

JT100 Mach 1/All Terrain

Operator's Manual



Overview



Chapter Contents

Serial Number Location 2

Intended Use 3

Equipment Modification 3

Unit Components 4

Operator Orientation 4

About This Manual 4

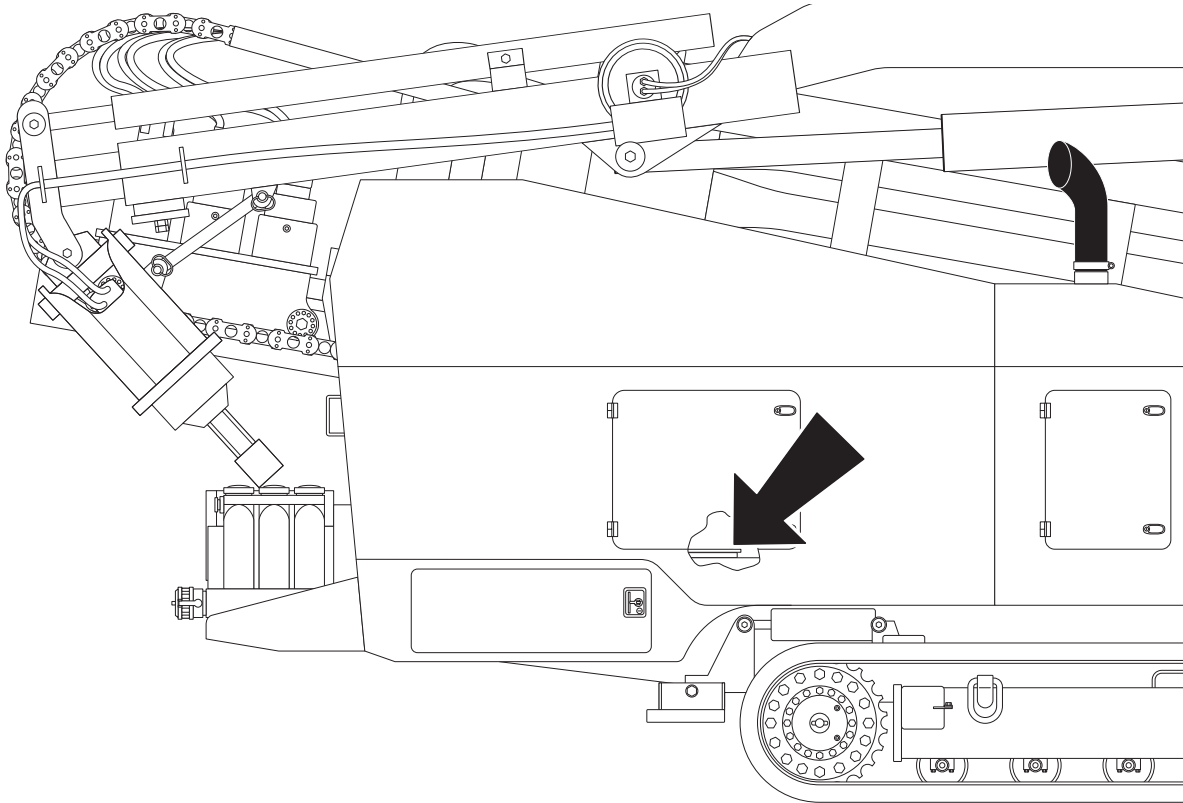
• Bulleted Lists5

• Numbered Lists5

• “Continued” Indicators5

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	
crane serial number	
engine serial number	

Intended Use



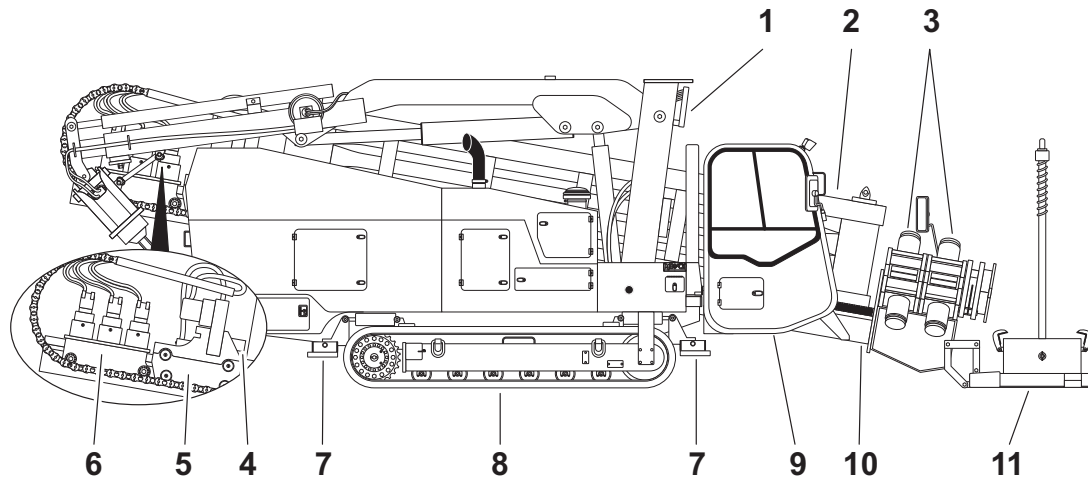
The JT100 Mach 1/All Terrain is a self-contained horizontal directional drilling unit capable of drilling and backreaming through solid rock, cobblestone, broken rock, gravel, and other soil/rock mixes, as well as less extreme soil conditions. It is designed to install buried cable and pipe at distances to 2,000' (610 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 unit can be used with Ditch Witch drilling fluid units and Ditch Witch tracking 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

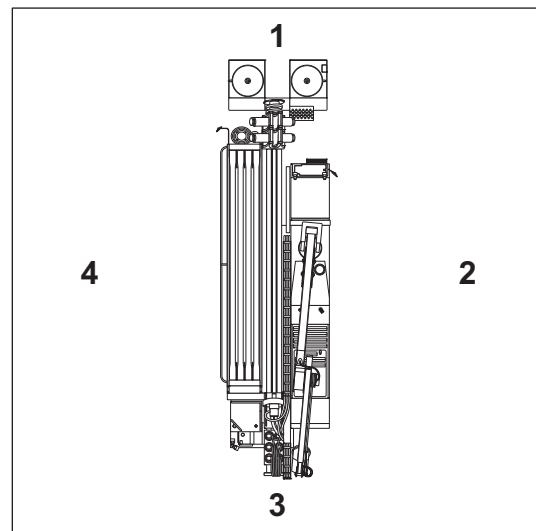


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- | | |
|--------------------------------|---------------------------------|
| 1. Crane attachment (optional) | 7. Front and rear stabilizers |
| 2. Pipel loader (optional) | 8. Tracks |
| 3. Front and rear wrenches | 9. Operator's station |
| 4. Spindle | 10. Drill frame |
| 5. Rotation carriage | 11. Anchoring system (optional) |
| 6. Thrust carriage | |

Operator Orientation

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



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About This Manual



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

Bulleted Lists

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

Numbered Lists

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

"Continued" Indicators



indicates that a procedure is continued on the next page.

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.

JT100 Mach 1/All Terrain Operator's Manual

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Part number 053-1348

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This product is covered by one or more of the following patents:

U.S. B1 4,858,704; 4,953,638; 5,148,880; 5,242,026; 5,341,887; 5,490,569; 5,684,466; 5,713,423; 5,794,719; 5,880,680; 5,941,322; 6,085,852; 6,109,371; 6,179,065; 6,216,803; 6,250,403; 6,250,404; 6,290,606; 6,311,790; 6,411,094; 6,543,551; 6,550,547; 6,672,409; 6,739,413; 6,761,231; 6,776,246; 6,808,210; 6,827,158; 6,848,506; 6,871,712; RE37,450; RE37,923; RE37,975; RE38,418; **AU** 689,533; 706,544; 718,034; 755,862; **CA** 2,156,398; 2,217,899; **DE** 694 17 019; 695 29 634; 297 01 406; **EP** 0683845; 0674093; 0817901; 0846841; 0927892; **FR** 674,093; **GB** 2,309,239; 2,312,006; EP674,093; EP846,841; **JP** 3,458,247; other U.S. and foreign patents pending.

Contents



	Overview machine serial number, information about the type of work this machine is designed to perform, basic machine components, and how to use this manual	1
	Foreword part number, revision level, and publication date of this manual, and factory contact information	7
	Safety machine safety alerts and emergency procedures	11
	Controls machine controls, gauges, and indicators and how to use them	25
	Operation Overview an overview for completing a job with this machine: planning, setting up, installing product, and restoring the jobsite; with cross references to detailed procedures	77
	Prepare procedures for inspecting and classifying the jobsite, planning the installation path, and preparing the jobsite for work	81
	Drive procedures for startup, cold start, driving, and shutdown	105
	Transport procedures for lifting, hauling, and towing	107
	Conduct a Bore procedures for drilling and backreaming	115
	Systems and Equipment downhole tools and drill pipe, anchor, electric strike, tracker control, and fluid systems	137
	Complete the Job procedures for backfilling and restoring the jobsite and rinsing and storing equipment	185
	Service service intervals and instructions for this machine including lubrication, replacement of wear items, and basic maintenance	189

**Specifications**

machine specifications including weights, measurements, power ratings, and fluid capacities

233**Support**

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

239**Service Record**

a record of major service performed on the machine

243

Safety

Chapter Contents



Guidelines 12

Safety Alert Classifications 13

Safety Alerts 14

Emergency Procedures 17

- Electric Strike Description17
- If an Electric Line is Damaged18
- If a Gas Line is Damaged19
- If a Fiber Optic Cable is Damaged19
- If Machine Catches on Fire19

Crane Precautions 20

- Preparation20
- Transportation20
- Jobsite Setup20
- Operation21
- Maintenance23

Guidelines

Follow these guidelines before operating any jobsite equipment:

- Complete proper training and read operator's manual before using equipment.
- Contact your local One-Call (811 in USA) or the One-Call referral number (888-258-0808 in USA and Canada) to have underground utilities located before digging. Also contact any utilities that do not participate in the One-Call service.
- 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.
- Replace missing or damaged safety shields and safety signs.
- Use equipment carefully. Stop operation and investigate anything that does not look or feel right.
- Do not operate unit where flammable gas is present.
- Contact your Ditch Witch dealer if you have any question about operation, maintenance, or equipment use.

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.



indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



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



indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

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

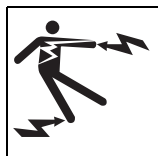
NOTICE can keep you from doing something that might damage the machine or someone's property. It can also alert you against unsafe practices.

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

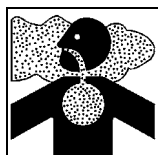
Safety Alerts


⚠ DANGER

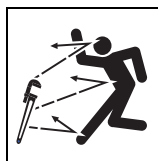
Turning shaft will kill you or crush arm or leg. Stay away.


⚠ DANGER

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


⚠ DANGER

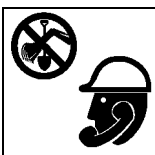
Deadly gases. Lack of oxygen or presence of gas will cause sickness or death. Provide ventilation.


⚠ DANGER

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


⚠ DANGER

Riding on boom, load, or load line will result in death or serious injury. Keep off.


⚠ WARNING

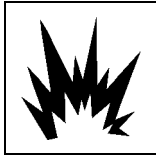
Jobsite hazards could cause death or serious injury. Use correct equipment and work methods. Use and maintain proper safety equipment.


⚠ WARNING

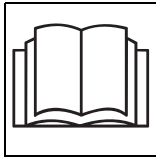
Crushing weight could cause death or serious injury. Use proper procedures and equipment or stay away.


⚠ WARNING

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



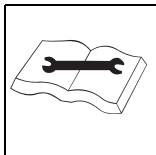
⚠ WARNING Explosion possible. Serious injury or equipment damage could occur. Follow directions carefully.



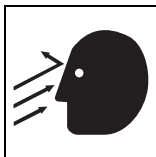
⚠ WARNING Incorrect procedures could result in death, injury, or property damage. Learn to use equipment correctly.



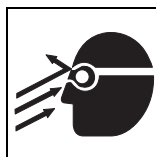
⚠ WARNING Rollover possible. If machine rolls over, you could be thrown from seat and killed or crushed. Wear seat belt.



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



⚠ WARNING Looking into fiber optic cable could result in permanent vision damage. Do not look into ends of fiber optic or unidentified cable.



⚠ WARNING Fluid or air pressure could pierce skin and cause injury or death. Stay away.



⚠ WARNING Runaway possible. Machine could run over you or others. Learn how to use all controls. Start and operate only from operator's position.



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



**⚠ WARNING**

Moving traffic - hazardous situation. Death or serious injury could result. Avoid moving vehicles, wear high visibility clothing, post appropriate warning signs.

**⚠ WARNING**

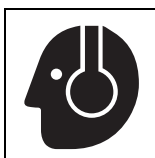
Hot pressurized cooling system fluid could cause serious burns. Allow to cool before servicing.

**⚠ CAUTION**

Flying objects may cause injury. Wear hard hat and safety glasses.

**⚠ CAUTION**

Hot parts may cause burns. Do not touch until cool.

**⚠ CAUTION**

Exposure to high noise levels may cause hearing loss. Wear hearing protection.

**⚠ CAUTION**

Fall possible. Slips or trips may result in injury. Keep area clean.

**⚠ CAUTION**

Battery acid may cause burns. Avoid contact.

**⚠ CAUTION**

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

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).

EMERGENCY CAB EXIT - Push out back window to exit cab if door cannot be opened.

Electric Strike Description



⚠ DANGER

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

When working near electric cables, remember the following:

- Electricity follows all paths to ground, not just path of least resistance.
- Pipes, hoses, and cables will conduct electricity back to all equipment.
- Low voltage current can injure or kill. Almost one-third of 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 ground mats**, DO NOT MOVE. Remain on drilling machine or mats 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 status 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 ground mats**, 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.



⚠ 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 order 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.

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) 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.

Crane Precautions

Preparation

Visually inspect crane each day to determine that it is in good condition before it is used. Check the following:

- Make sure crane is free of excess oil, grease, mud and debris before operation.
- Test crane at the beginning of each shift to determine that the operating systems are in good working order.
- Check safety devices to ensure they are functioning and in place.
- Check crane boom, hoses and connecting pins for wear and damage.

Transportation

- Always store auxiliary stabilizer before moving unit.
- Always store crane properly for transportation.
- Never drive with load suspended from crane.

Jobsite Setup

- Always use unit stabilizers during crane operation. Ensure that they are firmly positioned on solid footings.
- Always install auxiliary stabilizer for crane operation on **engine side** of unit.
- If auxiliary stabilizer rests on curb or other object that prevents it from supporting load, consider blocking under the arm of the auxiliary stabilizer as near the outer end as possible to support load.
- If auxiliary stabilizer does not rest on ground due to holes or grades, it must be blocked up to provide level and firm support for the unit.
- When working in soft soil conditions, use wide pad under auxiliary stabilizer foot to prevent sinking.
- Ensure loads are securely attached before lifting.



Operation

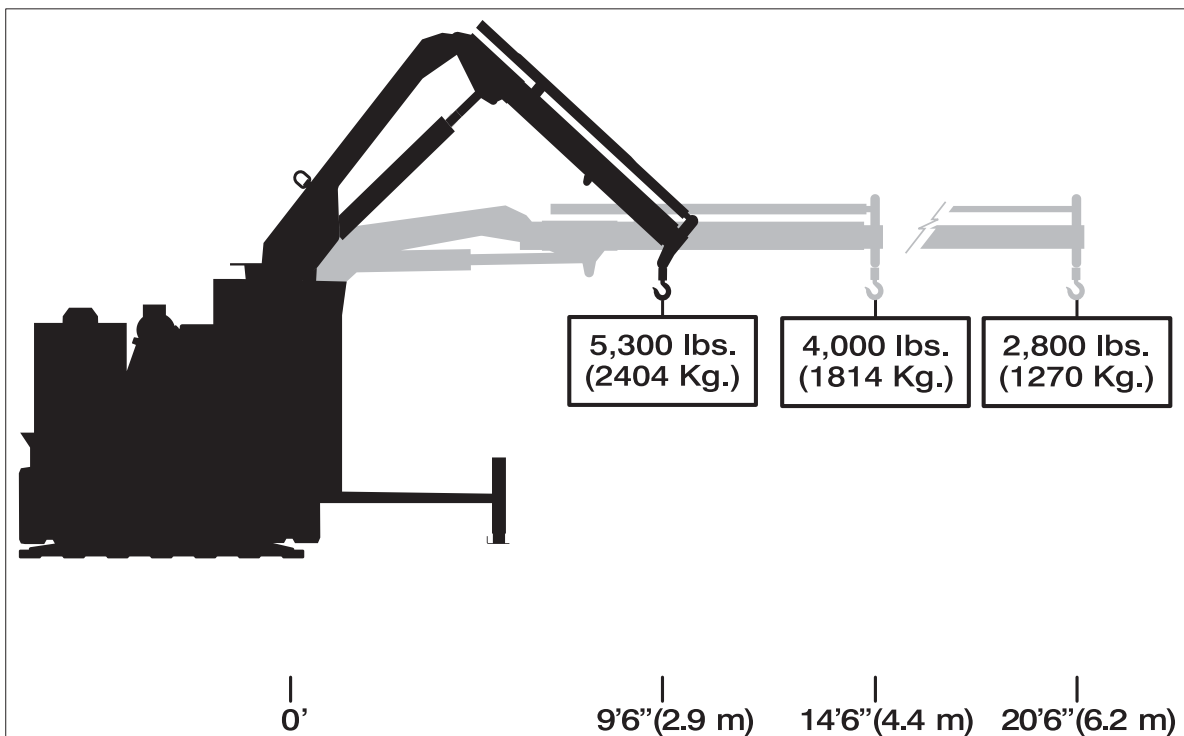
General



DANGER Riding on boom, hook, load or load line will result in death or serious injury. Keep off.



- Never place chain link on tip of hook to lift load.
- Close hook throat before lifting load.
- Never use a sling bar or anything larger than the hook throat that could prevent hook latch from closing. This prevents damage to material being hoisted and helps prevent injury to personnel.
- No unqualified or unauthorized person shall be allowed to operate the crane.
- Always comply with load chart capacities. Weight of heavy load can create enough tipping momentum to overturn drilling unit.



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- Observe operating area obstructions or power lines that might be a hazard.
- Keep objects and personnel clear of crane path during operation.
- Do not take your eyes off a moving load. Always look in the direction load is moving.

