accessories	Serial Numbers	
Name of Ditch Witch Dealership		
Your Signature		

Service Record

[illegible]

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Appendix



Chapter Contents

Engine Diagnostic Codes

KWP-Code	SPN	FMI	Description
932	29	3	Hand throttle error, short circuit to battery on idle validation switch or sensor error
937	29	4	Hand throttle error, short circuit to ground on idle validation switch or sensor error
978	29	2	Plausibility error between sensor and idle switch, Acceleration Pedal Detection. In case of Hand Throttle with Low Idle Switch, it is the plausibility check between hand throttle and idle switch.
1921	51	5	Intake throttle valve position; actuator disconnected
1922	51	6	Intake throttle valve position, current above normal or short circuit to ground
1924	51	3	Intake throttle valve position, short circuit to battery
1926	51	4	Intake throttle valve position, short circuit to ground
1931	51	7	Intake throttle valve position; not responding or out of adjustment.
935	91	3	Sensor error accelerator pedal. signal range check high.
940	91	4	Sensor error accelerator pedal. Signal is below the range.
976	91	11	Accelerator pedal; signal error between APP1 and APP2 or APP1 and idle switch.
472	94	3	Sensor error low fuel pressure; signal range check high
473	94	4	Sensor error low fuel pressure; signal range check low
474	94	1	Fuel delivery pressure low.
464	97	3	Sensor error water in fuel; signal range check high
465	97	4	Water in fuel indicator voltage is out of range low.
1157	97	12	Water level in fuel prefilter above maximum value
732	100	3	Sensor error oil pressure; signal range check high
733	100	4	Sensor error oil pressure sensor; signal range check low
734	100	0	Engine oil pressure high.
736	100	1	Engine oil pressure low.
88	102	2	Intake manifold pressure; signal is not valid
774	102	1	Pressure downstream charge air cooler, pressure below lower physical threshold
776	102	3	Pressure downstream charge air cooler, short circuit to battery or open load
777	102	4	Pressure downstream charge air cooler, short circuit to ground
992	105	1	Charged Air cooler down stream temperature. Temperature below lower physical threshold.
994	105	3	Intake manifold temperature; short circuit to battery.
995	105	4	Intake manifold temperature; short circuit to ground.
996	105	0	Intake manifold temperature high.
998	105	11	Diagnostic fault check for charged air cooler downstream temperature sensor No detail information!
750	107	3	Sensor error airfilter differential pressure; short circuit to battery
751	107	0	Air filter restriction high.
411	108	11	DFC for CAN message No detail information!
412	108	3	Sensor error ambient air pressure; signal range check high
413	108	4	Sensor error ambient air pressure; signal range check low
92	110	0	Engine coolant temperature high. Most severe. Derate started.
93	110	1	Physical Range Check low for Coolant temperature.
96	110	3	Engine coolant temperature; short circuit to battery.
97	110	4	Engine coolant temperature; short circuit to ground.
98	110	15	Engine coolant temperature high. Least severe.
99	110	16	Engine coolant temperature high. Moderately severe.
101	111	1	Coolant level too low
1	132	11	Air flow sensor load correction factor exceeding the maximum drift limit; plausibility error
877	157	3	Injector rail pressure; short circuit to battery.
878	157	4	Injector rail pressure; short circuit to ground.
1381	164	2	Rail pressure safety function is not executed correctly
45	168	3	Battery voltage; sensor short circuit to battery.
46	168	4	Battery voltage; sensor short circuit to ground.
47	168	2	High battery voltage; shot off threshold exceeded
1180	168	0	Battery voltage is out of the target range (too high)
1181	168	1	Battery voltage is out of the target range (too low)
415	171	0	Environment temperature sensor, temperature above upper physical threshold