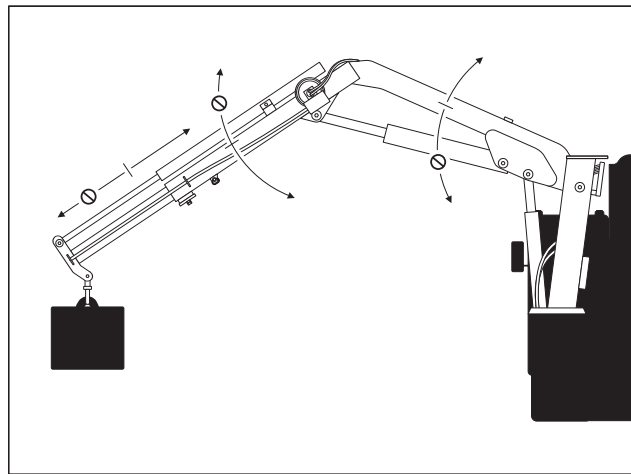


- Never swing a load over people.
- Consider overall height of unit when moving under objects with low overhead clearance.
- Operate controls smoothly and do not stop load sharply in midair so that it swings.
- Fluid pressure from broken hydraulic line could pierce skin and cause injury or death. Stay away.
- Keep crane boom length as short as possible for maximum lifting capacity and safety. Longer booms require additional care in accelerating and decelerating the swing motion and thus slow down the working cycle and reduce production.
- Never use crane for towing or pulling a load sideways. Keep load directly under boom point at all times. Boom can fail far below its rated capacity if the crane is side loaded.
- Always walk around unit and check for obstructions before moving load.
- Do not lift personnel with crane. There is no implied warranty or responsibility for such purposes.
- Know weight of rigging and load to avoid overloading crane. Deduct the weight of the load-handling equipment from the load rating to determine how much weight can be lifted.
- Heavy loads can create enough tipping movement to overturn vehicle. Always install auxiliary stabilizer when lifting on the **engine side** of unit.
- Except for anchoring drilling unit, do not apply down force with boom extensions, lift, or outer boom function.

Crane Overload

If crane becomes overloaded, crane components will not move in some directions (see illustration) until overload condition is overcome.

- Bring load closer to unit to overcome crane overload.
- Confirm load before continuing.



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Near Electrical Power Lines

Never operate the crane within 10' (3 m) of electric power lines carrying up to 50 kV. Add 1' (305 mm) of clearance for each additional 30 kV or less (see table on left). Also observe minimum clearance requirements during transport (see table on right).

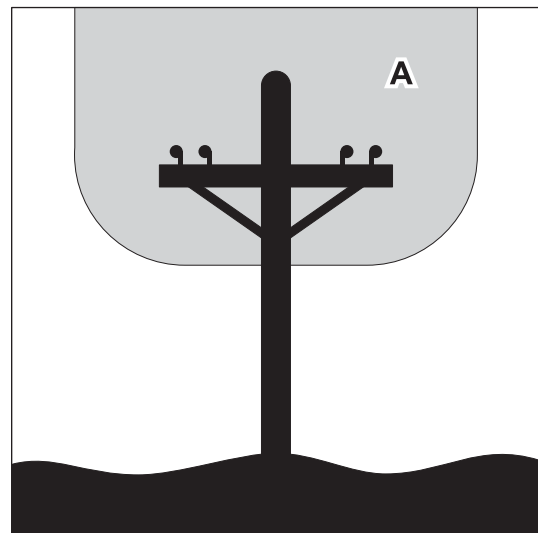
Normal voltage (phase to phase)	Minimum operating clearance required	
up to 50 kV	10'	3 m
51-200 kV	15'	4.6 m
201-350 kV	20'	6 m
351-500 kV	25'	7.6 m
501-750 kV	35'	10.7 m
751-1000 kV	45'	13.7 m

Normal voltage (phase to phase)	Minimum transporting clearance required	
up to 0.75 kV	4'	1.2 m
0.76-200 kV	6'	1.8 m
50-345 kV	10'	3.8 m
346-750 kV	16'	4.9 m
751-1000 kV	20'	6.1 m



Do not enter the danger zone (A), unless one of the following conditions is met:

- An appointed person has confirmed that the electrical distribution and transmission lines have been de-energized and visibly grounded at the point of work.
- Insulating barriers (not a part of the attachment or crane) have been erected to prevent physical contact with the lines.



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Maintenance

- Before working on the crane, lower boom to the ground, turn crane controls off and relieve hydraulic pressure from circuits.
- Never weld, modify, or use unauthorized components on crane attachment. This will void any warranty or liability, and crane failure could result.
- Check hook before each use for distortions or cracks.
- Stop all operations when cleaning, adjusting or lubricating the machine.
- Install all guards before returning crane to service.

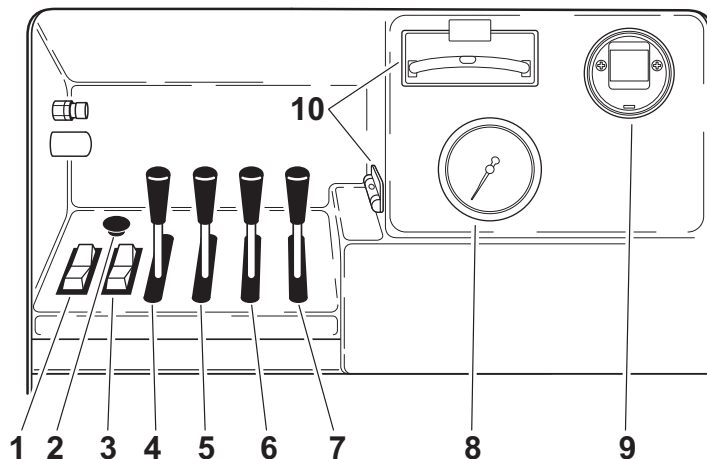
Controls

Chapter Contents

Set-Up Console	26
Tethered Crane Controller	30
Overhead Console	33
Left Control Console	39
• Pipeloading Controls	39
• Drilling Controls	42
• Operation Controls	47
Right Control Console	51
• Gauges and Indicators	51
• Lights	53
• Controls	56
Fluid Pump	59
JT/AT System	61
Seat	62
Override Box	63
Miscellaneous Controls	65
Battery	67
ESID	68
750/752 Display	71
• Indicators	71
• Controls	74



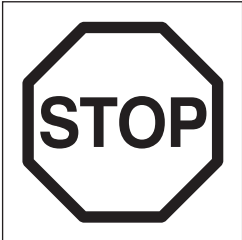
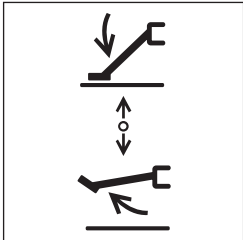
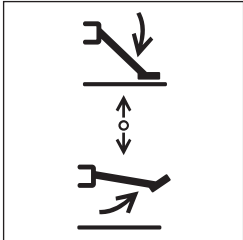
Setup Console



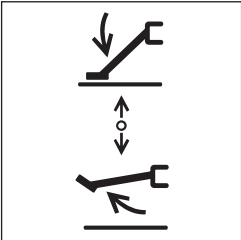
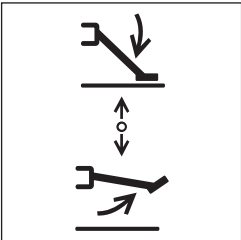
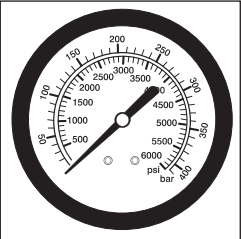
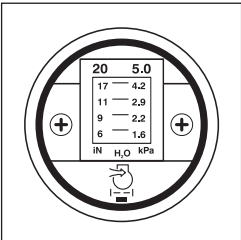
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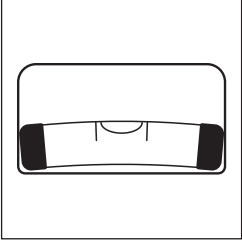
- | | |
|----------------------------------|---------------------------------------|
| 1. Engine throttle switch | 6. Left front stabilizer control |
| 2. Remote engine stop switch | 7. Right front stabilizer control |
| 3. Auxiliary light switch | 8. Auxiliary hydraulic pressure gauge |
| 4. Left rear stabilizer control | 9. Air filter service indicator |
| 5. Right rear stabilizer control | 10. Levels |

Item	Description	Notes
1. Engine throttle switch c00ic049t.eps	To increase engine speed, press  To decrease engine speed, press 	IMPORTANT: Throttle switch at operator's station must be in center position for this switch to control speed.

Item	Description	Notes
2. Remote engine stop switch  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, be sure to turn ignition switch off if machine will be left unattended for long periods of time. Battery discharge can occur. - If wrenches are engaged when remote stop is pressed, wrenches will remain engaged but could gradually open.
3. Auxiliary light switch  c00ic050t.eps	To turn on, press To turn off, press 	
4. Left rear stabilizer control  c00ic287h.eps	To lower, push. To raise, pull.	Lower both rear stabilizers to the ground together and then adjust individually.
5. Right rear stabilizer control  c00ic288h.eps	To lower, push. To raise, pull.	Lower both rear stabilizers to the ground together and then adjust individually.

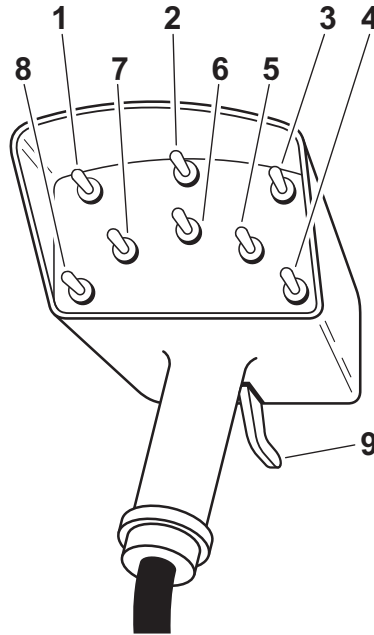


Item	Description	Notes
6. Left front stabilizer control  c00ic287h.eps	To lower, push. To raise, pull.	Lower both front stabilizers to the ground together and then adjust individually.
7. Right front stabilizer control  c00ic288h.eps	To lower, push. To raise, pull.	Lower both front stabilizers to the ground together and then adjust individually.
8. Auxiliary hydraulic pressure gauge  c00ic049h.eps	Displays hydraulic fluid pressure to any hydraulic function in use, including front and rear stabilizers, optional pipeloader, stationary and rotating wrenches, and optional crane attachment.	
9. Air filter service indicator  c00ic289h.eps	Displays level of vacuum in air filter. Change filter when yellow indicator mark reaches the red line at 20 in H ₂ O (5.0 kPa). Reset after replacing filter.	

Item	Description	Notes
10. Levels  c00ic290h.eps	Indicates that drilling unit is level if bubble rests between the lines as shown. Use stabilizer controls to set machine as level as possible, both front to back and side to side.	NOTICE: Failure to stabilize drilling unit in a level position may hinder crane swing capabilities.



Tethered Crane Control

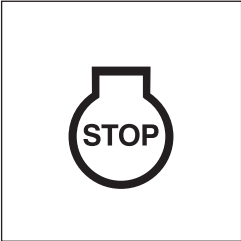
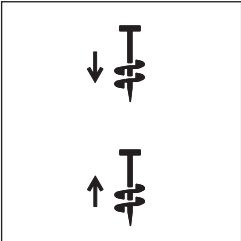
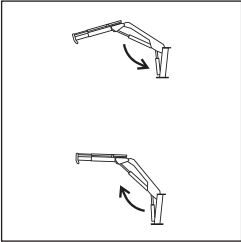


j28om013t.eps

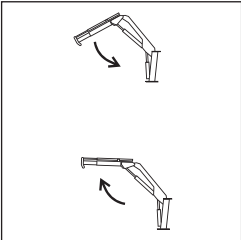
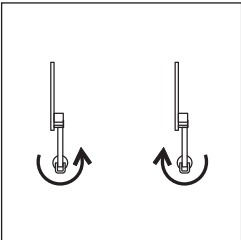
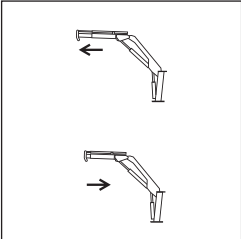
- | | |
|---------------------------------|-----------------------------------|
| 1. Power switch | 6. Crane arm swing control switch |
| 2. Remote engine stop switch | 7. Outer boom control switch |
| 3. Auxiliary control switch | 8. Inner boom control switch |
| 4. Anchor driver control switch | 9. Speed control |
| 5. Extension control switch | |

IMPORTANT:

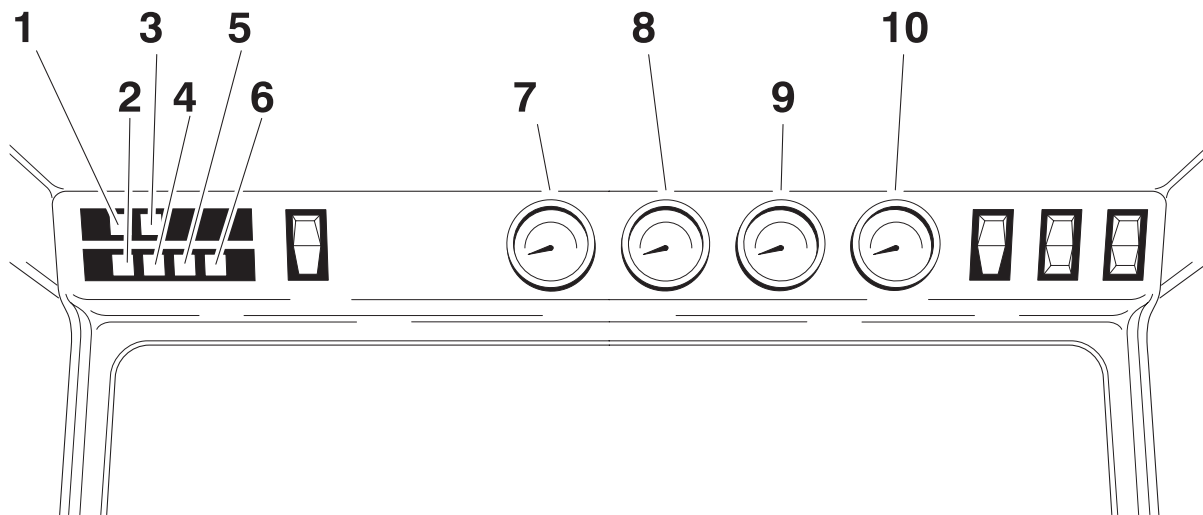
- Tethered crane controller will not work if operator is in drilling unit seat and crane enable switch is not enabled.
- Before operating crane, release stow strap on crane boom.

Item	Description	Notes
1. Power switch  c00ic315h.eps	To turn on power to crane, push to left. To turn off power to crane, push to right.	
2. Remote engine stop switch  c00ic314h.eps	To stop engine, push to right.	
3. Auxiliary control switch	Not used.	This switch is reserved for future auxiliary functions.
4. Anchor driver control switch  c00ic313h.eps	To drive anchor (rotate clockwise), push up and press speed control. To remove anchor (rotate counterclockwise), push down and press speed control. To stop, release switch or speed control.	
5. Inner boom control switch  c00ic309h.eps	To lower, push up and press speed control. To raise, push down and press speed control. To stop, release switch or speed control.	



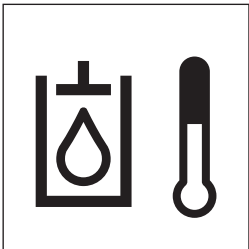
Item	Description	Notes
6. Outer boom control switch  c00ic310h.eps	To lower, push up and press speed control. To raise, push down and press speed control. To stop, release switch or speed control.	
7. Crane arm swing control switch  c00ic311h.eps	To swing counterclockwise, push to left and press speed control. To swing clockwise, push to right and press speed control. To stop, release switch or speed control.	IMPORTANT: Crane will not swing more than 360°.
8. Extension control switch  c00ic312h.eps	To extend, push up and press speed control. To retract, push down and press speed control. To stop, release switch or speed control.	
9. Speed control	To start any crane function, pull gently. To increase speed, pull closer to handle. To stop, release.	

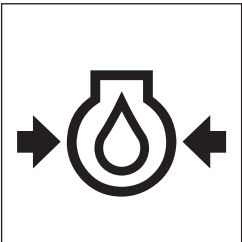
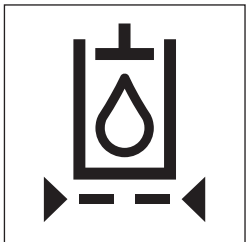
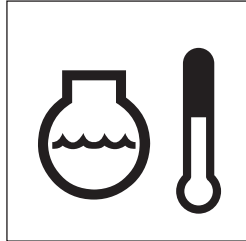
Overhead Console

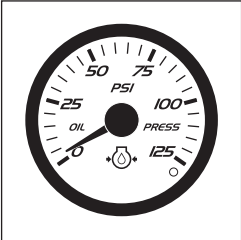
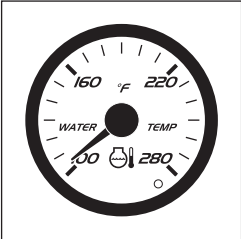
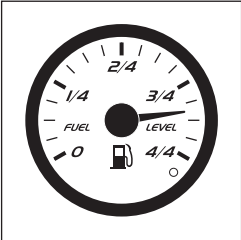


j17om104h.eps

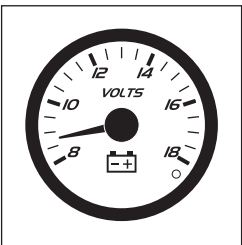
- | | |
|---|-------------------------------------|
| 1. Hydraulic oil temperature indicator | 6. Engine diagnostic indicator |
| 2. Engine oil pressure indicator | 7. Engine oil pressure gauge |
| 3. Hydraulic oil pressure indicator | 8. Engine coolant temperature gauge |
| 4. Engine coolant temperature indicator | 9. Fuel gauge |
| 5. Engine preheat indicator | 10. Voltmeter |

Item	Description	Notes
1. Hydraulic fluid temperature indicator  c00ic023h.eps	Indicates hydraulic fluid is overheating. Alarm also sounds.	Check hydraulic fluid level.

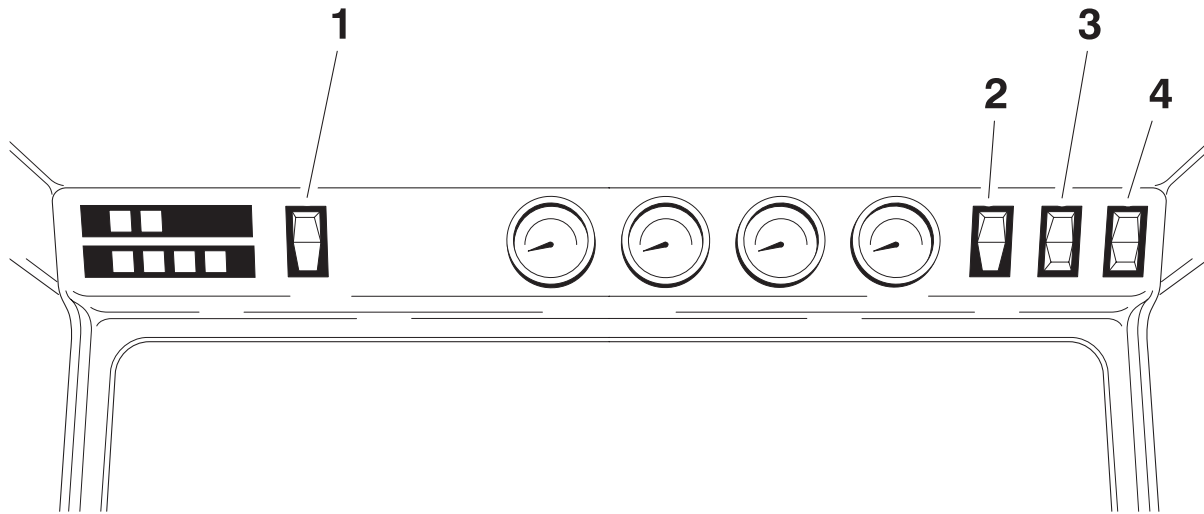
Item	Description	Notes
2. Engine oil pressure indicator  c00ic119h.eps	Indicates engine oil pressure is too low. Alarm also sounds and engine shuts down.	Check oil level.
3. Hydraulic fluid filter service indicator  c00ic024h.eps	Indicates hydraulic fluid filter needs replacing. Alarm also sounds.	Change filter when indicator lights continuously and as indicated in Service (see page 189).
4. Engine coolant temperature indicator  c00ic120h.eps	Indicates engine coolant temperature is too high. Alarm also sounds.	Stop engine and let cool. Check coolant level.
5. Engine preheat indicator  c00ic180h.eps	Lights when air intake pre-heater is operating.	NOTICE: If indicator is on after key is turned to on position, wait until it goes out before starting engine.

Item	Description	Notes
6. Engine diagnostic indicator  c00ic381h.eps	Indicates a measured value is outside of limits or a short has occurred.	Check diagnostic gauge for additional information. Solid light usually indicates a less severe fault. Blinking light is usually more severe.
7. Engine oil pressure gauge  c00ic374h.eps	Displays engine oil pressure.	Full load reading should be 35-65 psi (2.4-4.5 bar). At idle, reading should not drop below 15 psi (1 bar).
8. Engine coolant temperature gauge  c00ic376h.eps	Displays engine coolant temperature.	Normal coolant temperature is 190°-220° F (88°-105° C). IMPORTANT: Do not operate machine when coolant temperature exceeds 240° F (116° C).
9. Fuel gauge  c00ic375h.eps	Displays fuel level in tank.	Use only #2 diesel fuel. In temperatures below 40° F (4° C), use #1 diesel fuel. Tank holds 97 gal (367 L).



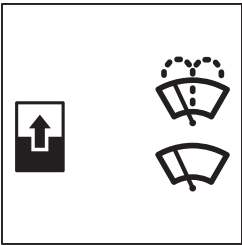
Item	Description	Notes
10. Voltmeter  c00ic373h.eps	Displays system voltage.	Should show 13 to 14 volts with engine running.

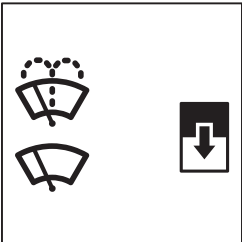
Overhead Console



j17om105h.eps

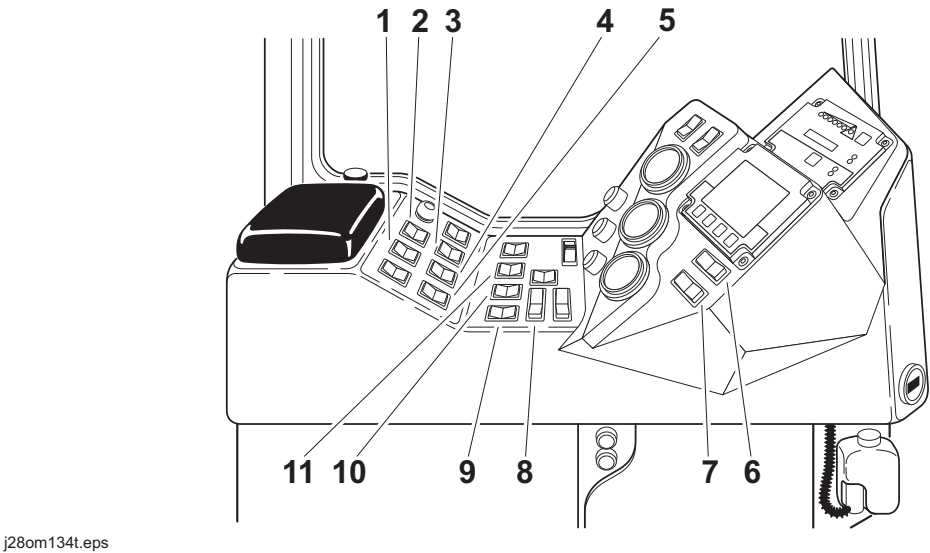
- | | |
|----------------------------------|----------------------------------|
| 1. Light switch | 3. Lower windshield wiper switch |
| 2. Upper windshield wiper switch | 4. Cab pivot control switch |

Item	Description	Notes
1. Light switch  c00ic050t.eps	To turn on, press  To turn off, press 	
2. Upper windshield wiper switch  c00ic051t.eps	To spray wiper fluid on windshield, press  To start wiper blade, move to center. To stop wiper blade, press 	

Item	Description	Notes
3. Lower windshield wiper switch  c00ic052t.eps	To spray wiper fluid on windshield, press  To start wiper blade, move to center. To stop wiper blade, press 	
4. Cab pivot control switch	To move cab into drilling position, disengage cab pivot lock and press  To move cab into driving position, press 	See "Cab pivot lock" on page 47 for more information.

Left Control Console

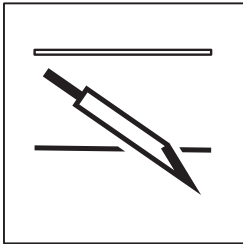
Pipelading Controls



j28om134t.eps

- | | |
|---------------------------------------|---------------------------------|
| 1. Shuttle stop switch | 7. Back frame tilt switch |
| 2. Add pipe/manual/remove pipe switch | 8. Pipe lubricator switch |
| 3. Pipe lift switch | 9. Front wrench clamp switch |
| 4. Pipe gripper switch | 10. Rear wrench clamp switch |
| 5. Pipe shuttle switch | 11. Rear wrench rotation switch |
| 6. Front frame tilt switch | |

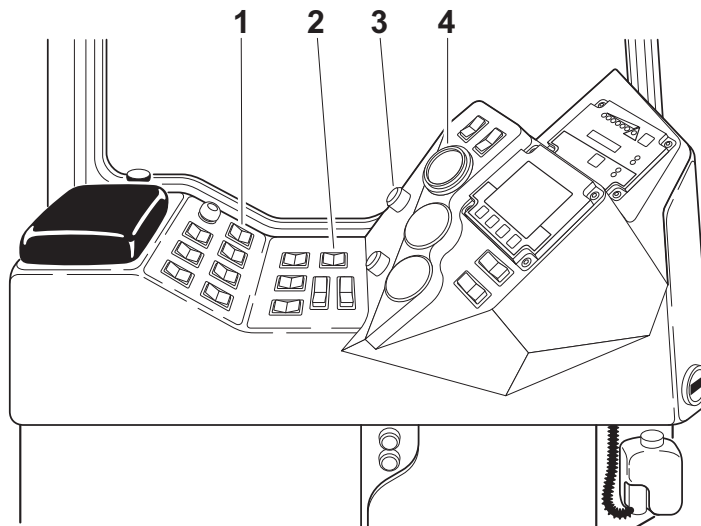
Item	Description	Notes
1. Shuttle stop switch	To lower shuttle stop, press 	IMPORTANT: Look at pipe row indicator on drill frame to see which row shuttles will stop under.
	To raise shuttle stop, press 	IMPORTANT: Shuttles will not function unless shuttle guard is in operating position.

Item	Description	Notes	
2. Add pipe/manual/ remove pipe switch 	To select “add pipe” automated pipeloader function, press green part of switch. To use manual pipeloader controls, move to center. To select “remove pipe” automated pipeloader function, press white part of switch.	See “Add Pipe” on page 126. See “Remove Pipe” on page 133.	
3. Pipe lift switch	To lower, press To raise, press	 	
4. Pipe gripper switch	To close, press To open, press	 	
5. Pipe shuttle switch	To move toward pipe box, press To move toward spindle, press	 	IMPORTANT: Shuttles will not function unless shuttle guard is in operating position.
6. Front frame tilt switch	To lower front of drill frame, press To raise front of drill frame, press	 	
7. Back frame tilt switch	To lower rear of drill frame, press To raise rear of drill frame, press	 	
8. Pipe lubricator switch	To spray joint compound on threads at saver sub and wrenches, press		
9. Front wrench clamp switch	To unclamp, press To clamp, press	 	

Item	Description	Notes
10. Rear wrench clamp switch	To unclamp, press 	
	To clamp, press 	
11. Rear wrench rotation switch	To rotate counterclockwise, press 	
	To rotate clockwise, press 	
	To stop rotation, release.	

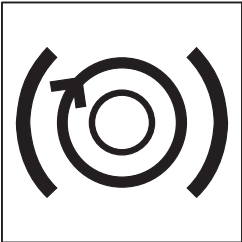
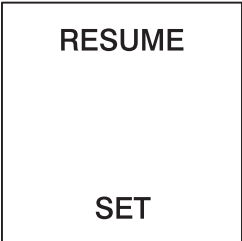


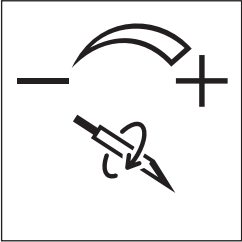
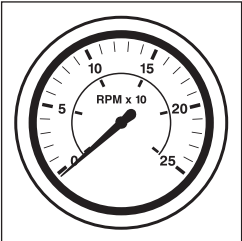
JT Drilling Controls



j28om005t.eps

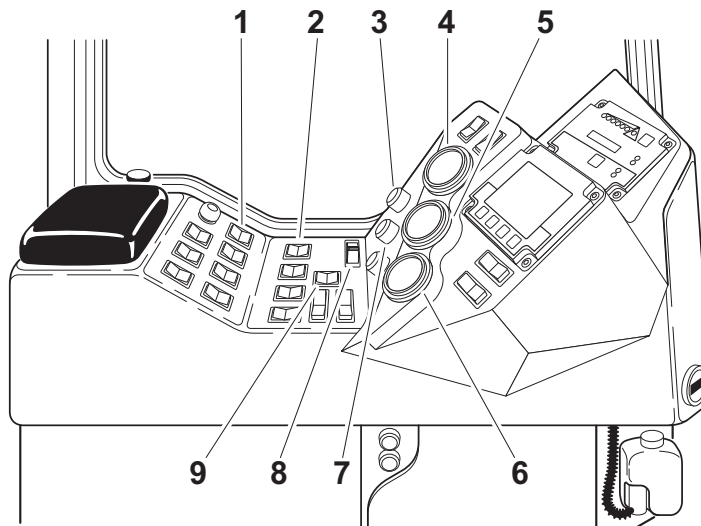
- | | |
|-------------------------|---------------------------|
| 1. Spindle brake switch | 3. Rotation speed control |
| 2. Set/resume switch | 4. Rotation tachometer |

Item	Description	Notes
1. Spindle brake switch  c00ic053t.eps	To engage, press  To disengage, press	IMPORTANT: Use when making directional change.
2. Set/resume switch  c00ic054t.eps	To resume operation or increase operation levels, press green part of switch. To set operating conditions or reduce operation levels, press white part of switch.	See "Cruise Control" on page 174.

Item	Description	Notes
3. Rotation speed control  c00ic297h.eps	To increase, turn clockwise. To decrease, turn counterclockwise.	
4. Rotation tachometer  c00ic305h.eps	Displays spindle speed.	

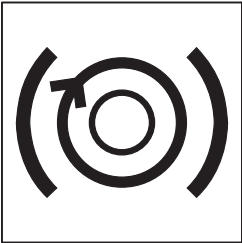


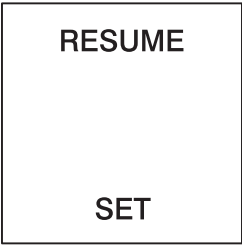
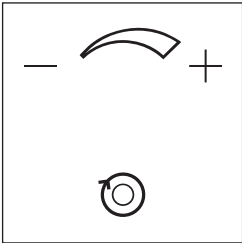
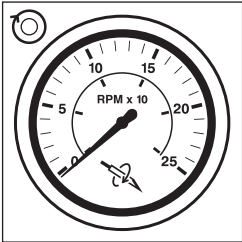
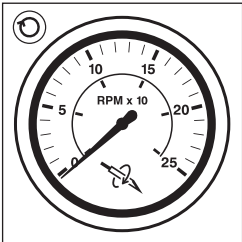
AT Drilling Controls



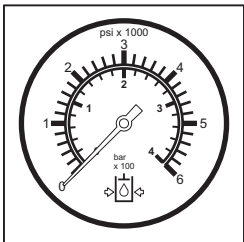
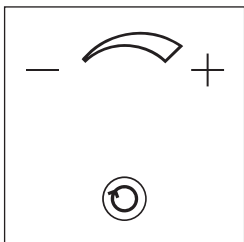
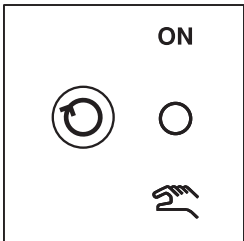
j28om135t.eps

- | | |
|---------------------------------|----------------------------------|
| 1. Outer spindle brake switch | 6. Inner rotation pressure gauge |
| 2. Set/resume switch | 7. Inner rotation speed control |
| 3. Outer rotation speed control | 8. Manual inner rotation switch |
| 4. Outer spindle tachometer | 9. Inner spindle switch |
| 5. Inner spindle tachometer | |

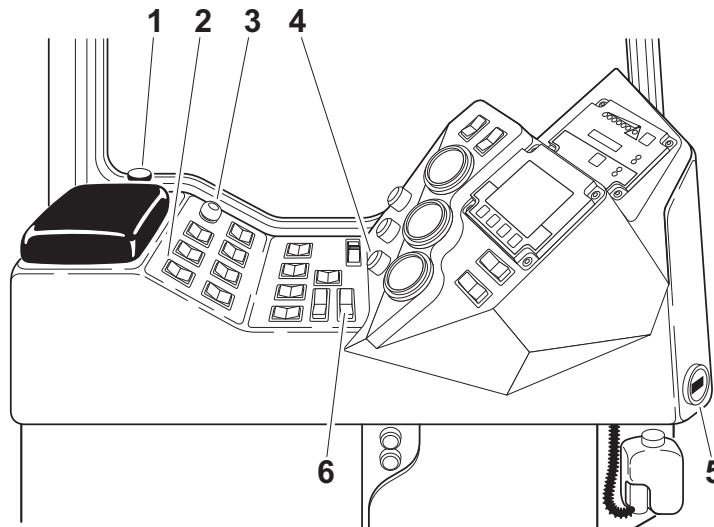
Item	Description	Notes
1. Outer spindle brake switch  c00ic053t.eps	To engage, press To disengage, press	IMPORTANT: Use when making directional change. - Prevents outer spindle from turning when inner spindle or mud motor is in use. - Is temporarily released when front wrench is closed to allow pipe change.

Item	Description	Notes
2. Set/resume switch  c00ic054t.eps	To resume operation or increase operation levels, press green part of switch. To set operating conditions or reduce operation levels, press white part of switch.	See "Cruise Control" on page 174.
3. Outer rotation speed control  c00ic041h.eps	To increase, turn clockwise. To decrease, turn counterclockwise.	
4. Outer spindle tachometer  c00ic092h.eps	Displays outer spindle speed.	
5. Inner spindle tachometer  c00ic091h.eps	Displays inner spindle speed.	



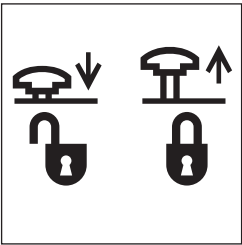
Item	Description	Notes
6. Inner spindle rotation pressure gauge  c00ic088t.eps	Displays inner spindle rotation pressure.	
7. Inner rotation speed control  c00ic040h.eps	To increase, turn clockwise. To decrease, turn counterclockwise.	
8. Manual inner rotation switch	To rotate counterclockwise, move  To rotate clockwise, move switch to right. 	IMPORTANT: Inner spindle switch must be in manual position.
9. Inner spindle switch  c00ic087t.eps	To turn on, press top. To turn off, move to center. To manually dither, press bottom and toggle manual inner rotation switch left and right.	IMPORTANT: To restart inner rotation after operator has left seat, turn inner rotation off and then on.

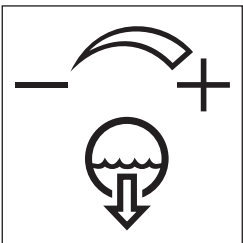
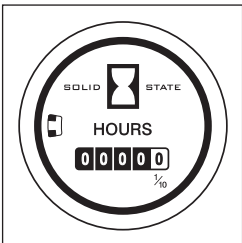
Operation Controls



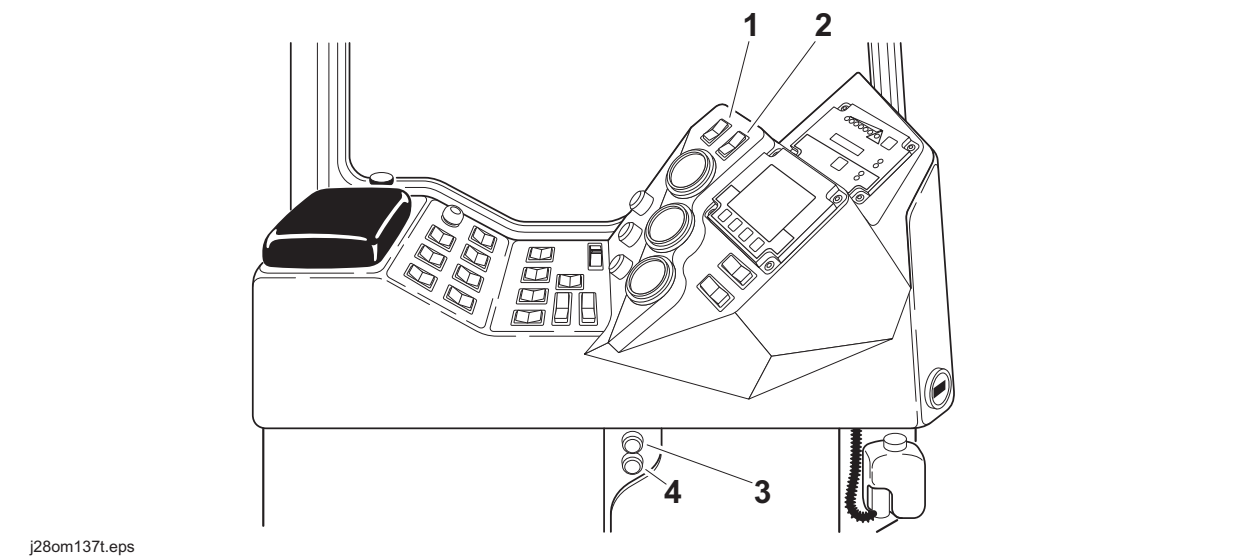
j28om136t.eps

- | | |
|---------------------------|-------------------------|
| 1. Cab pivot lock | 4. Fluid flow control |
| 2. Engine throttle switch | 5. Hourmeter |
| 3. Horn | 6. Drill/drive selector |

Item	Description	Notes
1. Cab pivot lock  c00ic298h.eps	To move cab into drilling position, press down and pivot cab into position. Lock automatically engages when cab moves into drive position.	See "Cab pivot control switch" on page 38 for more information.
2. Engine throttle switch	To increase engine speed, press  To decrease engine speed, press  To further increase or decrease speed, press additional times.	