KWP-Code	SPN	FMI	Description
416	171	1	Physical Range Check low for Environment Temperature No detail informationen!
417	171	3	Sensor error SCR-System environment temperature; DPF-System air inlet temperature; signal range check high
418	171	4	Sensor error SCR-System environment temperature; DPF-System air inlet temperature; signal range check low
9	172	2	intake air temperature sensor, signal is not valid
981	172	3	Air flow temperature sensor; short circuit to battery or open load.
982	172	4	Air flow temperature sensor; short circuit to ground
1183	172	1	Air inlet filter sensor out of physical range check
1425	172	0	air temperature within air filter box above maximum physical value
743	175	3	Sensor error oil temperature; signal range check high
744	175	4	Sensor error oil temperature; signal range check low
745	175	0	High oil temperature; warning threshold exceeded
1171	175	2	Customer oil temperature signal is not valid
388	190	0	Engine speed above warning threshold Overspeed detection in component engine protection
390	190	11	Engine speed above warning threshold (FOC-Level 2)
391	190	14	Engine speed target range exceeded; overrun mode
419	190	8	Camshaft speed; signal is not valid.
420	190	12	Speed sensor no signal
421	190	2	Speed sensor of crankshaft and camshaft signals are out of phase
791	411	0	delta pressure across venturi in EGR line above physical high limit
792	411	1	delta pressure across venturi in EGR line below physical low limit
793	411	11	Plausibility Check fault for deviation of desired and actual EGR-mass flow, where the latter is calculated out of EGR Delta Pressure Sensor.
795	411	3	Sensor error differential pressure Venturiunit (EGR), signal range check low.
796	411	4	Sensor error differential pressure Venturiunit (EGR), signal range check high.
1007	412	3	Electrical error EGR cooler downstream temperature. Signal range check high.
1008	412	4	electrical error EGR cooler downstream temperature. Signal range check low.
306	520	9	Timeout Error of CAN-Receive-Frame TSC1TR
969	624	5	SVS lamp; open load
970	624	12	Temperature too high for power stage of SVS lamp
971	624	3	Short circuit to battery on SVS lamp
972	624	4	Short circuit to ground on SVS lamp
376	630	12	Access error EEPROM memory
84	639	14	CAN-Bus 0 "BusOff"-Status
568	651	5	Injector 1 (in firing order); interruption of electric connection
580	651	3	Injector 1 (in firing order); short circuit
569	652	5	Injector 2 (in firing order); interruption of electric connection
581	652	3	Injector 2 (in firing order); short circuit
570	653	5	Injector 3 (in firing order); interruption of electric connection
582	653	3	Injector 3 (in firing order); short circuit
571	654	5	Injector 4 (in firing order); interruption of electric connection
583	654	3	Injector 4 (in firing order); short circuit
543	676	11	Cold start aid relay error.
958	677	5	No load error starter relay
959	677	12	Over load ECU power stage for Starter (overtemp.)
960	677	3	Starter relay: short circuit to battery.
961	677	4	Starter relay: short circuit to ground.
545	729	5	Intake air heater relay disconnected.
547	729	12	Cold start aid relay; over temperature error
549	729	3	Intake Air Heater Device; Short circuit to battery
551	729	4	Air intake heater; Short circuit to ground error for powerstage on CJ945.
305	898	9	Timeout Error of CAN-Receive-Frame TSC1TE; Setpoint
455	975	5	Fan actuator (PWM output); open load
457	975	3	Fan actuator (PWM output); short circuit to battery
458	975	4	Fan actuator (PWM output); short circuit to ground

KWP-Code	SPN	FMI	Description
946	1079	13	Failure of sensor supply voltage 1.
947	1080	13	Failure of sensor supply voltage 2.
121	1109	2	Engine off request ignored
1398	1136	0	Physical range check high for ECU temperature
847	1176	0	Pressure sensor upstream turbine, Physical Range Check high.
848	1176	1	Pressure sensor upstream turbine, Physical Range Check low.
849	1176	3	Pressure sensor upstream turbine, signal range check (SRC) high.
850	1176	4	Pressure sensor upstream turbine, signal range check (SRC) low.
1528	1176	2	Pressure sensor upstream turbine, plausibility error
1067	1180	3	Turbocharger turbine intake temperature; short circuit to battery.
1068	1180	4	Turbocharger turbine intake temperature; short circuit to ground.
1412	1188	11	Wastegate actuator; signal error or temperature too high.
1788	1188	7	Turbocharger wastegate, not responding or out of adjustment
1789	1188	2	Turbocharger wastegate, CAN Error
1790	1188	13	Turbocharger wastegate, calibration error.
1791	1188	12	Turbocharger wastegate, internal electrical error.
1793	1188	6	Turbocharger wastegate, current above maximum threshold.
1794	1188	3	Turbocharger wastegate, supply voltage above maximum threshold.
1795	1188	4	Turbocharger wastegate, supply voltage below minimum threshold.
1799	1188	0	Turbocharger wastegate, temperature critical high.
85	1231	14	CAN-Bus 1 "BusOff"-Status
82	1235	14	CAN-Bus 2 "BusOff"-Status
747	1237	2	Override switch; plausibility error.
610	1322	12	Too many recognized misfires in more than one cylinder
604	1323	12	Too many recognized misfires in cylinder 1 (in firing order)
605	1324	12	Too many recognized misfires in cylinder 2 (in firing order)
606	1325	12	Too many recognized misfires in cylinder 3 (in firing order)
607	1326	12	Too many recognized misfires in cylinder 4 (in firing order)
608	1327	12	Too many recognized misfires in cylinder 5 (in firing order)
609	1328	12	Too many recognized misfires in cylinder 6 (in firing order)
459	1639	12	Fan speed sensor; electrical error or signal disturbed
460	1639	0	Sensor error fan speed; signal range check high
461	1639	1	Sensor error fan speed; signal range check low
1593	1761	0	DEF tank, DEF level above upper physical threshold
1594	1761	1	DEF level low.
1869	1761	2	DEF tank level, plausibility error
1880	1761	14	DEF tank, DEF level below warning threshold
1524	2659	0	Exhaust Gas Recirculation AGS Sensor; Sensed exhaust mass value above maximum physical value
1525	2659	1	Exhaust Gas Recirculation AGS Sensor; Sensed exhaust mass flow too low.
1526	2659	12	Exhaust Gas Recirculation AGS Sensor; invalid signal.
1527	2659	2	Exhaust Gas Recirculation AGS Sensor; temperature signal is not valid.
1752	2791	7	EGR actuator, mechanical failure
1753	2791	2	EGR actuator, CAN error
1754	2791	13	EGR actuator, calibration error
1755	2791	12	EGR Actuator, electrical failure
1757	2791	6	EGR actuator current is above maximum threshold
1758	2791	3	EGR actuator supply voltage is above the maximum threshold
1759	2791	4	EGR actuator supply voltage is below minimum threshold.
1762	2791	16	EGR actuator, temperature high.
1763	2791	0	EGR actuator, temperature critical high
1339	2797	4	Injector diagnostic; Short circuit to ground cylinder bank 0
1340	2798	4	Injector diagnostic; Short circuit to ground cylinder bank 1
1135	3031	0	DEF temperature high.
1136	3031	1	DEF temperature low.
127	3224	2	DLC Error of CAN-Receive-Frame AT1IG1 NOX Sensor (SCR-system upstream cat; DPF-system downstream cat); length of frame incorrect