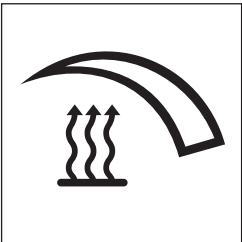
Item	Description	Notes
3. Horn  c00ic044h.eps	To sound horn, press.	
4. Fluid flow control  c00ic045h.eps	To increase flow, turn clockwise. To decrease flow, turn counterclockwise.	
5. Hourmeter  c00ic019h.eps	Displays engine operating time.	Use this time to schedule service.
6. Drill/drive selector  c00ic055t.eps	To drill, press  To set parking brake, move to center. To drive, press 	

Climate Controls



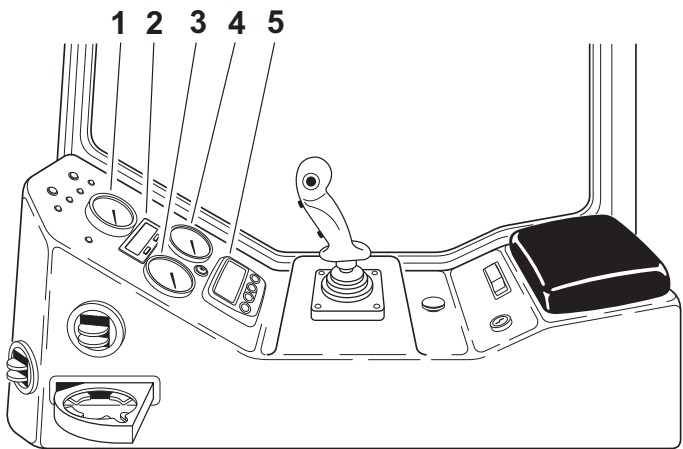
1. Climate fan speed selector
2. Climate control control selector
3. Heater temperature control
4. Air conditioner temperature control

Item	Description	Notes
1. Climate control fan speed selector	To select high fan speed, press  To select medium speed, move to center. To select low speed, press 	
2. Climate control selector	To start heater, press  To turn climate control off, move to center. To start air conditioning, press 	

Item	Description	Notes
3. Heater temperature control  c00ic301h.eps	To make air warmer, turn clockwise. To make air cooler, turn counterclockwise.	
4. Air conditioner temperature control  c00ic302h.eps	To make air cooler, turn clockwise. To make air warmer, turn counterclockwise.	

Right Control Console

Gauges and Indicators



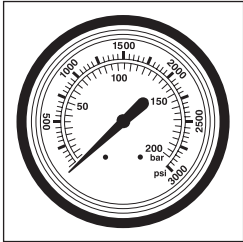
j28om008t.eps

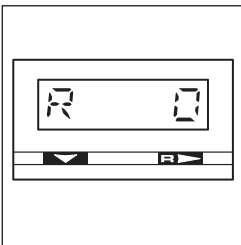
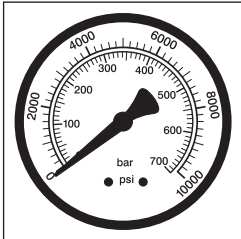
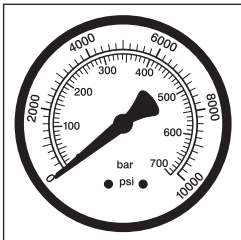
1. Drilling fluid pressure gauge

2. Drilling fluid flowmeter

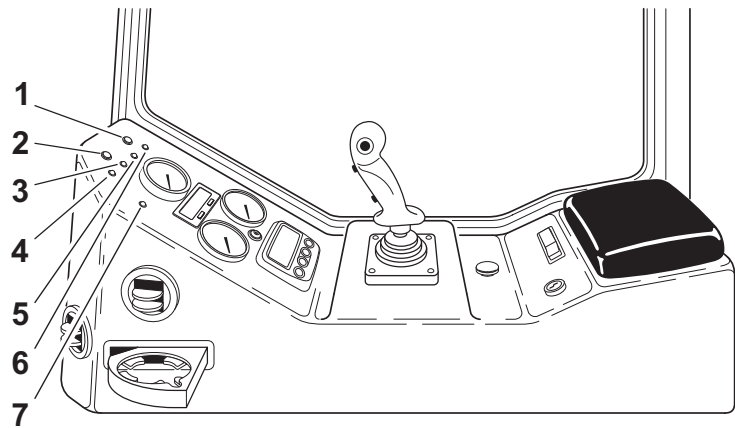
3. Thrust pressure gauge
4. Rotation pressure gauge

5. Diagnostic gauge/engine tachometer

Item	Description	Notes
1. Drilling fluid pressure gauge  c00ic303h.eps	Displays discharge pressure of drilling fluid pump.	IMPORTANT: Monitor this gauge and drilling fluid flowmeter carefully to see if values are rising or falling at the same time. If they are not, nozzle might be plugged.

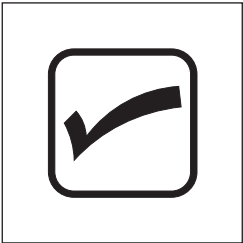
Item	Description	Notes
2. Drilling fluid flowmeter  c00ic050h.eps	Displays approximate rate of drilling fluid flow and records amount of drilling fluid used. To reboot, press and hold both buttons. To reset total, press and hold right button. To toggle between rate and total, press left button.	IMPORTANT: Monitor the flowmeter and drilling fluid pressure gauge carefully to see if values are rising or falling at the same time. If they are not, nozzle might be plugged.
3. Thrust pressure gauge  c00ic304h.eps	Displays hydraulic fluid pressure to thrust motor during thrust and pullback.	
4. Rotation pressure gauge  c00ic304h.eps	Displays hydraulic fluid pressure to rotation motor when spindle is turning.	
5. Diagnostic gauge/engine tachometer	Displays engine speed, engine data and diagnostic codes.	See "Diagnostic Gauge" on page 181 and "Engine Diagnostic Codes" on page 180 for more information.

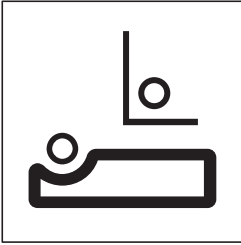
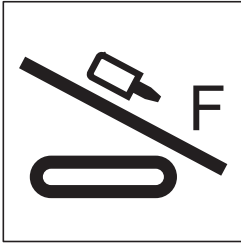
Lights

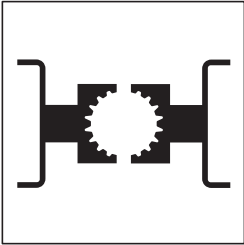
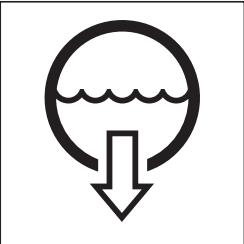


j28om009t.eps

- | | |
|--------------------------------|-------------------------------------|
| 1. Control cycle light (green) | 5. Front home status light |
| 2. Diagnostic light (red) | 6. Front wrench status light |
| 3. Shuttle home status light | 7. Drilling fluid pump status light |
| 4. Rear home status light | |

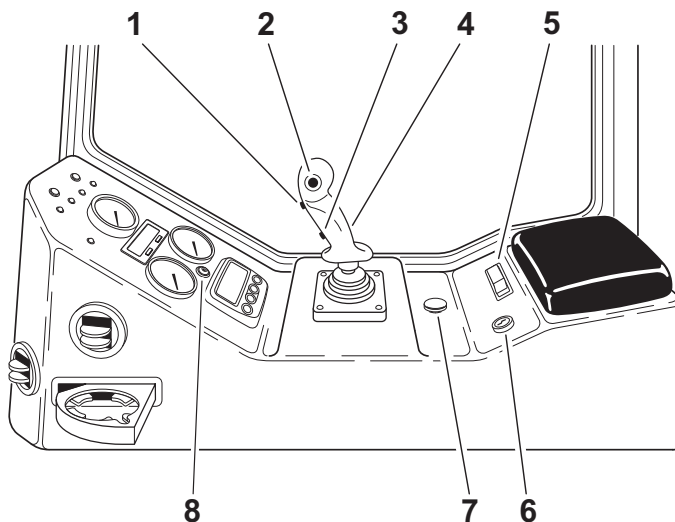
Item	Description	Notes
1. Control cycle light (green)  c00ic056h.eps	If nothing is being controlled, light is off. If system is waiting for an action before starting cycle, light flashes on and off. If something is being controlled, light is on. If control cycle is interrupted, light flashes twice quickly.	See "Diagnostic Codes" on page 175.

Item	Description	Notes
2. Diagnostic light (red)  c00ic051h.eps	If system is OK, light is off. If controller is not getting power, light is on. If a non-essential diagnostic code is recorded, light flashes on and off for 10 seconds. If an essential diagnostic code is recorded, light continually flashes on for three seconds and off for half a second.	See "Diagnostic Codes" on page 175.
3. Shuttle home status light  c00ic044t.eps	If shuttle is retracted, light is on. If shuttle is extended, light is off.	IMPORTANT: This light indicates the shuttle is under the pipe box and out of the path of the carriage. It does not mean the shuttle is under the correct pipe row.
4. Rear home status light  c00ic043t.eps	If carriage is at rear of drill frame, light is on. If carriage is away from rear of drill frame, light is off.	
5. Front home status light  c00ic045t.eps	If carriage is at front of drill frame, light is on. If carriage is away from front of drill frame, light is off.	

Item	Description	Notes
6. Front wrench status light  c00ic046t.eps	If front wrench is closed and pressured up, light is on. If front wrench is open or pressure has dropped, light is off.	
7. Drilling fluid pump status light  c00ic047t.eps	If pump is on, light is on. If pump is off, light is off.	



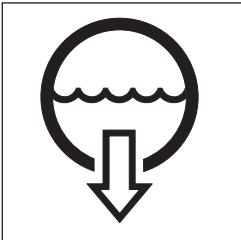
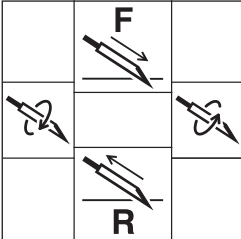
Controls



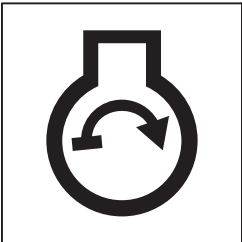
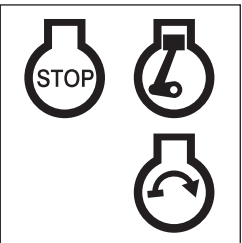
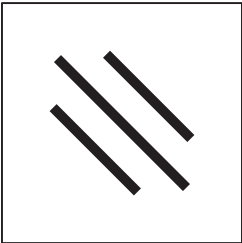
j28om010t.eps

- | | |
|-------------------------------------|------------------------------|
| 1. Dual speed carriage control | 5. Shutdown override switch |
| 2. Drilling fluid quick fill switch | 6. Ignition switch |
| 3. Drilling fluid pump switch | 7. Remote engine stop switch |
| 4. Track and carriage control | 8. Reset switch |

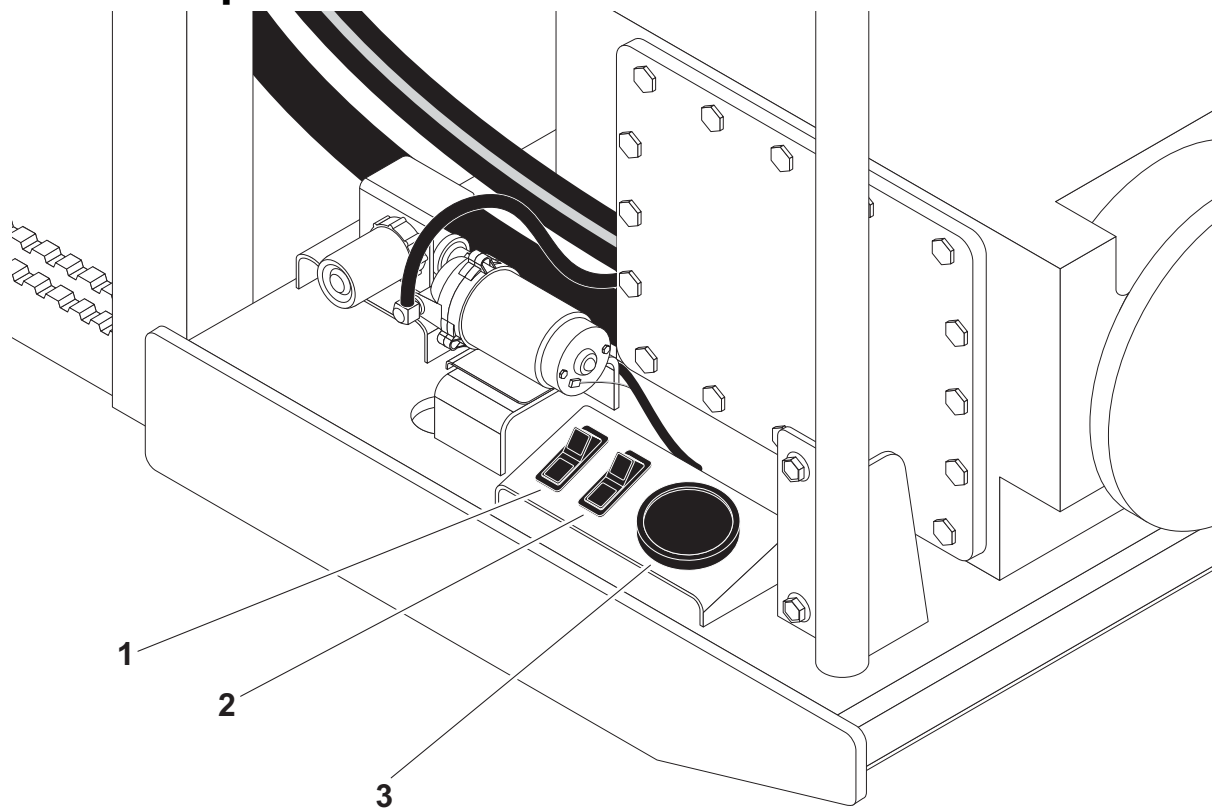
Item	Description	Notes
1. Dual speed carriage control  c00ic058h.eps	To increase carriage travel speed, push and hold. To return to normal carriage speed, release.	Use during bore or pullback when no pipe is in spindle to save time. IMPORTANT: Drill/drive selector must be in drill position.

Item	Description	Notes
2. Drilling fluid quick fill switch  c00ic059h.eps	For full pump flow to fill pipe with fluid, press and hold. To return fluid flow to flow control setting, release.	
3. Drilling fluid pump switch  c00ic060h.eps	To turn on, press once. To turn off, press once.	IMPORTANT: To adjust flow, see "Fluid flow control" on page 48.
4. Track and carriage control  c00ic061h.eps	Track control: - To move forward, push. - To move backward, pull. - To steer, move right or left while moving. Carriage control: - To move carriage forward, push. - To move carriage backward, pull. - To rotate spindle counterclockwise (breakout), move right. - To rotate spindle clockwise (makeup), move left.	IMPORTANT: - Drill/drive selector must be in drive position. See "Steer Unit" on page 106 for more information. - Cab must be in drive position. IMPORTANT: - Drill/drive selector must be in drill position. See "Operate Carriage Control" on page 119 for more information. - Cab can be in either position. - Shuttle guard must be lowered.



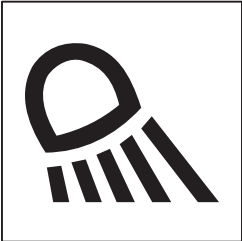
Item	Description	Notes
5. Shutdown override switch  c00ic056t.eps	Temporarily override engine shutdown, press and hold	
6. Ignition switch  c00ic065h.eps	To start engine, insert key and turn clockwise. To stop engine, turn key counterclockwise.	IMPORTANT: Restart engine with ignition switch after it has been turned off with remote engine stop switch.
7. Remote engine stop switch  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, be sure to turn ignition switch off if machine will be left unattended for long periods of time. Battery discharge can occur.
8. Reset switch  c00ic057t.eps	Press to clear active engine diagnostic codes.	

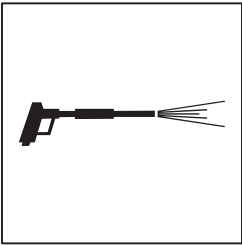
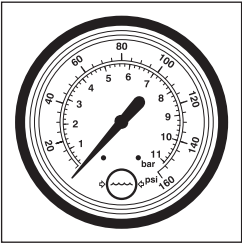
Fluid Pump



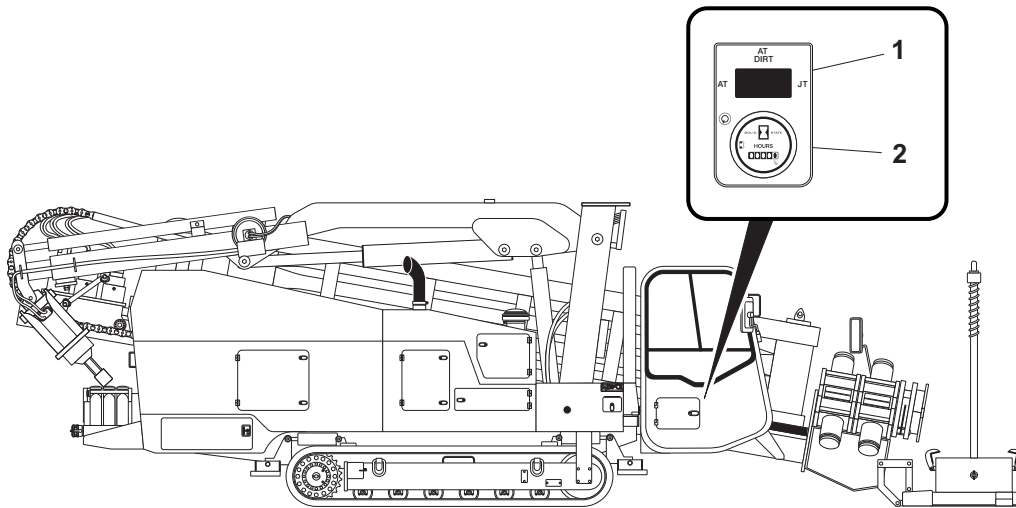
i17om089t.eps

1. Light switch
3. Fluid pressure gauge
2. Wash wand switch

Item	Description	Notes
1. Light switch  c00ic050t.eps	To turn on, press  To turn off, press 	Controls light at fluid pump work station.