KWP-Code	SPN	FMI	Description
130	3224	9	SCR intake NOx sensor; abnormal update rate.
889	3224	1	SCR intake NOx sensor; signal is not valid.
137	3234	9	Timeout Error of CAN-Receive-Frame AT1OG1; NOX sensor (SCR-system downstream cat; DPF-system downstream cat)
138	3234	2	DLC Error of CAN-Receive-Frame AT1O1Vol NOX
887	3234	11	SCR outlet NOx sensor; signal is not valid.
905	3241	0	Sensor SCR catalyst upstream temperature too high; plausibility error.
1047	3248	4	Sensor error particle filter downstream temperature; signal range check low
908	3361	7	Dosing valve blocked
1075	3361	6	DEF dosing valve; power at the end of injection too high
1077	3361	3	DEF dosing valve; short circuit to battery.
1079	3361	4	DEF dosing valve; short circuit to ground.
1895	3519	12	DEF tank temperature, temperature too high
1898	3519	3	DEF quality sensor, internal temperature sensor short circuit to battery or open load
1899	3519	4	DEF quality sensor, internal temperature sensor short circuit to ground
1908	3519	13	Temperature at UQS invalid
1896	3520	3	DEF quality sensor, short circuit to battery or open load
1897	3520	4	DEF quality sensor, short circuit to ground
1904	3520	2	DEF quality seonsor, bad DEF quality detected or no DEF measuring possible.
1905	3520	8	DEF quality seonsor, measurement conditions not fulfilled
1907	3520	13	DEF quality at UQS invalid
943	3532	3	DEF tank level or DEF quality sensor; short circuit to battery.
945	3532	4	DEF tank level or DEF quality sensor; short circuit to ground.
1617	3699	2	Aftertreatment pressure sensor or temperature sensor; signal is not valid.
1635	3699	0	Maximum standstill time reached; oil exchange request ignored
1455	3711	12	Temperature during stand-still main phase too low or too high
1917	3936	14	Standstill request ignored too long.
1089	4243	11	SCR system heater errors
1122	4334	0	DEF dosing pressure high.
1123	4334	1	DEF dosing pressure low.
1866	4334	2	DEF supply module pressure, plausibility error
1086	4341	5	DEF heater relay DEF supplyline side; open load
1104	4341	3	DEF-heater DEF supplyline; short circuit to battery
1105	4341	4	DEF-heater DEF supply line; short circuit to ground
893	4343	11	DEF dosing pressure; signal is not valid.
1083	4343	5	DEF pressure line heater relay; disconnected.
1094			DEF pressure line heater relay; short circuit to battery.
1096	4343	3	DEF pressure line heater relay; short circuit to ground.
1097	4343	4	DEF heater DEF pressureline; short circuit to ground
892	4345	11	DEF return pressure; signal is not valid.
1090	4345	5	DEF heater relay DEF returnline side; open load
1092	4345	3	DEF heater DEF returnline; short circuit to battery
1093	4345	4	DEF heater DEF returnline; short circuit to ground
1069	4360	0	SCR intake gas temperature high.
1070	4360	1	SCR intake gas temperature low.
1865	4360	2	Exhaust temperature sensor upstream SCR, plausibility error
1072	4361	3	SCR intake gas temperature; short circuit to battery.
1073	4361	4	SCR intake gas temperature; short circuit to ground.
903	4365	0	DEF tank temperature too high.
1137	4365	2	Signal error for CAN message
1914	4365	3	DEF quality and temperature sensor; short circuit to battery or disconnected.
1915	4365	4	DEF quality and temperature sensor; short circuit to ground.
1110	4366	5	DEF heater relay or valve; short circuit or disconnected.
1112	4366	3	DEF Tank heating valve; short circuit to battery
1113	4366	4	DEF Tank heating valve; short circuit to ground
894	4374	13	Pressure stabilization error dosing valve (SCR)
1118	4375	5	DEF supply pump disconnected.