Item	Description	Notes
2. Wash wand switch  c00ic058t.eps	To spray, press To turn off, press 	
3. Fluid pressure gauge  c00ic308h.eps	Displays drilling fluid pressure supplied to the pump.	

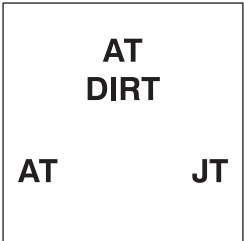
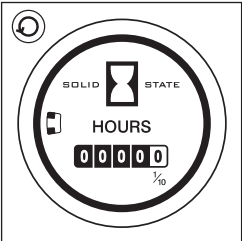
JT/AT System



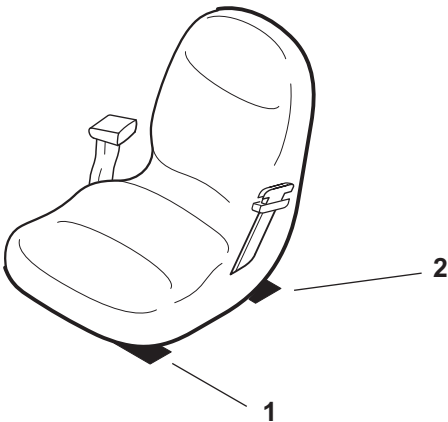
j28om138t.eps

1. Mode selector switch

2. Inner rotation hourmeter

Item	Description	Notes
1. Mode selector switch  c00ic094h.eps	To select AT mode, press left. To select AT DIRT mode, move to center. To select JT mode, press right.	Use AT or AT DIRT drilling mode when using AT pipe with inner shaft. Use JT drilling mode when using JT pipe without inner shaft. IMPORTANT: See "Prepare Drilling Unit" on page 102 for how to set up unit for each drilling mode.
2. Inner rotation hourmeter  c00ic090h.eps	Displays inner rotation operating time.	Use these times to schedule service for downhole tool and inner shaft. See "Service" on page 189.

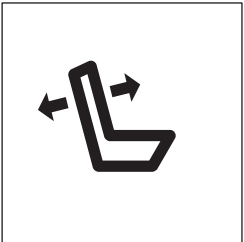
Seat



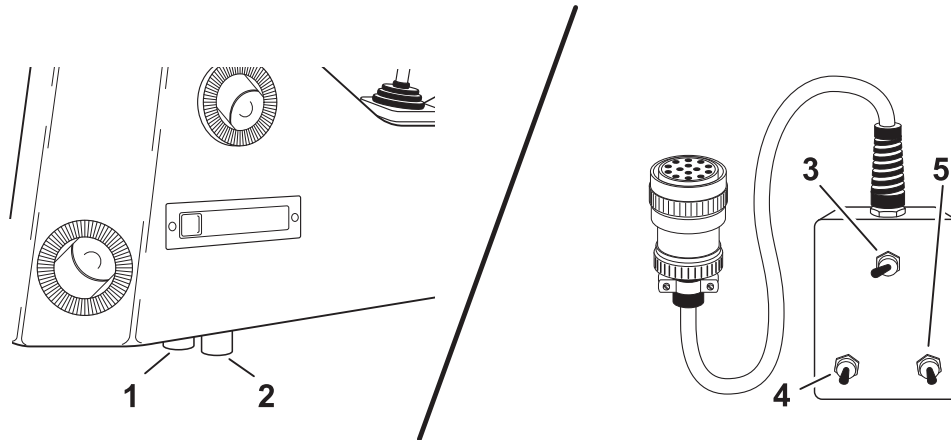
j07om045h.eps

1. Seat slide control

2. Seat recline control

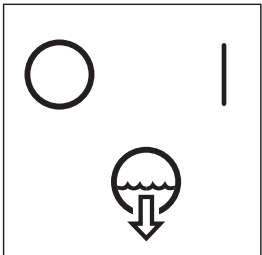
Item	Description	Notes
1. Seat slide control  c00ic095h.eps	To slide forward or backward, move left. To lock seat in position, move right.	
2. Seat recline control  c00ic096h.eps	To recline or raise seatback, lift. To lock seatback in position, release.	

Override Box

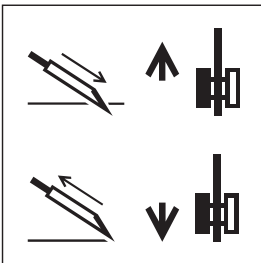
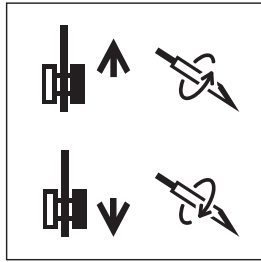


j17om015h.eps

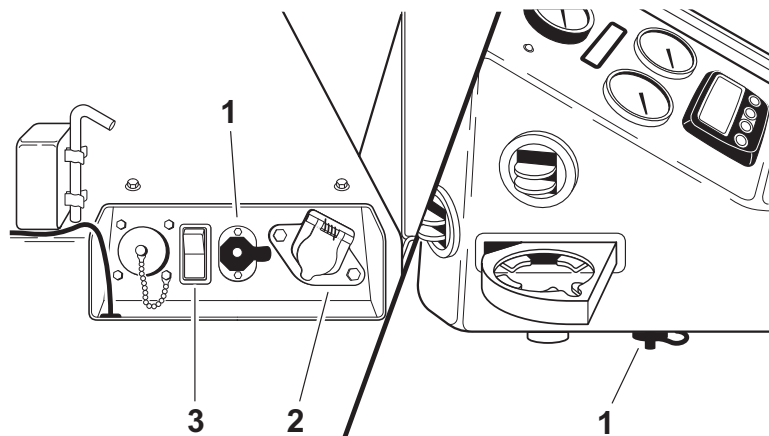
- | | |
|--|---|
| 1. Drive override connector | 4. Thrust/pullback or right track override switch |
| 2. Drill override connector | 5. Rotation or left track override switch |
| 3. Drilling fluid flow override switch | |

Item	Description	Notes
1. Drive override connector	Allows drive function override when box is attached.	Use switches 4 and 5 to control tracks.
2. Drill override connector	Allows drill function override when box is attached.	Use switches 3, 4 and 5 to control drill functions.
3. Drilling fluid flow override switch 	To turn fluid on, move right. To turn fluid off, move left.	Connect to drill connector (2) to control fluid flow.

c00ic068h.eps

Item	Description	Notes
4. Thrust/pullback or right track override switch  c00ic069h.eps	For thrust or to move track forward, move up. For pullback or to move track backward, move down.	Connect to drill connector (2) to control thrust/pullback. Connect to drive connector (1) to control right track.
5. Rotation or left track override switch  c00ic070h.eps	For counterclockwise rotation or to move track forward, move up. For clockwise rotation or to move track backward, move down.	Connect to drill connector (2) to control rotation. Connect to drive connector (1) to control left track.

Miscellaneous Controls

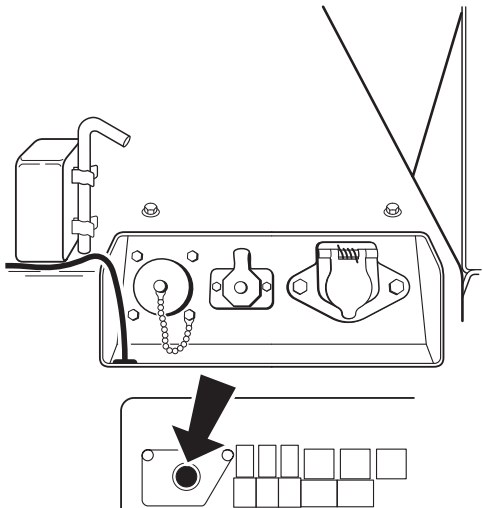


j28om014t.eps



Item	Description	Notes
1. Auxiliary outlets	Supplies power to work lights or other 12V devices.	Outlet has power only when ignition switch is on.
2. Auxiliary outlet	Supplies power to 12V devices.	
3. Crane enable switch	To enable, press To disable, press	 Enables tethered crane controls to function. IMPORTANT: Disable crane when not in use.

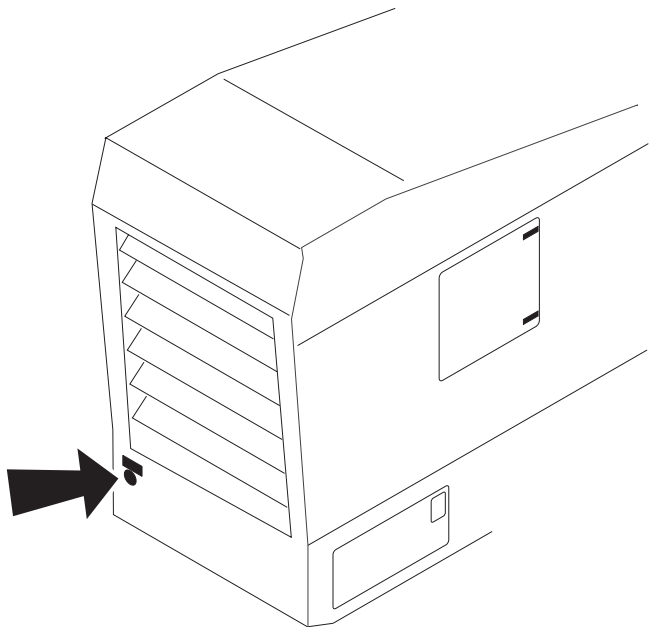
Engine Diagnostic Connector



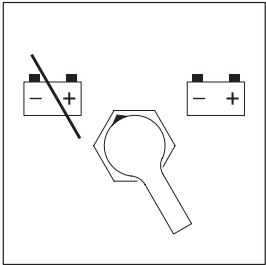
j170m116h.eps

Item	Description	Notes
Engine diagnostic connector	Connects diagnostic test equipment to unit.	

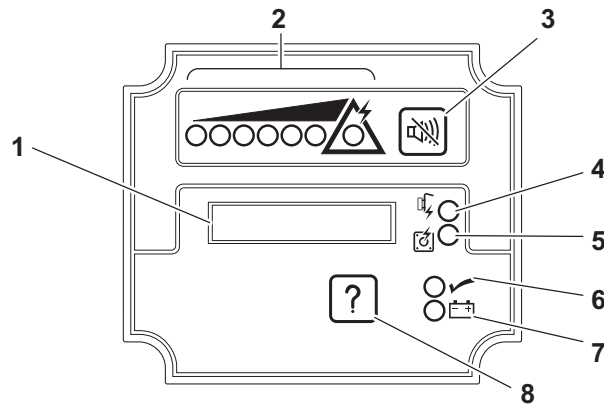
Battery



j17om090h.eps

Item	Description	Notes
Battery disconnect switch  c00ic097h.eps	To connect, move switch so that indicator points right. To disconnect, move switch so that indicator points left.	Use when servicing unit and during long-term storage.

ESID

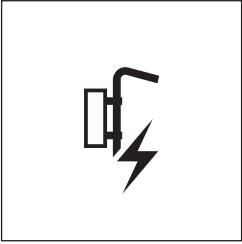
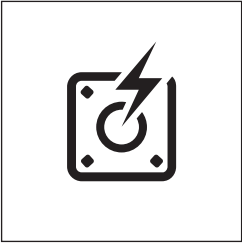
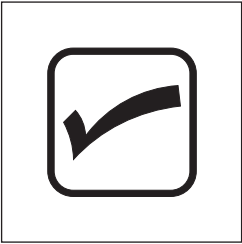


j07om042h.eps

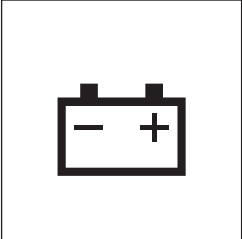
- | | |
|------------------------------|--------------------------------------|
| 1. Alphanumeric display | 5. Current problem indicator |
| 2. Strike indicator | 6. OK indicator |
| 3. Alarm interrupt button | 7. Electrical power supply indicator |
| 4. Voltage problem indicator | 8. Self test button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

Item	Description	Notes
1. Alphanumeric display	Display amount of current and voltage being detected as a percentage of strike condition. The line with the "V" shows voltage reading and the line with the "A" shows current reading.	
2. Strike indicator	Red lights come on as values in display increase. Light in triangle represents strike warning condition and will trigger alarm(s) and strobe(s). Remember that system can go from one or two lights 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.

c00ic077h.eps

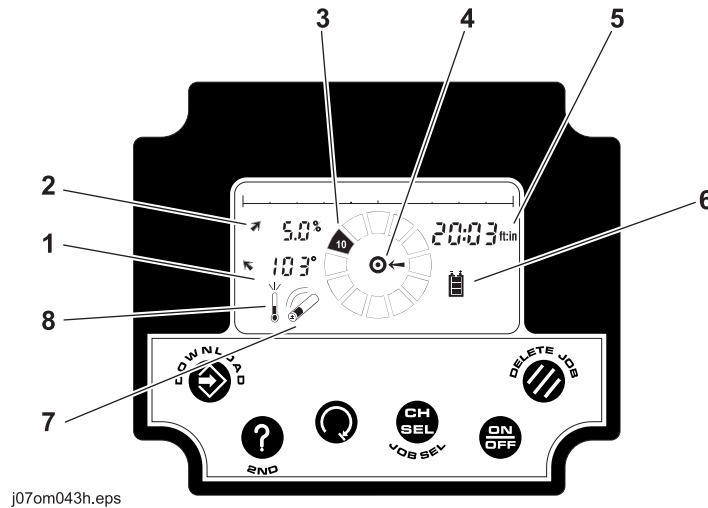
Item	Description	Notes
3. Alarm interrupt button  c00ic078h.eps	To turn off strike alarm at drilling unit, press.	
4. Voltage problem indicator  c00ic078h.eps	Red light indicates a voltage indicator problem.	See "Troubleshoot Strike System" on page 150.
5. Current problem indicator  c00ic080h.eps	Red light indicates a current indicator problem.	See "Troubleshoot Strike System" on page 150.
6. OK indicator  c00ic056h.eps	Green light means system self test detected no problems. Strike system is operating.	



Item	Description	Notes
7. Electrical power supply indicator  c00ic081h.eps	Green light means control box has sufficient electrical power for operation. Strike system is operating if OK indicator is also on.	
8. Self test button  c00ic075h.eps	To start manual self test, press. To reset system after a strike has been detected, press.	Checks all systems and circuits except voltage limiter. NOTICE: See "If an Electric Line is Damaged" on page 18.

750/752 Display

Indicators

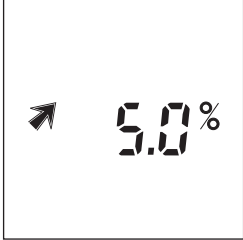
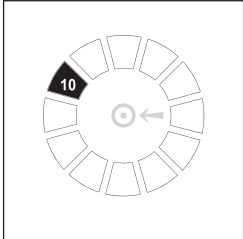
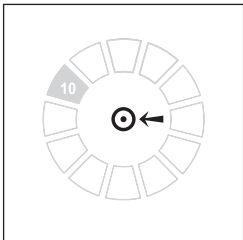


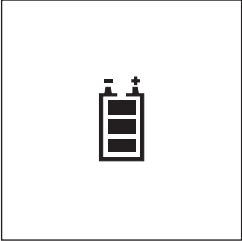
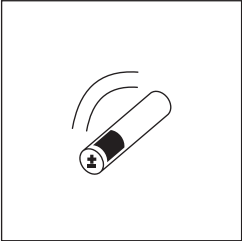
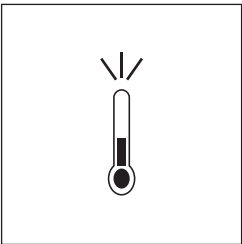
j07om043h.eps

- | | |
|---|---|
| 1. Beacon temperature display | 5. Depth estimate |
| 2. Pitch/slope indicator and percentage indicator | 6. 750/752 Display battery status indicator |
| 3. Roll indicator | 7. Beacon battery status indicator |
| 4. Target identifier indicator | 8. Beacon temperature indicator |

IMPORTANT: Some items operate differently depending where data is being saved. **Internal** refers to pipe data being saved to 750/752 Display memory. **External** refers to pipe data being sent to a properly connected laptop computer running a version of Trac Management System software.

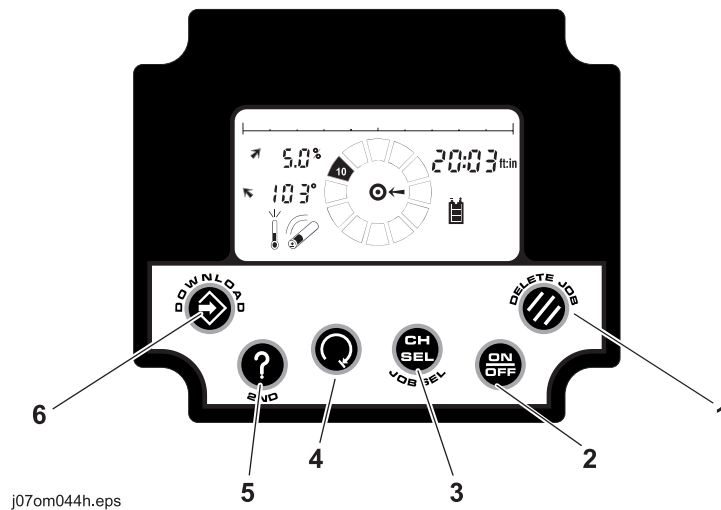
Item	Description	Notes
1. Beacon temperature display  c00ic286h.eps	Shows beacon temperature readings in degrees Fahrenheit (°F) and degrees Centigrade (°C).	See beacon instruction sheet.

Item	Description	Notes
2. Pitch/slope indicator and percentage indicator  c00ic083h.eps	Indicates pitch beacon percent of grade.	Internal: shows pipe label and stored pitch. External: shows desired pitch.
3. Roll indicator  c00ic084h.eps	Indicates beacon roll angle.	
4. Target identifier indicator  c00ic085h.eps	Indicates approximate beacon location.	Only one set of arrows is active at a time.
5. Depth estimate  c00ic086h.eps	Indicates beacon depth estimate.	Internal: shows job number and stored depth. External: shows desired depth.

Item	Description	Notes
6. 750/752 Display battery status indicator  c00ic087h.eps	Indicates display power from drilling unit.	If all three bars are not showing, check display power connections.
7. Beacon battery status indicator  c00ic088h.eps	Indicates beacon battery status.	See beacon instruction sheet.
8. Beacon temperature indicator  c00ic089h.eps	Indicates beacon temperature.	See beacon instruction sheet.

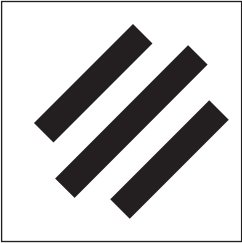


Controls



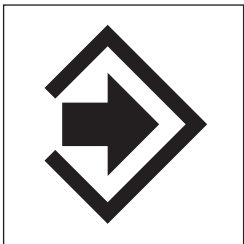
- | | |
|--------------------------|---------------------|
| 1. Delete button | 4. Roll stop button |
| 2. On/Off button | 5. Recall button |
| 3. Channel select button | 6. Store button |

IMPORTANT: Some items operate differently depending where data is being saved. **Internal** refers to pipe data being saved to 750/752 Display memory. **External** refers to pipe data being sent to a properly connected laptop computer running a version of Trac Management System software.