KWP-Code	SPN	FMI	Description
1120	4375	3	DEF supply pump; short circuit to battery.
1121	4375	4	DEF supply pump; short circuit to ground.
1131	4376	3	DEF reversing valve; short circuit to battery
1132	4376	4	DEF reversing valve; short circuit to ground
1490	4376	5	DEF reversing valve disconnected.
1491	4376	12	DEF reverting valve; over temperature
1039	4765	0	Diesel oxidation catalyst intake gas temperature high.
1029	4766	0	Diesel oxidation catalyst outlet gas temperature high.
1036	4768	2	Diesel oxidation catalyst intake gas temperature; signal is not valid.
1044	4768	3	Diesel oxidation catalyst intake gas temperature; short circuit to battery.
1045	4768	4	Diesel oxidation catalyst intake gas temperature; short circuit to ground.
1026	4769	2	Diesel oxidation catalyst outlet gas temperature; signal is not valid.
1034	4769	3	Diesel oxidation catalyst outlet gas temperature; short circuit to battery.
1035	4769	4	Diesel oxidation catalyst outlet gas temperature; short circuit to ground.
1016	5763	7	Throttle position sensor; signal error.
1022	5763	6	Throttle position sensor; current above normal or short circuit to ground.
1023	5763	5	Throttle position sensor; disconnected
1025	5763	4	Throttle position sensor; short circuit to ground.
1226	5763	3	Throttle position sensor; short circuit to battery.
1231	5763	11	Power stage overtemperature due to high current.
1423	5763	0	Throttle sensor error.
1424	5763	1	Throttle sensor error.
1015	520521	5	EGR actuator; disconnected.
648	523008	1	Manipulation control was triggered
649	523008	2	Timeout error in Manipulation control
825	523009	9	The pressure relief valve (PRV) has reached the number of allowed activations.
833	523009	10	Open time of Pressure Relief Valve (PRV) for wear out monitoring had exceeded
362	523090	2	Engine Brake Pre-Selection switch; Plausibility Error
171	523212	9	Timeout Error of CAN-Receive-Frame ComEngPrt
198	523216	9	Timeout Error of CAN-Receive-Frame PrHtEnCmd; pre-heat command, engine command
179	523240	9	Timeout CAN-message FunModCtl; Function Mode Control
919	523330	14	Immobilizer status; fuel blocked
565	523350	4	Short circuit injector cylinder bank 1
566	523352	4	Short circuit injector cylinder bank 2
567	523354	12	Injector high current output defect
839	523450	4	Short circuit to ground on Multiple Stage Switch constant speed
827	523470	2	Pressure Relief Valve (PRV) forced to open. Performed by pressure increase.
828	523470	12	Pressure Relief Valve (PRV) forced to open. Shutoff conditions.
830	523470	14	Pressure relief valve (PRV) is open
831	523470	11	Rail pressure out of tolerance range
876	523470	7	Maximum rail pressure exceeded (PRV)
980	523550	12	Starter switch engaged too long.
948	523601	13	Sensor supply voltage 3 error
462	523602	0	High fan speed; warning threshold exceeded
126	523603	9	Timeout Error of CAN-Receive-Frame AMB; Ambient Temperature Sensor
644	523612	3	Reported Over Voltage of Supply
646	523612	4	Reported UnderVoltage of Supply
717	523612	12	Engine ECU reported internal software error
973	523612	14	Software reset engne ECU
861	523613	1	Minimum rail pressure exceeded (Metering Unit)
862	523613	0	Rail pressure metering unit, Maximum rail pressure exceeded.
864	523613	2	Rail pressure metering unit, Setpoint of metering unit in overrun mode is not valid.
592	523615	5	Open load of metering unit
593	523615	12	Temperature too high for power stage of fuel metering unit
596	523615	3	Short circuit to battery Metering Unit
597	523615	4	Short circuit to ground Metering Unit

KWP-Code	SPN	FMI	Description
486	523618	3	Gearbox oil temperature; Short circuit to battery or broken harness
487	523618	4	Gearbox oil temperature; Short circuit to ground
488	523619	2	SCR inlet temperature; signal is invalid.G461
897	523632	16	Pump pressure SCR metering unit too high.
898	523632	18	Pump pressure SCR during metering too low
899	523632	0	Pressure overload at SCR-System
900	523632	1	Error pressure build-up SCR
1117	523632	11	Pump motor not available for actuation
1127	523632	3	DEF supply pump pressure; short circuit to battery.
1128	523632	4	DEF supply pump pressure; short circuit to ground.
883	523633	11	Nox conversion rate insufficient (SCR-catalyst defect, bad DEF quality)
122	523698	11	Shutoff request from supervisory monitoring
167	523704	12	Timeout Error of CAN-Transmit-Frame EEC3
125	523717	12	Timeout Error of CAN-Transmit-Frame AmbCon; Weather environments
1098	523718	5	SCR main relay (primary side); open load
1099	523718	12	SCR main relay (primary side); powerstage over temperature
1100	523718	3	SCR main relay (primary side); short circuit to battery
1101	523718	4	SCR main relay (primary side); short circuit to ground
1087	523719	5	SCR heater relay DEF supply modul secondary side; open load
1106	523719	5	SCR heater relay DEF supplymodule primary side; open load
1108	523719	3	SCR heater DEF supplymodule; short circuit to battery
1109	523719	4	SCR heater DEF supplymodule; short circuit to ground
914	523720	2	DEF supply pump temperature, signal is not valid.
925	523720	8	DEF supply pump heater temperature; abnormal frequency pulse width.
917	523721	2	DEF supply pump temperature sensor, signal is not valid.
927	523721	11	DEF supply pump temperature measurement not available.
930	523721	8	DEF supply module temperature; duty cycle in failure range.
928	523722	8	Urea supply module PWM signal; period outside valid range.
929	523722	8	Detect faulty PWM signal from Supply Modul.
291	523776	9	Timeout Error of CAN-Receive-Frame TSC1TE - active
292	523777	9	Passive Timeout Error of CAN-Receive-Frame TSC1TE; Setpoint
299	523788	12	Timeout Error of CAN-Transmit-Frame TrbCH; Status Wastegate
1300	523788	0	Timeout Error of CAN-Receive-Frame ComTrbChActr; Wastegate
202	523793	9	Timeout Error of CAN-Receive-Frame UAA10; AGS sensor service message
203	523794	9	Timeout Error of CAN-Receive-Frame UAA11; AGS sensor data
212	523803	9	Timeout error of CAN Receive Message RxEngPres; Status Burner Air Pump
313	523858	12	Timeout Error of CAN-Transmit-Frame UAA11 No detail informationen!
559	523895	13	Check of missing injector adjustment value programming (IMA) injector 1 (in firing order).
560	523896	13	check of missing injector adjustment value programming (IMA) injector 2 (in firing order).
561	523897	13	check of missing injector adjustment value programming (IMA) injector 3 (in firing order).
562	523898	13	check of missing injector adjustment value programming (IMA) injector 4 (in firing order).
834	523906	5	Electrical fuel pre - supply pump; open load
835	523906	12	Electrical fuel pre - supply pump. ECU powerstage over temperature.
836	523906	3	Electrical fuel pre - supply pump; short circuit to battery
837	523906	4	Electrical fuel pre - supply pump. Short circuit to ground.
73	523912	4	Intake throttle valve error; disconnected, short circuit to ground or battery, blocked valve, or incorrect control signal.
74	523913	3	Voltage of glow plug control diagnostic line too high
75	523913	4	Voltage of glow plug control diagnostic line too low
76	523914	5	Glow plug control disconnected.
77	523914	12	Glow plug control; powerstage over temperature
78	523914	3	Glow plug control; short circuit to battery.
79	523914	4	Glow plug control; short circuit to ground.

KWP-Code	SPN	FMI	Description
500	523915	0	HCI dosing valve (DV1); overcurrent at the end of the injection phase
501	523915	12	HCI dosing valve (DV1); powerstage over temperature
503	523915	3	Short circuit to battery on a power stage of HCI dosing valve (DV1)
504	523915	4	Short circuit to ground on a power stage of HCI dosing valve (DV1)
505	523915	11	Short circuit in the high side power stage of HCI dosing valve (DV1)
1257	523915	7	HCI dosing valve (DV1); blocked open
506	523916	2	Fuel pressure sensor after HCI dosing valve (DV 1); signal is not valid.
508	523916	0	HCI dosing valve (DV1) pressure value downstream out of target range, too high
511	523916	1	HCI dosing valve (DV1) pressure value downstream out of target range, too low
514	523916	3	Sensor error HCI dosing valve (DV1) downstream pressure; short circuit to battery.
515	523916	4	Sensor error HCI dosing valve (DV1) downstream pressure; short circuit to ground.
524	523917	3	Sensor error DV1 & DV2 upstream pressure; short circuit to battery.
525	523917	4	Sensor error DV1 & DV2 upstream pressure; short circuit to ground.
534	523918	3	Temperature sensor voltage upstream DV1 & DV2 too high
535	523918	4	Temperature sensor voltage upstream DV1 & DV2 too low
37	523924	3	UB2; Short circuit to battery error of actuator relay 2
42	523924	4	UB2; Short circuit to ground actuator relays 2
38	523925	3	UB3; Short circuit to battery error of actuator relay 3.
43	523925	4	UB3; Short circuit to ground actuator relays 3
44	523926	4	UB4; Short circuit to ground aktuator relays 4.
40	523927	3	UB5; Short circuit to battery error of actuator relay 5 (UB6) SCR-Heater/Rev.Valve
168	523935	12	Timeout Error of CAN-Receive-Frame EE3CVOL1; EEC3VOL2
169	523936	12	Timeout Error of CAN-Transmit-Frame EEC3VOL2; Engine send messages
133	523938	9	Timeout Error (BAM to packet) for CAN-Receive-Frame AT1IGCVol1.
134	523939	9	Broadcast Announce Message of the calibration message of the upstream catalytic NOx sensor has failed.
135	523940	9	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT1IGCVol1
140	523941	9	Timeout Error (BAM to packet) for CAN-Receive-Frame AT1OGCVol2.
141	523942	9	Calibration message 1 of the after catalyst NOx sensor has failed.
142	523943	9	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT1OGCVol2.
1158	523946	0	Zerofuel calibration injector 1 (in firing order); maximum value exceeded
1164	523946	1	Zerofuel calibration injector 1 (in firing order); minimum value exceeded
1159	523947	0	Zerofuel calibration injector 2 (in firing order); maximum value exceeded
1165	523947	1	Zerofuel calibration injector 2 (in firing order); minimum value exceeded
1160	523948	0	Zerofuel calibration injector 3 (in firing order); maximum value exceeded
1166	523948	1	Zerofuel calibration injector 3 (in firing order); minimum value exceeded
1161	523949	0	Zerofuel calibration injector 4 (in firing order); maximum value exceeded
1167	523949	1	Zerofuel calibration injector 4 (in firing order); minimum value exceeded
1011	523960	0	Physical range check high for EGR cooler downstream temperature.
1012	523960	1	Physical range check low for EGR cooler downstream temperature.
1458	523960	0	High exhaust gas temperature EGR cooler downstream; warning threshold exceeded
1173	523973	14	SCR Tamper detection; derating timer below limit 1
1174	523974	14	SCR Tamper detection; derating timer below limit 2
1175	523975	14	DEF quality; derating timer below limit 1
1176	523976	14	DEF qulaity; derating timer below limit 2
1177	523977	14	DEF tank level; derating timer below limit 1
1178	523978	14	DEF tank level; derating timer below limit 2
918	523981	11	SCR plausibility, OBD and diagnosis; Stuck in range check of DEF tank temperature sensor DEF-tank without heating function (heating phase)
360	523982	0	Powerstage diagnosis disabled; high battery voltage
361	523982	1	Powerstage diagnosis disabled; low battery voltage
1239	523984	3	UB6; Short circuit to battery error of actuator relay 5
1241	523986	4	Relais SCR-Heater, Short Circuit to Ground (Highside Contro side)
1242	523987	4	UB6; Short circuit to ground actuator relay 5