Item	Description	Notes
1. Delete button  c00ic071h.eps	To delete current pipe, press. Second function: To delete all jobs in internal logging memory, press with Recall button.	Previous pipe number will appear in numeric display when data is deleted.

Item	Description	Notes
2. On/Off button  c00ic112h.eps	To turn on, press. To turn off, press again.	
3. Channel select button  c00ic073h.eps	To display current channel, press and release. To switch channels, press and hold. Second function: To start a new job, press with Recall button. "Init" and job number will be displayed.	Unit defaults to channel one each time unit is turned on. IMPORTANT: Make sure display and tracker are set to the same channel.
4. Roll stop button  c00ic074h.eps	This feature is not yet available.	
5. Recall button  c00ic075h.eps	To see data about pipe, press and release. Second function: To access second functions, press with other buttons.	Internal: shows data about previous pipe. External: shows data about next pipe.



Item	Description	Notes
6. Store button  c00ic076h.eps	To display serial number, press and hold while pressing on/off button. To store current pipe data, press. Second function: To download all jobs stored in internal logging memory: • Press with Recall button • Connect display to PC running Trac Management System software.	Pipe number will appear in numeric display when data is stored. IMPORTANT: Pipe data cannot be stored without a valid depth estimate.

Operation Overview

Chapter Contents

Planning 78

Setting Up at Jobsite 78

Drilling 79

Backreaming 80

Leaving Jobsite 80

Storing Equipment 80



Planning

1. Gather information about jobsite. See page 83.
2. Inspect jobsite. See page 84.
3. Classify jobsite. See page 86.
4. Plan bore path. See page 89.
5. Check supplies and prepare equipment. See page 99.
6. Load equipment. See page 110.

Setting Up at Jobsite

1. Prepare jobsite. See page 98.
2. Unload drilling unit from trailer. See page 112.
3. Assemble drill string. See page 121.
4. Position drilling unit and frame. See page 117.
5. Assemble strike system. See page 148.
6. Anchor drilling unit. See page 139.
7. Connect fluid system. See page 117.
8. Calibrate tracker with beacon that will be installed in beacon housing. See tracker operator's manual.

Drilling

1. Start system. See page 118.
2. Engage tracker control if desired. See page 159.
3. Drill first pipe. See page 124.
 - JT mode
 - AT dirt mode
 - AT mode
4. Swab the hole to remove cuttings (AT mode only). See page 125.
5. Record bore path. See page 130.
6. Enable automated pipeloader system. See page 125.
7. Add pipe. See page 126.
8. Drill remaining pipes in pipe box.
 - Correct direction. See page 128.
 - Engage cruise control. See page 174.
9. Remove empty pipe box and add full box (see page 142) to complete bore.
10. Surface drill head. See page 130.
 - Remove drill head.
 - Grease downhole tool (AT mode). See page 194.



Backreaming

1. Assemble backream string. See page 131.
2. Start drilling unit and adjust throttle.
3. Set drilling fluid flow. Check that fluid flows through all nozzles. See page 162.
4. Remove pipe from bore. See page 133.
5. Remove full pipe box and add empty box (see page 142) to complete backream.
6. Remove pullback device. See page 135.

Backreaming Tips

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

Leaving Jobsite

1. Remove anchors. See page 139.
2. Rinse unit and downhole tools. See page 187.
3. Disassemble strike system (see page 148) and disconnect from fluid system (see page 188).
4. Stow tools. See page 188.
5. Load unit onto trailer. See page 188 and page 110.

Storing Equipment

1. For cold weather storage, antifreeze drilling unit. See page 186.
2. For long-term storage, disconnect battery disconnect switch.

Prepare

Chapter Contents

Gather Information 83

- Review Job Plan83
- Notify One-Call Services83
- Examine Pullback Material83
- Arrange for Traffic Control83
- Plan for Emergency Services83

Inspect Site 84

- Identify Hazards84
- Select Start and End Points85

Classify Jobsite. 86

- Inspect Jobsite86
- Select a Classification86
- Apply Precautions87

Plan Bore Path 89

- Recommended Bend Limits90
- Entry Pitch.94
- Minimum Setback95
- Minimum Depth95
- Bore Path Calculator96



Prepare Jobsite 98

- Mark Bore Path98
- Prepare Entry Point.98

Check Supplies and Prepare Equipment 99

- Check Supplies99
- Prepare Equipment100
- Assemble Accessories103

Gather Information

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

Review Job Plan

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

Notify One-Call Services

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

Examine Pullback Material

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

Arrange for Traffic Control

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

Plan for Emergency Services

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



Inspect Site

Inspect jobsite before transporting equipment. Check for the following:

- overall grade or slope
- changes in elevation such as hills or open trenches
- obstacles such as buildings, railroad crossings, or streams
- signs of utilities (See "Inspect Jobsite" on page 86.)
- traffic
- access
- soil type and condition
- water supply
- sources of locator interference (rebar, railroad tracks, etc.)

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

Identify Hazards

Identify safety hazards and classify jobsite. See "Classify Jobsite" on page 86.

**WARNING**

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

NOTICE:

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

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

Select Start and End Points

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

Slope

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 95.

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

Comfort

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

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



Classify Jobsite

Inspect Jobsite

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

Select a Classification

Jobsites are classified according to underground hazards present.

If working. . .	then classify jobsite as . . .
within 10' (3 m) of a buried electric line	electric
within 10' (3 m) of a natural gas line	natural gas
in sand 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.

Electric Jobsite Precautions



Electric shock. Contacting electric lines will cause death or serious injury. Know location of lines and 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. Have someone observe clearance between drill head and backreamer when crossing a line.
- Have service shut down while work is in progress. Have electric company test lines before returning them to service.



Natural Gas Jobsite Precautions



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



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

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

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

Other Jobsite Precautions

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

Plan Bore Path

Plan the bore path, from entry to end, before drilling begins. The Ditch Witch **Trac Management System Plus** is available for planning your bore path. 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 - JT Pipe" on page 96 and use these measurements to help plan your bore.

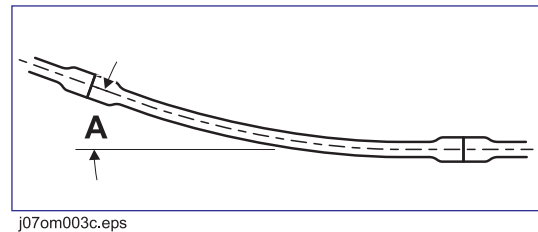
Recommended Bend Limits

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. For JT100 **Mach 1** drill pipe, make sure pitch (A) changes no more than **7%** over the full length of each pipe. For JT100 **All Terrain** drill pipe, make sure pitch (A) changes no more than **7%** over the full length of each 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 750/752 or 8500 Display on the operator's console. See "750/752 Display" on page 71.

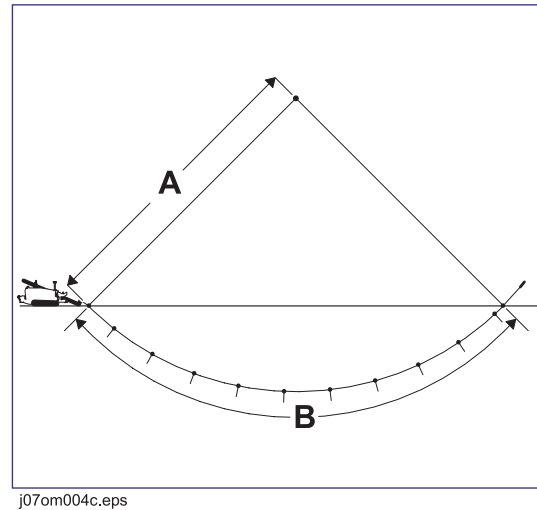
Bend Radius

JT100 Mach 1 drill pipes have a tested minimum bend radius of **205' (62.5 m)**. This means that a 90° bend in the bore path:

- has a radius (A) of 205' (62.5 m)
- requires approximately 325' (99 m) of drill pipe (B).

JT100 All Terrain drill pipes have a tested minimum bend radius of **205' (62.5)**. This means that a 90° bend in the bore path:

- has a radius (A) of 205' (62.5 m)
- requires approximately 325' (99 m) of drill pipe (B).



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

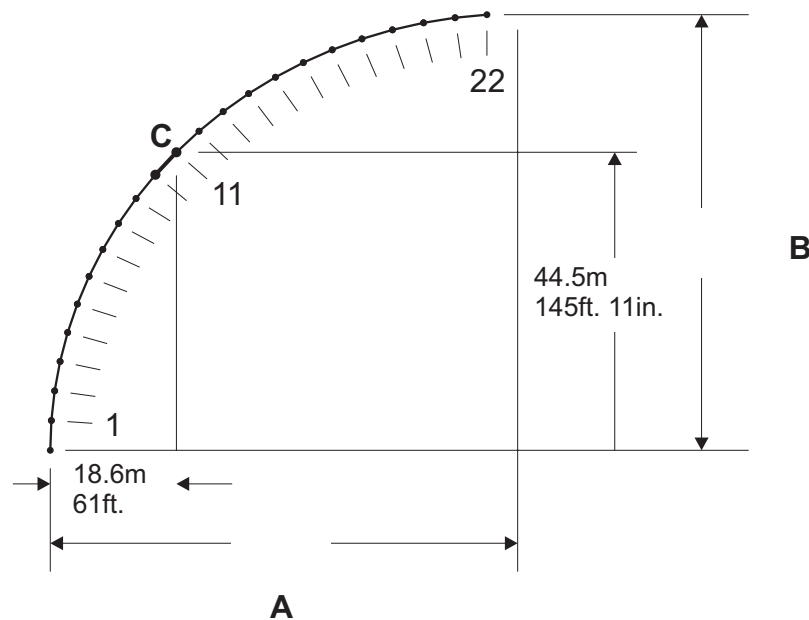
- If bend radius is reduced, drill pipe life is reduced.
- If bend radius is increased, drill pipe life is increased.



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

Pipe-By-Pipe Bend Limits - JT Pipe

Pipe (C)	Forward (B)	Deflection (A)	Pipe (C)	Forward (B)	Deflection (A)
1	14 ft 9 in (4.5 m)	0 ft 6 in (0.2 m)	12	155 ft 11 in (47.5 m)	71 ft 11 in (21.9 m)
2	29 ft 5 in (9.0 m)	2 ft 1 in (0.6 m)	13	165 ft 1 in (50.3 m)	83 ft 6 in (25.4 m)
3	43 ft 11 in (13.4 m)	4 ft 9 in (1.5 m)	14	173 ft 5 in (52.9 m)	95 ft 8 in (29.2 m)
4	58 ft 3 in (17.8 m)	8 ft 5 in (2.6 m)	15	180 ft 10 in (55.1 m)	108 ft 5 in (33.1 m)
5	72 ft 3 in (22 m)	13 ft 2 in (4.0 m)	16	187 ft 4 in (57.1 m)	121 ft 8 in (37.1 m)
6	85 ft 10 in (26.2 m)	18 ft 10 in (5.7 m)	17	192 ft 10 in (58.8 in)	135 ft 5 in (41.3 m)
7	99 ft 0 in (30.2 m)	25 ft 6 in (7.8 m)	18	197 ft 4 in (60.1 m)	149 ft 5 in (45.6 m)
8	111 ft 8 in (34 m)	33 ft 1 in (10.1 m)	19	200 ft 10 in (61.2 m)	163 ft 9 in (49.9 m)
9	123 ft 9 in (37.7 m)	41 ft 7 in (12.7 m)	20	203 ft 3 in (62.0 m)	178 ft 4 in (54.4 m)
10	135 ft 2 in (41.2 m)	50 ft 11 in (15.5 m)	21	204 ft 8 in (62.4 m)	193 ft 0 in (58.8 m)
11	145 ft 11 in (44.5 m)	61 ft 0 in (18.6 m)	22	205 ft 0 in (62.5 m)	205 ft 0 in (62.5 m)

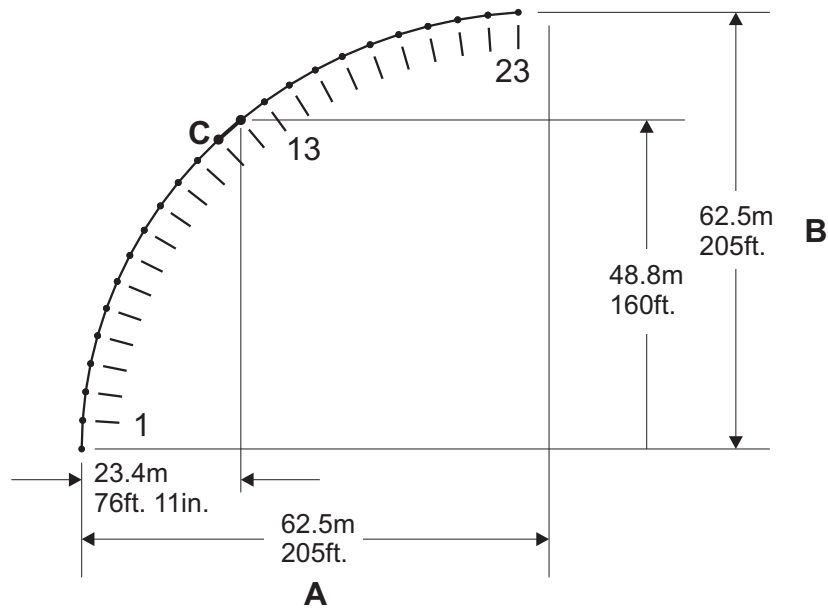


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Pipe 11 is illustrated.

Pipe-By-Pipe Bend Limits - All Terrain Pipe

Pipe (C)	Forward (B)	Deflection (A)	Pipe (C)	Forward (B)	Deflection (A)
1	14 ft 1 in (4.3 m)	0 ft 6 in (0.1 m)	13	160 ft 0 in (48.8 m)	76 ft 11 in (23.4 m)
2	28 ft 2 in (8.6 m)	1 ft 11 in (0.6 m)	14	168 ft 6 in (51.4 m)	88 ft 2 in (26.9 m)
3	42 ft 1 in (12.8 m)	4 ft 4 in (1.3 m)	15	176 ft 1 in (53.7 m)	100 ft 1 in (30.5 m)
4	55 ft 9 in (17.0 m)	7 ft 9 in (2.4 m)	16	182 ft 11 in (55.8 m)	112 ft 6 in (34.3 m)
5	69 ft 3 in (21.1 m)	12 ft 1 in (3.7 m)	17	188 ft 10 in (57.6 m)	125 ft 3 in (38.2 m)
6	82 ft 4 in (25.1 m)	17 ft 3 in (5.3 m)	18	193 ft 11 in (59.1 in)	138 ft 6 in (42.2 m)
7	95 ft 1 in (29 m)	23 ft 5 in (7.1 m)	19	198 ft 0 in (60.4 m)	152 ft 0 in (46.3 m)
8	107 ft 4 in (32.7 m)	30 ft 4 in (9.3 m)	20	201 ft 2 in (61.3 m)	165 ft 9 in (50.5 m)
9	119 ft 2 in (36.3 m)	38 ft 2 in (11.6 m)	21	203 ft 5 in (62.0 m)	179 ft 8 in (54.8 m)
10	130 ft 4 in (39.7 m)	46 ft 9 in (14.3 m)	22	204 ft 8 in (64.5 m)	193 ft 9 in (59.1 m)
11	140 ft 11 in (43 m)	56 ft 1 in (17.1 m)	23	205 ft 0 in (62.5 m)	205 ft 0 in (62.5 m)
12	150 ft 10 in (46 m)	66 ft 2 in (20.2 m)			



Pipe 13 is illustrated.

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Entry Pitch

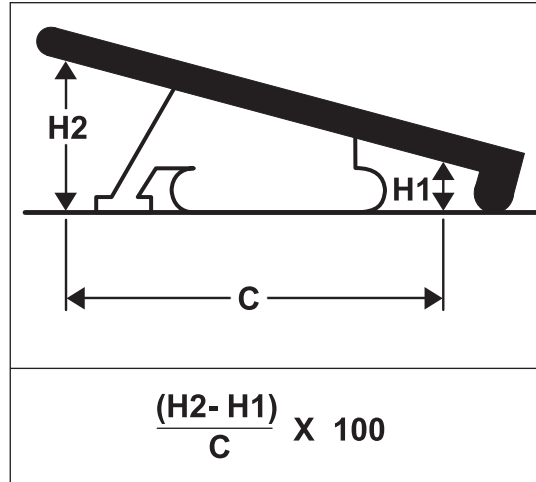
Entry pitch is the slope of the drill frame compared with the slope of the ground. Determine entry pitch one of two ways:

1. With Pitch Beacon

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

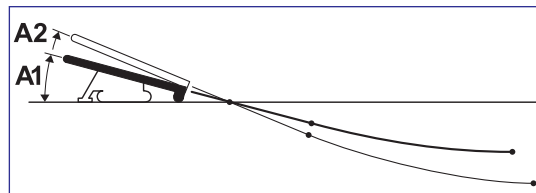
2. With Measurements

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



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

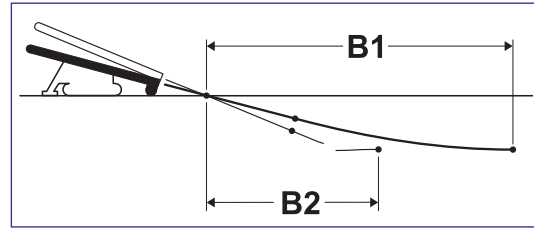


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Minimum Setback

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

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

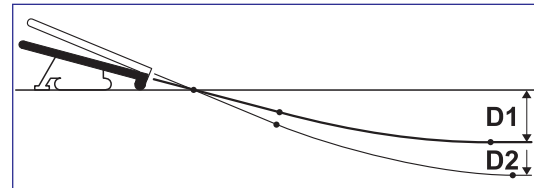


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Minimum Depth

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

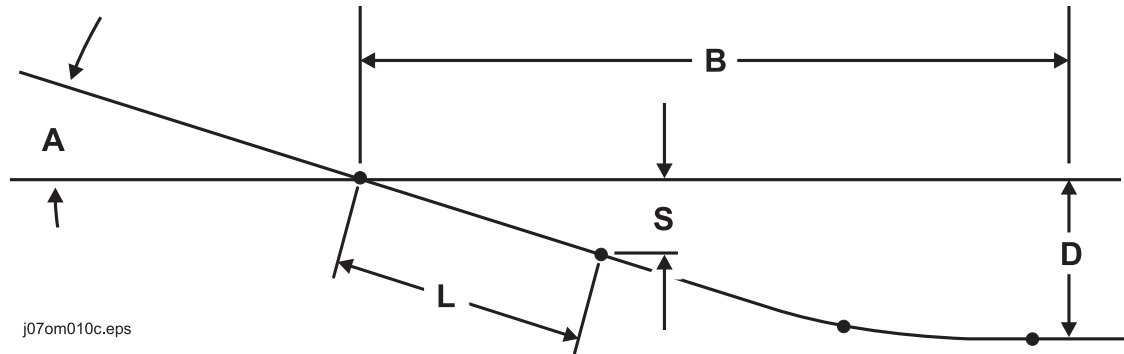


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Bore Path Calculator - JT Pipe

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.