KWP-Code	SPN	FMI	Description
1324	523995	13	Check of missing injector adjustment value programming (IMA) injector 7 (in firing order)
1325	523996	13	check of missing injector adjustment value programming (IMA) injector 8 (in firing order)
1326	523997	4	Injector cylinder bank 1 slave; short circuit
1327	523998	4	Injector cylinder bank 2 slave; short circuit
1328	523999	12	Injector powerstage output Slave defect
1329	524000	5	Injector 7 (in firing order); interruption of electric connection
1333	524000	3	Injector 7 (in firing order); short circuit
1330	524001	5	Injector 8 (in firing order); interruption of electric connection
1334	524001	3	Injector 8 (in firing order); short circuit
1254	524014	1	Air inlet EPV - pressure too low Air pressure glow plug flush line; below limit
1258	524016	11	Burner Control; HFM - Electrical Fault HFM sensor; electrical fault
1259	524016	2	Burner Control; HFM - Plausibilitätsfehler 1 Amount of air is not plausible to pump speed
1247	524019	11	Burner Control; Air Line - Blocked us pAir Air Pump; air lines blocked
1302	524024	11	Deviation of the exhaust gas temperature setpoint to actual value downstream (DOC) too high
805	524025	14	Particulate filter regeneration. Regeneration after time X is not successful (The error occurs when the regeneration times (3x) over the max. has been aborted allowed recovery time).
1481	524025	5	DPF system; operating voltage error
1882	524025	14	The standstill-regeneration mode time exceeds the long-limit. Vehicle was too long or too often in standstill mode. Make oil change and reset counter.
1883	524025	14	The standstill-regeneration mode time exceeds the short-limit. Vehicle was too long or too often within a short time in standstill mode. Make oil change and reset counter.
1431	524028	2	CAN message PROEGRActr; plausibility error
1432	524029	2	Timeout Error of CAN-Receive-Frame ComEGRActr - exhaust gas recirculation positioner
1440	524030	7	EGR actuator; internal error
1441	524031	13	EGR actuator, calibration error
1442	524032	2	EGR actuator; status message "EGRCust" is missing
1443	524033	7	EGR actuator; due to overload in Save Mode
1436	524034	5	Disc Separator; open load
1437	524034	12	Disc Separator; powerstage over temperature
1438	524034	3	Separador en disco; cortocircuito en la masa
1439	524034	4	Disc separator; short circuit to ground
1342	524036	12	Injector diagnostics Slave; time out error in the SPI communication
1285	524038	9	Timeout error of CAN-Receive-Frame ComMS_Sys1TO (error memory Slave); Master-Slave internal CAN message
1286	524039	9	Timeout error of CAN-Receive-Frame ComMS_Sys2TO (error memory Slave); Master-Slave internal CAN message
1287	524040	9	Timeout error of CAN-Receive-Frame ComMS_Sys3TO (error memory Slave); Master-Slave internal CAN message
1288	524041	9	Timeout error of CAN-Receive-Frame ComMS_Sys4TO (error memory Slave); Master-Slave internal CAN message
1289	524042	9	Timeout error of CAN-Receive-Frame ComMS_Sys5TO (error memory Slave); Master-Slave internal CAN message
1290	524043	9	Timeout error of CAN-Receive-Frame ComMS_Sys6TO (error memory Slave); Master-Slave internal CAN message
1482	524044	9	CAN message ComMS_Sys7 not received from slave