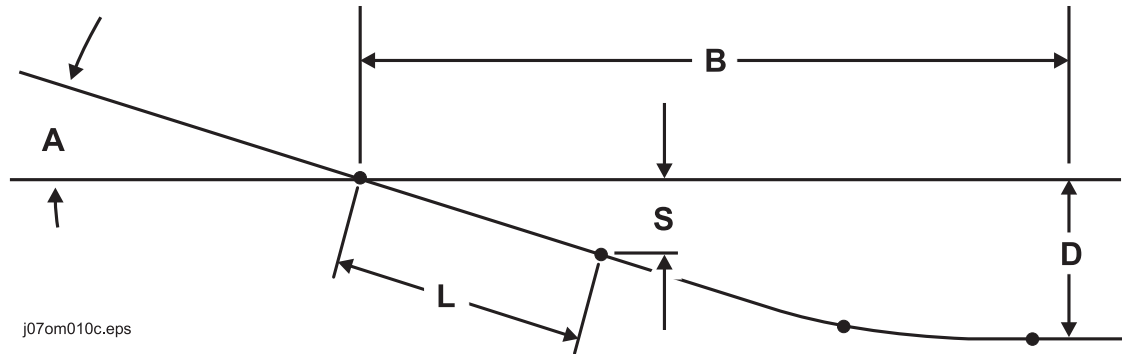


Minimum depth (D)	Entry pitch (A)	Setback (B)	Depth to begin steering (S)
6 ft 10 in (2.08 m)	11.3° / -20%	54 ft 6 in (16.61 m)	2 ft 10 in (0.86 m)
7 ft 11 in (2.41 m)	12.4° / -22%	58 ft 3 in (17.75 m)	3 ft 2 in (0.97 m)
9 ft 1 in (2.77 m)	13.5° / -24%	62 ft 0 in (18.90 m)	3 ft 5 in (1.04 m)
10 ft 3 in (3.12 m)	14.6° / -26%	65 ft 8 in (20.02 m)	3 ft 8 in (1.12 m)
11 ft 6 in (3.51 m)	15.6° / -28%	69 ft 4 in (21.13 m)	3 ft 11 in (1.19 m)
12 ft 10 in (3.91 m)	16.7° / -30%	72 ft 10 in (22.20 m)	4 ft 2 in (1.27 m)
14 ft 2 in (4.32 m)	17.7° / -32%	76 ft 4 in (23.27 m)	4 ft 5 in (1.35 m)

IMPORTANT: Numbers in table based on **205' (62.5 m) minimum bend radius**, and beacon housing, EZ-Connect, transition sub, and half of first drill pipe (L, totaling 14' 7" [4.45 m]) in the ground before steering.

Bore Path Calculator - AT Pipe

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.



Minimum depth (D)	Entry pitch (A)	Setback (B)	Depth to begin steering (S)
6 ft 7 in (2.01 m)	11.3° / -20%	53 ft 4 in (16.26 m)	2 ft 7 in (0.79 m)
7 ft 8 in (2.34 m)	12.4° / -22%	57 ft 1 in (17.40 m)	2 ft 10 in (0.86 m)
8 ft 9 in (2.67 m)	13.5° / -24%	60 ft 10 in (18.54 m)	3 ft 1 in (0.94 m)
10 ft 0 in (3.05 m)	14.6° / -26%	64 ft 6 in (19.66 m)	3 ft 4 in (1.02 m)
11 ft 2 in (3.40 m)	15.6° / -28%	68 ft 2 in (20.78 m)	3 ft 7 in (1.09 m)
12 ft 6 in (3.81 m)	16.7° / -30%	71 ft 9 in (21.87 m)	3 ft 10 in (1.17 m)
13 ft 10 in (4.22 m)	17.7° / -32%	75 ft 3 in (22.94 m)	4 ft 1 in (1.24 m)

IMPORTANT: Numbers in table based on **205' (62.5 m) minimum bend radius**, Rockmaster housing, 6.25-in bit, and half of first drill pipe (L, totaling 13.5' [4.1 m]) in the ground before steering.



Prepare Jobsite

**WARNING**

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

NOTICE:

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

Mark Bore Path

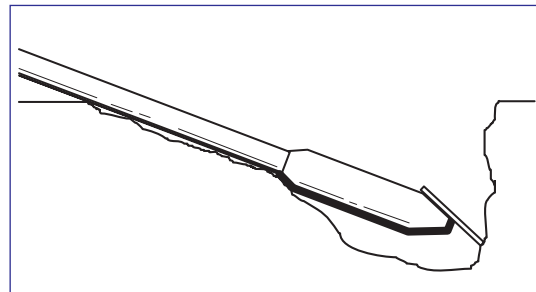
Mark your planned bore path and all located utility lines with flags or paint.

Prepare Entry Point

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

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

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



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Check Supplies and Prepare Equipment

Check Supplies

- receiver/transmitter or tracker with spare batteries
- beacons with new and spare batteries
- two-way radios with new and spare batteries
- hydraulic wrench (see "Hydratong Wrenches" on page 167)
- transition sub
- anchoring equipment and accessories
- bits, screens, nozzles (see "Downhole Tools" on page 162)
- adapters, pipe, beacon housings
- marking flags or paint
- water and additional hoses
- fuel
- drilling fluid additives (see "Drilling Fluid" on page 154)
- spare fuses
- keys
- backreamers, swivels, pulling devices (see "Backreamers" on page 164)
- wash down hose and spray gun
- duct tape
- spray lubricant
- tool joint compound (see "Recommended Lubricants/Service Key" on page 192)
- electrically insulating boots and gloves
- personal protective equipment, such as hard hat and safety glasses
- notepad and pencil



Prepare Equipment

Fluid Levels

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

Condition and Function

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

Select Drilling Mode

Three drilling setups are available with this unit:

- AT mode
- AT dirt mode
- JT mode

Select the best setup based on jobsite conditions.

Mode	Situation used	Downhole tools	Capabilities
AT	Rock, soft rock, other non-compressible soils. Any other situation with difficult steering because of hard soil conditions.	• All Terrain drill pipe • Rockmaster tool	• 70,000 lb (311 kN) of thrust • dither • inner rotation
AT dirt	When one bore out of several can be better or more quickly done with conventional downhole tools. This bore is such that changing to JT pipe is not practical.	• All Terrain drill pipe • beacon housing • transition sub (p/n 400-1383) • standard JT tools	• 70,000 lb (311 kN) of thrust • dither • no inner rotation
JT	Soft or intermittent soft rock or other compressible soils.	• JT drill pipe • standard JT tools	• 70,000 lb (311 kN) of thrust • no dither • no inner rotation



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

Prepare Drilling Unit

AT Mode

- Verify unit has not been converted to JT mode. Ensure All Terrain saver sub, shuttle stop, roller, and roller pin are installed.
- Inspect Rockmaster tool and select bit based on jobsite conditions.
- Use appropriate anchors for jobsite conditions.
- Load All Terrain pipe and pipe box onto unit.
- Move mode selector switch to AT position.

AT Dirt Mode

- Verify unit has not been converted to JT mode. Ensure All Terrain saver sub, shuttle stop, roller, and roller pin are installed.
- Use transition sub (p/n 400-1383) between All Terrain pipe and beacon housing. Select soil bit based on jobsite conditions.
- Use appropriate anchors for jobsite conditions.
- Load All Terrain pipe and pipe box onto unit.
- Move mode selector switch to AT DIRT position.

JT Mode

IMPORTANT: Use conversion kit (p/n 190-1548).

- Install saver sub, shuttle stop, roller, and roller pin for Mach 1 pipe.
- Use standard transition sub and beacon housing. Select soil bit based on jobsite conditions.
- Use auger type anchors.
- Load JT pipe and pipe box onto unit.

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

- Move mode selector switch to JT position.

Assemble Accessories

Fire Extinguisher

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

Lighting Kit

If you will need additional light, plug lighting kit into provided outlet. Contact your Ditch Witch dealer for further information.



Drive

Chapter Contents

Start Unit 106

Steer Unit 106

Shut Down Unit 106



Start Unit

1. Insert key.
2. Turn key clockwise. See "Ignition switch" on page 58 for more information. Wait until start light goes out to crank engine. See "Engine preheat indicator" on page 34.
3. Run engine at low throttle for 5 minutes.

Steer Unit

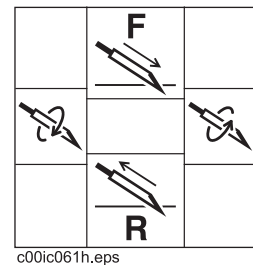
IMPORTANT: Operator's station must be in drive position. See "Cab pivot control switch" on page 38.

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

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

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

For tight steering in low speed, move control to center position and then fully to right or left. From there, move forward or backward until desired counter-rotation speed is reached.



Shut Down Unit

1. Stop track movement.
2. Move drill/drive selector to center position to engage parking brake.
3. Run engine at low throttle for 3 minutes to cool.
4. Turn key to STOP.
5. Remove key.

Transport

Chapter Contents

Lift 108

- Points108
- Procedure108

Haul 109

- Inspect Trailer109
- Load110
- Tie Down111
- Unload112

Tow 113



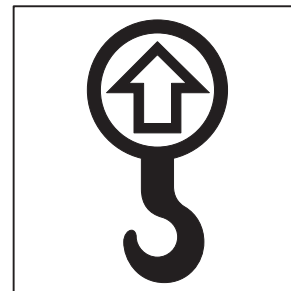
Lift



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

Points

Lifting points are identified by lifting decals. Lifting at other points is unsafe and can damage machinery.

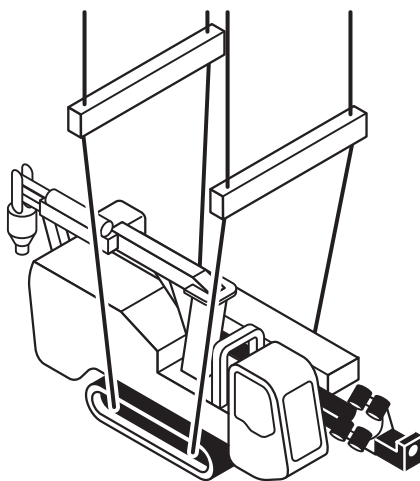


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Procedure

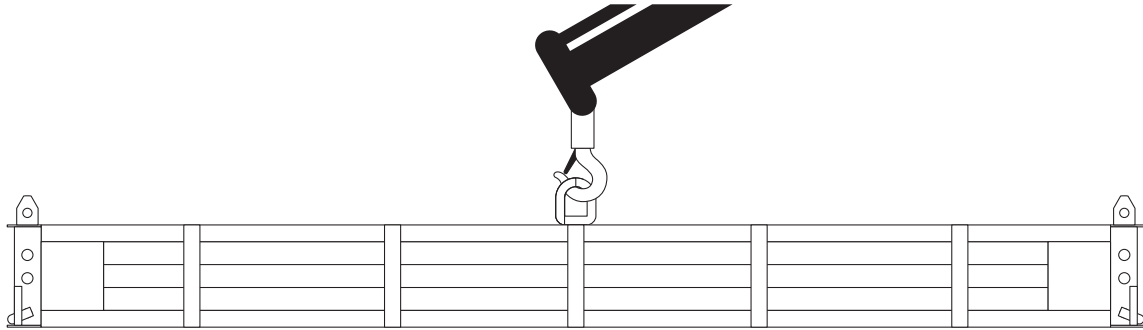
Drilling Unit

Use a crane capable of supporting the equipment's size and weight. See "Specifications" on page 233 or measure and weigh equipment before lifting. Use four lift points. Attach securely to cross members.



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Pipe Box



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Use optional onboard crane attachment (see “Remove/Install Pipe Box” on page 142) or other crane capable of supporting the equipment's size and weight. See “Specifications” on page 233 or measure and weigh equipment before lifting.

Haul

Inspect Trailer

- Check hitch for wear and cracks. Lubricate if needed.
- Check battery for 12V charge.
- Inspect lights for cleanliness and correct operation. Inspect reflectors and replace if needed.
- Check tire pressure. Check lug nut tightness with a torque wrench. Adjust if needed.
- Ensure trailer brakes are adjusted to come on in synchronization with tow vehicle brakes.
- Check ramps and trailer bed for cracks.



Load



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

NOTICE:

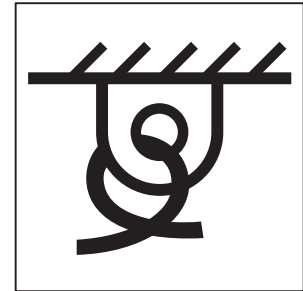
- Load and unload trailer on level ground.
- Incorrect loading can cause trailer swaying.
- Attach trailer to vehicle before loading or unloading.
- Ten to fifteen percent of total vehicle weight (equipment plus trailer) must be on tongue to help prevent trailer sway.

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

Tie Down

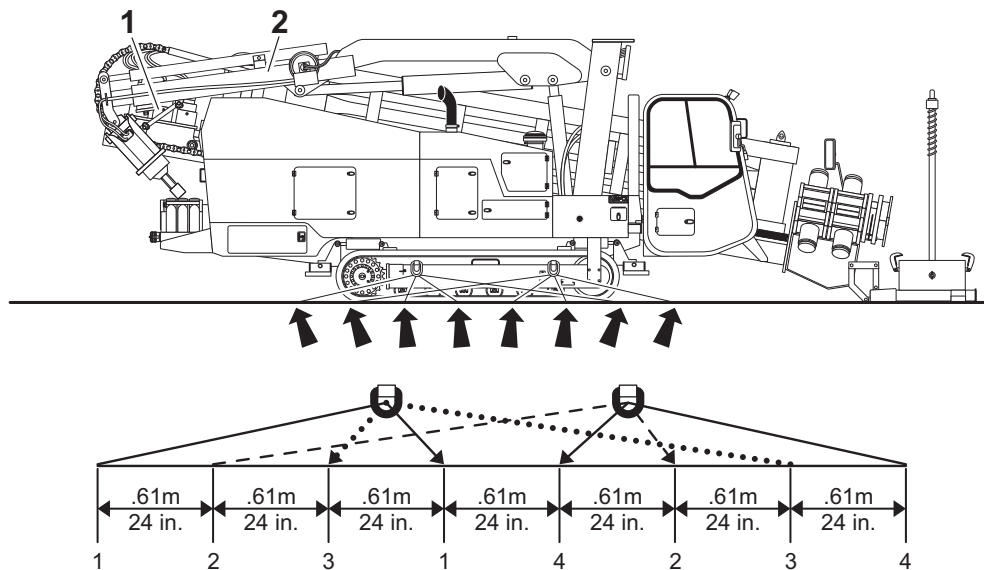
Points

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



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Procedure



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Ensure crane is in stowed position and stow strap (2) is tight. Ensure anchor drive motor is in stowed position (1). Loop tiedowns around unit at tiedown points. Make sure tiedowns are tight before transporting.

IMPORTANT: You must use eight total tiedowns, four per side and two in each ring, to meet standards.

Unload

**WARNING**

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

NOTICE:

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

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

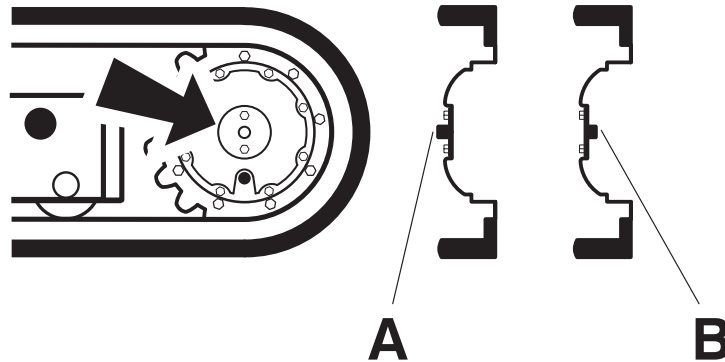
Tow

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

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

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

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



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A. Normal operation

B. Towing



Conduct a Bore



Chapter Contents

Position Equipment 117

Connect Fluid System 117

Start System 118

Prime Drilling Fluid Pump 118

Operate Carriage Control 119

Clamp Pipe 120

Assemble Drill String 121

- Prepare Beacon Housing121
- Attach Transition Sub122
- Connect Drill Pipe123

Drill First Pipe 124

- JT Mode/AT Dirt Mode124
- AT Mode124

Swab the Hole 125

Enable Automated Pipeloader System 125

Add Pipe 126

Correct Direction 128

- Basic Rules128
- Procedure129
- Drill Head Position129

Record Bore Path 130

Surface Drill Head 130

Backream 131

Remove Pipe 133

Remove Pullback Device 135

Position Equipment

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



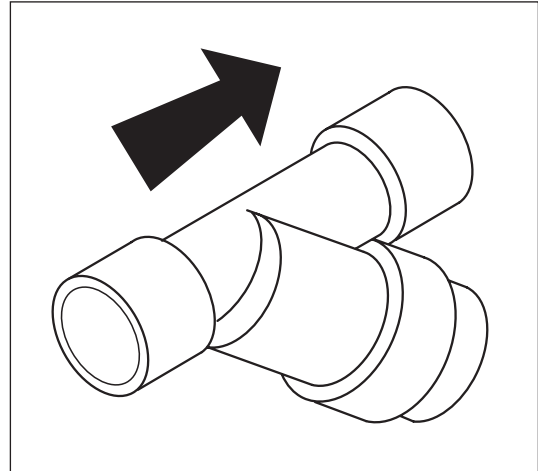
Connect Fluid System

1. Connect fluid hose from mixing system to drilling fluid pump. A 3" (76 mm) supply hose no more than 50' (15 m) is required. **To prevent pump cavitation**, hose must provide 30 psi (2 bar) of continuous pressure at the drilling fluid pump inlet.

IMPORTANT: Pump cavitation causes damage to pump and other machine components and reduces pump output.

2. Install y-strainer between mixing unit and drilling fluid pump. Position strainer so that drilling fluid flows in the direction of the arrow. In most cases, positioning strainer at outlet of mixing unit gives best results.

IMPORTANT: Clean y-strainer regularly. See page 200.



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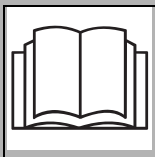
Start System

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

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

2. Enable tracker control mode if desired. See "Tracker Control" on page 159.
3. Press top of drilling unit throttle switch until engine is at full throttle.
4. Press and hold quick fill fluid pump switch until pipe fills and fluid pressure begins to rise.

Prime Drilling Fluid Pump



WARNING

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

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



WARNING

Pressurized fluid or air could pierce skin and cause injury or death. Stay away.