KWP-Code	SPN	FMI	Description
1291	524045	9	Master Slave, Error of message counter CAN receive message ComMSMoFOvR; ComMSMoFOvR1CNT
1292	524046	9	Master-Slave CAN; Error Checksum of CAN-Receive Message
1293	524047	9	Master-Slave CAN; Error of message length of CAN receive message ComMSMoFOvR;_ComMSMoFOvR1DLC
1294	524048	9	Timeout error CAN message ComMSMoFOvR1TO error memory Slave
1434	524050	11	CAN; not used
1435	524051	11	CAN; not used
1485	524052	11	Master ECU and Slave ECU data sets or software are not identical
1505	524057	2	Fuel low pressure pump; error pressure build up
1555	524063	5	DEF return line heater; disconnected.
1558	524063	3	SCR heater mainrelay; short circuit to battery
1559	524063	4	SCR heater main relay load side (K31) on heating valve (Y31), Short cut to ground.
1647	524063	12	DEF tank, thawing time too long.
1565	524065	0	Pressure sensor upstream SCR-CAT, pressure above upper physical threshold
1566	524065	1	Pressure sensor upstream SCR-CAT, pressure below lower physical threshold
1569	524065	3	Pressure sensor upstream SCR-CAT; short circuit battery or open load
1570	524065	4	Pressure sensor upstream SCR-CAT; short circuit ground
1598	524065	2	Pressure sensor upstream SCR-CAT, plausibility error
1581	524067	0	DEF supply module, heater temperature above upper physical threshold
1582	524067	1	DEF supply module, heater temperature below lower physical threshold
1867	524067	2	Supply module heater temperature, plausibility error
1484	524068	2	Master ECU and Slave ECU have been identified as the same types
1345	524069	9	Timeout Error of CAN-Receive-Frame MSMon_FidFCCTO; Master-Slave CAN communication faulty
1529	524070	2	(Upstream NOx-Sensor) Diagnostic Fault Check for invalid upstream NOx value (Sensor self diagnostic DFC set by Deutz-SW) NOx-Sensor before SCR-Cat: Invalid upstream NOx value
1530	524071	2	(Downstream NOx-Sensor) Diagnostic Fault Check for invalid downstream lambda value (Sensor self diagnostic DFC set by Deutz-SW)
1531	524072	2	(Upstream NOx-Sensor) Diagnostic Fault Check for invalid upstream lambda value (Sensor self diagnostic DFC set by Deutz-SW)
1532	524073	2	(Downstream NOx-Sensor) Diagnostic Fault Check for invalid downstream NOx value (Sensor self diagnostic DFC set by Deutz-SW)
1533	524074	9	NOx sensor downstream SCR-CAT, sensor internally open load
1860	524074	2	NOx-Sensor after SCR-Cat: Nox-Sensor dew point problem or plausibility problem
1534	524075	11	NOx sensor downstream SCR-CAT, sensor internally short circuit
1535	524076	9	NOx sensor upstream SCR-CAT, sensor internally open line
1861	524076	2	NOx-Sensor before SCR-Cat: Nox-Sensor dew point problem or plausibility problem
1536	524077	11	NOx sensor upstream SCR-CAT, sensor internally short circuit
1537	524078	9	NOx sensor downstream SCR-CAT, lambda value above upper physical threshold
1538	524079	9	NOx sensor downstream SCR-CAT, lambda value below lower physical threshold
1539	524080	9	NOx sensor upstream SCR-CAT, lambda value above upper physical threshold
1540	524081	9	NOx sensor upstream SCR-CAT, lambda value below lower physical threshold
1541	524082	9	(Downstream NOx-Sensor) Diagnostic Fault Check for downstream NOx value over maximum limit (DFC set by Deutz-SW)
1542	524083	9	NOx-Sensor downstream SCR-CAT, NOx value below minimum value.
1543	524084	9	NOx-Sensor upstream SCR-CAT, NOx value above maximum value.
1544	524085	9	NOx sensor upstream SCR-CAT, NOx value below lower physical threshold
1619	524087	5	DEF Error Lamp; open load
1620	524087	12	DEF Error Lamp; temperatur over limit
1621	524087	3	DEF Error Lamp; short circuit battery
1622	524087	4	DEF Error Lamp; short circuit ground

KWP-Code	SPN	FMI	Description
1658	524096	14	Control of the SCR system; If the start stop counter (EPA-Counter) exceeds the threshold SCRctl_ctEngStrtStopThresh_C. This counter will increment only once in each driving cycle in case of an SCR error. If the counter reaches the threshold, the DFC will be set to inhibit the engine start Engine will not be started, because of EPA-Counter
1663	524097	9	Timeout error of CAN-Transmit-Frame DPFBrnAirPmpCtl
1664	524098	9	Timeout error of CAN-Transmit-Frame ComDPFBrnPT
1665	524099	9	Timeout error of CAN-Transmit-Frame ComDPFC1
1666	524100	9	Timeout error of CAN-Transmit-Frame ComDPFHisDat.
1667	524101	9	Timeout error of CAN-Transmit-Frame ComDPFTstMon
1674	524102	9	Timeout error of CAN-Receive-Frame ComRxDPFBrnAirPmpCtl
1675	524103	9	Timeout error of CAN-Receive-Frame ComRxDPFBrnAirPmp
1676	524104	9	Timeout error of CAN-Receive-Frame ComRxDPFctl.
1668	524105	9	Timeout error of CAN-Transmit-Frame ComEGRMsFlw
1677	524106	9	Timeout error of CAN-Receive-Frame ComRxEGRMsFlw1
1678	524107	9	Timeout error of CAN-Receive-Frame ComRxEGRMsFlw2
1669	524108	9	Timeout error of CAN-Transmit-Frame ComEGRTVActr.
1679	524109	9	Timeout error of CAN-Receive-Frame ComRxEGRTVActr
1670	524110	9	Timeout der CAN-Sendebotschaft ComETVActr
1680	524111	9	Timeout error of CAN-Receive-Frame ComRxETVActr
1671	524112	9	Timeout ComIntake Throttle Valve Actr.
1681	524113	9	Timeout error of CAN-Receive-Frame ComRxITVActr
1659	524114	9	Timeout error of CAN-Transmit-Frame A1DOC
1660	524115	9	Timeout error of CAN-Transmit-Frame AT1S
1661	524116	9	Timeout error of CAN-Transmit-Frame SCR2
1662	524117	9	Timeout error of CAN-Transmit-Frame SCR3
1672	524118	9	Timeout error of CAN-Receive-Frame ComRxCM1
1673	524119	9	Timeout error of CAN-Receive-Frame ComRxCustSCR3
1682	524120	9	Timeout error of CAN-Receive-Frame ComRxSCRHtDiag
1683	524121	9	Timeout error of CAN-Receive-Frame ComRxTrbChActr
1684	524122	9	Timeout error of CAN-Receive-Frame ComRxUQSens
1685	524123	9	Timeout error of CAN-Receive-Frame ComSCRHtCtl
1686	524124	9	Timeout error of CAN-Receive-Frame ComTxAT1IMG
1687	524125	9	Timeout error of CAN-Receive-Frame ComTxTrbChActr
1630	524132	2	Fuel low pressure upstream fuel low pressure pump not plausible
1632	524132	0	Fuel low pressure upstream fuel low pressure pump, pressure above maximum shut off threshold
1633	524132	1	Fuel low pressure upstream fuel low pressure pump, pressure below minimum shut off threshold
1698	524133	2	HMI system; set if restore button blocked
1699	524134	0	DPF, ash load exceeds the shutoff threshold
1701	524135	0	DPF, soot load exceeds the shutoff threshold
1702	524135	14	DPF, soot load exceeds the service request threshold
1827	524141	7	DEF dosing valve, dosing valve blocked
1639	524147	13	SCR System,pressure build up not possible
1858	524147	7	SCR-System, reverting valve blocked
1597	524149	2	Pressure downstream turbine, plausibility error
1874	524152	2	DEF Quality Sensor; Timeout CAN message
1875	524153	2	DEF tank level & DEF tank temperature via CAN bus, timeout of CAN message
1705	524156	9	Timeout error of CAN-Receive-Frame ComRxEBC2.
1859	524175	0	SCR-CAT, Nox emissions above maximum threshold
1863	524177	7	SCR System, DEF suction line blocked
1864	524178	7	SCR System, DEF pressure out of range
1889	524189	9	Master / Slave Can disturbed.
1891	524190	14	Inducement level 1 activ
1892	524191	14	Inducement level 2 activ

KWP-Code	SPN	FMI	Description
1893	524193	8	The standstill-regeneration mode time exceeds the long limit threshold. Vehicle was too long or too often in standstill mode.
1894	524194	8	The standstill-regeneration mode time exceeds the short-limit. Vehicle was too long or too often within a short time in standstill mode.
1900	524195	14	Standstill request due to crystallisation ignored too long
1901	524196	13	Variant handling, address error
1902	524196	2	Variant handling, Synchronisation error
1906	524197	7	DEF backflow line is blocked
1939	524198	11	Inducement HW Failure Master
1940	524199	11	Inducement SCR Tamp Master
1941	524200	11	Inducement DEF QTY Master
1942	524201	11	DEF Level Error Master
1943	524202	11	DEF Temp. Error Master
1944	524203	11	DEF Level Replace Master
1945	524204	11	SCR System Afterrun Master
1946	524205	11	Switch Off SCR System Master
1947	524206	11	Disable SCR Dosing Master
1948	524207	11	INH EAT Regeneration Master
1949	524208	11	Power Reduction 1 Master
1950	524209	11	Power Reduction 2 Master
1951	524210	11	DEF CONC Replace Master
1952	524211	11	DEF Quality Error Master
1953	524212	11	DEF Sensor Diag. Off Master
1954	524213	11	DEF Sens Temp. Replace Master
1971	524230	11	Inducement HW Failure Slave
1972	524231	11	Inducement SCR Tamp. Slave
1973	524232	11	Inducement DEF QTY Slave
1974	524233	11	DEF Level Error Slave
1975	524234	11	DEF Temp. Error Slave
1976	524235	11	DEF Level Replace Slave
1977	524236	11	SCR System Afterrun Slave
1978	524237	11	Switch Off SCR System Slave
1979	524238	11	Disable SCR Dosing Slave
1980	524239	11	INH EAT Regeneration Slave
1981	524240	11	Power Reduction 1 Slave
1982	524241	11	Power Reduction 2 Slave
1983	524242	11	DEF CONC Replace Slave
1984	524243	11	DEF Quality Error Slave
1985	524244	11	DEF Sensor Diag. Off Slave
1986	524245	11	DEF Sens Temp. Replace Slave