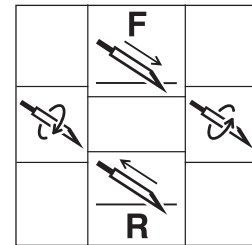
Prime drilling fluid pump each time tank is changed. To prime the pump:

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. Check gauge to ensure at least 30 gpm (113.5 L/min) of flow.
4. If drilling fluid pressure surges are observed, repeat step 2.

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

Operate Carriage Control

The thrust/rotation control has allows the four basic functions (shown) to be combined. The chart below shows examples of functions that occur when control is put at a combined position. Operator must be in seat for control to function.



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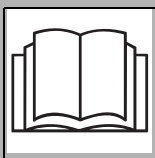
Carriage Movement	Rotation Direction	
forward	clockwise (makeup) IMPORTANT: On units equipped with assisted makeup, moving the joystick to the left will initiate the makeup cycle. See page 173.	 ic1102a.eps
reverse	counterclockwise (breakout) IMPORTANT: On units equipped with assisted makeup, moving the joystick to the right will initiate the breakout cycle. See page 173.	 ic1104a.eps

Clamp Pipe

**⚠ DANGER**

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

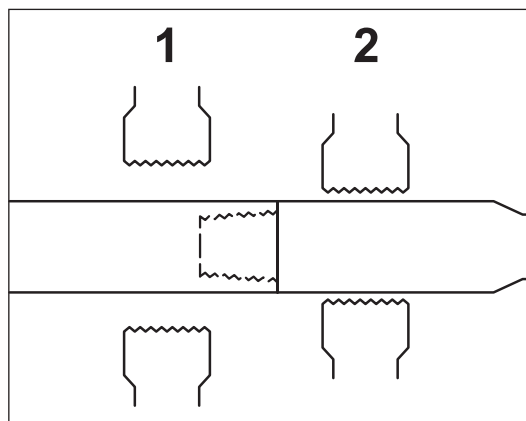
NOTICE: Clamping anywhere else on the pipe will weaken the pipe. Pipe can later break, even when operating under normal loads.

**⚠ WARNING**

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

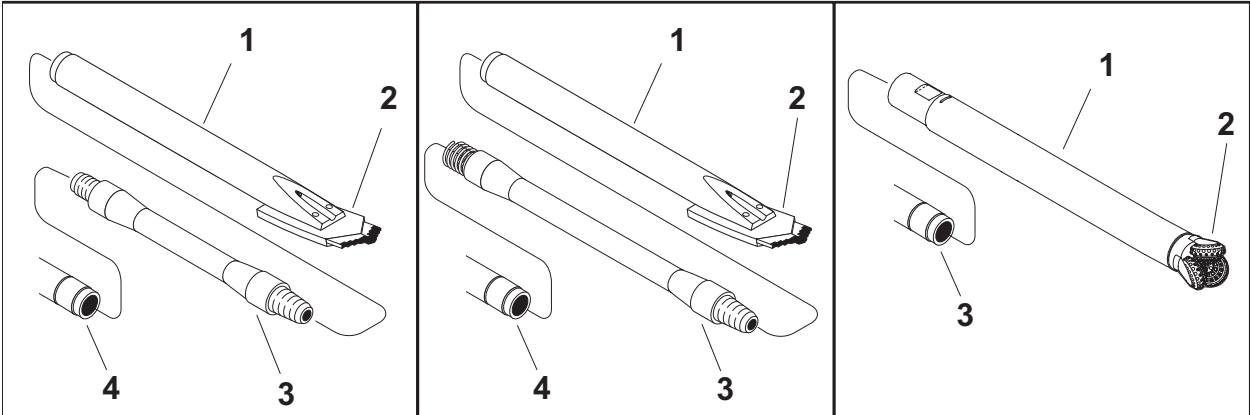
NOTICE: Wrenches can open after engine shutdown. Ensure that any downhole tool or pipe in wrenches is attached to spindle or removed before transport.

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



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Assemble Drill String



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JT mode	AT dirt mode	AT mode
1. beacon housing	1. beacon housing	1. Rockmaster tool
2. bit	2. bit	2. bit
3. transition sub	3. transition sub (p/n 400-1383)	3. JT100 All Terrain drill pipe
4. JT100 Mach 1 drill pipe	4. JT100 All Terrain drill pipe	

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

Prepare Beacon Housing

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

IMPORTANT: A variety of nozzles and bits are available to suit your particular job conditions. See “Downhole Tools” on page 162 for more information, or contact your Ditch Witch dealer.

2. Insert nozzle into beacon housing (JT and AT dirt modes only).
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 163.
6. Follow beacon instructions to check beacon operation.
7. Follow tracker instructions to calibrate beacon.

Attach Transition Sub



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

Use either machine torque or Hydratong wrenches 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

1. Lube joints with tool joint compound.
2. Attach Hydratong wrenches to the joint in the join position and tighten joint. See "Hydratong Wrenches" on page 167.

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 120.
4. Load pipe (4).
 - Make sure pipe box is positioned correctly.
 - Close grippers.
 - Lubricate threads on transition sub.
 - Move pipe to spindle.
 - Raise pipe in box.
5. 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.
 - Open grippers.
 - Retract shuttles fully.
 - Lower pipe lifters.
6. Close guides.

Drill First Pipe



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

NOTICE:

- 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.



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

JT Mode/AT Dirt Mode

1. Turn on drilling fluid.
2. Visually check for drilling fluid flow.
3. Turn drill bit to starting position. See "Prepare Entry Point" on page 98.
4. Slowly move carriage forward. Drill in downhole tools and 1/3 of first pipe before steering.
5. Monitor gauges.

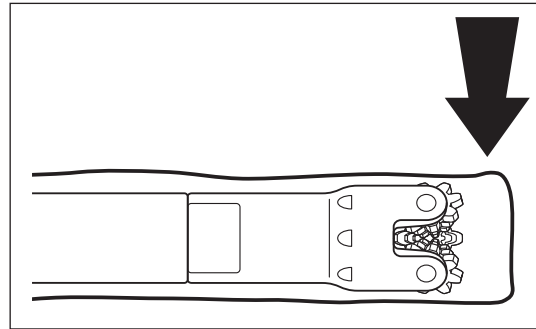
AT Mode

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

Swab the Hole

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

1. Move carriage forward until carriage touches front frame.
2. Move carriage to rear of drill frame with drilling fluid and inner rotation on.
3. Move carriage forward until pipe joint is properly positioned in clamps (see "Clamp Pipe" on page 120) to leave gap between end of bore and drill head (shown).



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Enable Automated Pipeloader System

Add Pipe	Remove Pipe
1. Make sure pipe box is properly positioned. 2. With carriage in center of drill frame, open front wrench and retract shuttles for add pipe function to work. 3. Press top/front of add pipe/manual/remove pipe switch. 4. Green control cycle light will come on, grippers will open, pipe will be lowered, and then green control cycle light will flash.	1. Make sure pipe box is properly positioned. 2. With carriage in center of drill frame, open front wrench and retract shuttles for add pipe function to work. 3. Press bottom/rear of add pipe/manual/remove pipe switch. 4. Green control cycle light will come on, grippers will open, pipe will be lowered and lifted off shuttles, and then green control cycle light will flash.

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

Add Pipe

1. Press top of drilling unit throttle switch until engine is at full throttle.
2. Enable automated pipeloader system (automated pipeloader control only). See "Enable Automated Pipeloader System" on page 125.
3. Break joint at saver sub.

Manual Pipeloader Controls	Automated Pipeloader Control
• Clamp pipe joint. See "Clamp Pipe" on page 120. • Locate drill head. • Engage front wrench until pipe is clamped and pressure develops. • Slowly rotate spindle counterclockwise. Carriage will move back automatically as threads unscrew. • After threads are fully unscrewed, stop rotation and move carriage to back of frame.	• Clamp pipe joint. See "Clamp Pipe" on page 120. • Locate drill head. • Engage front wrench until pipe is clamped and pressure develops. • Slowly rotate spindle counterclockwise. Carriage will move back automatically as threads unscrew. • After threads are fully unscrewed, stop rotation and move carriage to back of frame. • While carriage is moving, green control cycle light will come on, grippers will grip, pipe will be lubed, and then green control cycle light will flash.

4. Load pipe.

Manual Pipeloader Controls	Automated Pipeloader Control
• Make sure lift arms are completely lowered. • Close grippers. • Move pipe to spindle and lube lower threads. • Raise pipe in box.	• When carriage is moved to back of drill frame, press resume switch. • Green control cycle light will come on, pipe will be moved to spindle, front threads will be lubed, pipe in box will be lifted, and then green control cycle light will flash.



5. Connect pipe to saver sub.

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

- Move carriage forward until saver sub meets pipe.
- Slowly rotate spindle clockwise. Carriage will move forward automatically as pipes thread together.

6. Connect new pipe.

Manual Pipeloader Controls	Automated Pipeloader Control
• Slowly move carriage forward until pipe ends touch. • To thread pipes together and fully torque joint, slowly rotate pipe until spindle stops turning and full pressure is developed. • Open wrench. • Open grippers. • Retract shuttles fully. • Lower pipe lifters.	• Slowly move carriage forward until pipe ends touch. • To thread pipes together and fully torque joint, slowly rotate pipe until spindle stops turning and full pressure is developed. • Open wrench. • Press resume. Green control cycle light will come on. • Green control cycle light will come on, grippers will open, shuttles will retract, pipe lifters will lower, and then green control cycle light will flash.

7. Press and hold quick fill fluid pump switch until pipe fills and fluid pressure begins to rise.
8. Rotate spindle.
9. Slowly move carriage forward. Adjust rotation speed control according to bit size and soil conditions.
10. Engage and set cruise control as desired. See "Cruise Control" on page 174.
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 90.
- 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.

JT Mode/AT Dirt Mode

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

AT Mode

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

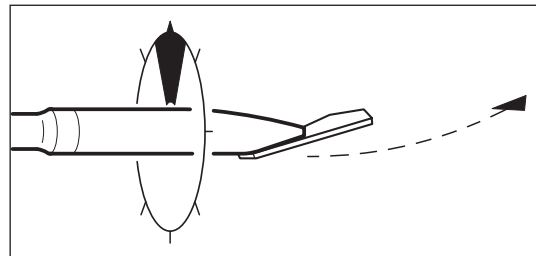
Procedure

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



To change direction:

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

To move forward without changing direction:

JT mode/AT dirt mode	AT mode
Rotate and push pipe into ground.	1. Engage inner rotation. 2. Rotate outer pipe and push 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 750/752 or 8500 Tracker, 750/752 or 8500 Display, a tracking beacon, and special software. The display can store jobs in its memory or the system can be run in the field using a laptop computer equipped with the Windows® 95 or higher operating system. See your Ditch Witch dealer for details.

Surface Drill Head



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

1. Guide drill head to target pit or up through surface. Make all bends gradual. See "Recommended Bend Limits" on page 90.
2. Clean area around exit point.
3. If using tracker control mode, tracker operator turns off tracker to disable drilling unit thrust/pullback and rotation hydraulics. Tracker operator waits for green light to enter pit and change tools.

If not using tracker control mode, tracker operator signals to drilling unit operator to stop engine before changing downhole tools.

4. Turn fluid flow control to off position as soon as drill head emerges.
5. Clean drill head especially around threads.
6. Disconnect EZ-Connect joint or use Hydratong wrenches to remove drill head. Keep threads clean. See "Hydratong Wrenches" on page 167.

Backream



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



⚠ DANGER

Moving tools will kill or injure. Shut off drill string power when anyone can be struck by moving or thrown tools. 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.

NOTICE: Continue to use strike system during backreaming.

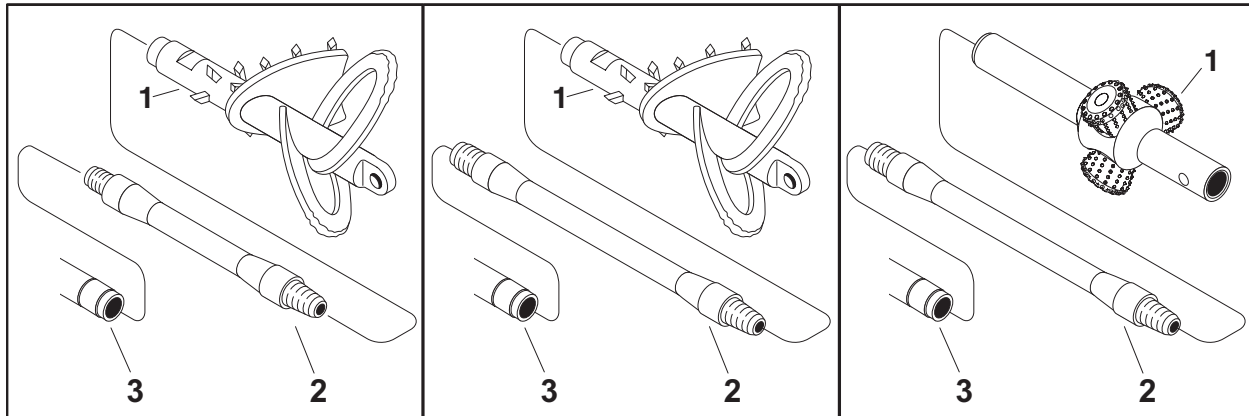


⚠ DANGER

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

NOTICE:

- 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 tracker control (see page 159).
- Do not allow anyone to stand to the side of the exposed drill string. Drill string and backreamer can move sideways suddenly if rotated while away from the exit hole.

Assemble Backream String

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JT mode	AT dirt mode	AT mode
1. backreamer	1. backreamer	1. backreamer
2. transition sub	2. transition sub (p/n 400-1383)	2. transition sub (p/n 400-1383)
3. JT100 Mach 1 drill pipe	3. JT100 All Terrain drill pipe	3. JT100 All Terrain drill pipe

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

1. Select backreaming devices. See "Backreamers" on page 164.
2. Determine fluid rate requirements and install appropriate nozzles to provide sufficient flow. See "Backream Fluid Requirements" on page 165 and "Nozzles" on page 162.
3. Attach backreamer to beacon housing if tracking backream.
4. Install beacon, following beacon instructions for:
 - battery replacement
 - beacon positioning
5. Install beacon housing lid. See page 163.
6. Follow beacon instructions to check beacon operation.
7. Follow tracker instructions to calibrate beacon.
8. Use quick wrenches to attach transition sub to drill pipe string. See "Hydratong Wrenches" on page 167.
9. Use quick wrenches to attach backreamer/beacon housing assembly to transition sub. See "Hydratong Wrenches" on page 167.
10. Attach additional pullback devices or product to end of backreamer/beacon housing assembly.

Begin Backream

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



Remove Pipe

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. Enable automated pipeloader system (automated pipeloader control only). See page 125.
2. Stop carriage when pipes are aligned in wrenches.
3. Clamp pipe in front wrench. See page 120.
4. Clamp and rotate rear wrench to break front joint. See “Rear wrench clamp switch” on page 39 and “Rear wrench rotation switch” on page 39.
5. Disengage rear wrench.
6. Grip pipe.

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

7. Unscrew front joint.
 - Slowly rotate spindle counterclockwise to unscrew pipe. Carriage will move back automatically until threads unscrew.
 - Move carriage back until pipe is properly positioned in rear wrench
8. 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 until front end of pipe is positioned inside front end of pipe box.
 - Stop rotation and grip pipe.
 - Rotate spindle counterclockwise until saver sub is unscrewed from pipe.
 - Move carriage to back of frame.
9. Ensure pipe box is positioned correctly.
10. Load pipe into pipe box.

Manual Pipeloader Controls	Automated Pipeloader Control
• Move shuttle under pipe box. • Release grippers. • Raise lift arms to place pipe in box. • Lube front threads.	• Press resume. • Green control cycle light will come on, shuttles will retract, front threads will be lubed, grippers will release pipe, pipe lifters will raise until pipe is off shuttles, and then green control cycle light will flash.

11. 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.
12. 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. Shut off drill string power when anyone can be struck by moving or thrown tools. Never use pipe wrenches on drill string.

1. Press bottom of drilling unit throttle switch until engine is at low throttle.
2. Turn off drilling fluid.
3. Turn drilling unit engine off.
4. Clean pullback device.
5. Use Hydratong wrenches to remove pullback device. See "Hydratong Wrenches" on page 167.



Systems and Equipment

Chapter Contents



Crane Attachment 139

- Anchor Drilling Unit139
- Remove/Install Pipe Box142
- Troubleshoot Crane System145

Electric Strike System 148

- FCC Statement148
- Assemble Voltage Detector149
- Test Strike System149
- Troubleshoot Strike System150
- Use Electric Strike Simulator152

Drilling Fluid 154

- Guidelines154
- Polymer154
- Bentonite155
- Mixtures155
- Basic Fluid Recipes156
- Drilling Fluid Requirements157
- Funnel Viscosity158

Tracker Control 159

- Overview159
- Operation159

Downhole Tools 162

- Nozzles162
- Bits162
- Beacon Housings163
- Backreamers164
- Backream Fluid Requirements165

Hydratong Wrenches 167**Drill Pipe 170**

- Perform Regular Drill Pipe Care170
- Use Drill Pipe Correctly172

Cruise Control 174

- Engage174
- Adjust Settings174
- Override175
- Disengage175
- Resume175

Machine Diagnostic Codes 175

- Diagnostic Light175
- Code Severity Levels175
- Review Modes176
- Diagnostic Code Interpretation176
- Diagnostic Codes177

Tier 3 Engine 180

- Overview180
- Diagnostic Codes180

Crane Attachment

Anchor Drilling Unit



WARNING

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

NOTICE:

- Drive anchors properly before drilling.
- 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.



DANGER

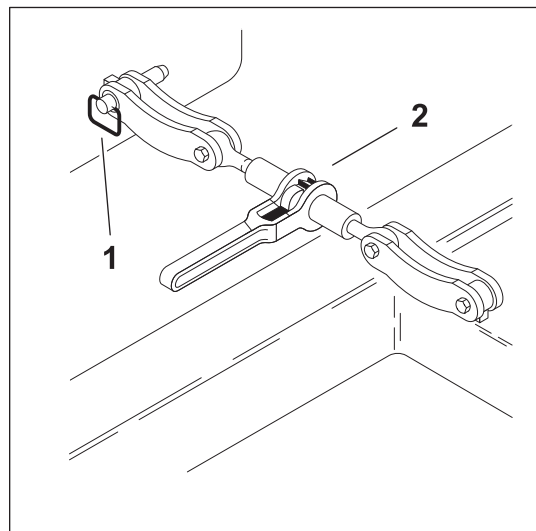
Contacting electrical lines will cause death or serious injury. Know location of lines and stay away.

NOTICE: Maintain minimum clearance of 10' (3 m) between crane or load being lifted and energized power lines.

Drive Anchors

1. With drill frame at desired entry pitch, rotate ratchet binders (2) to lower anchor plate until it rests on ground.
2. Remove pull pins (1).

NOTICE: If pull pins are not removed before drilling, ratchet binders will be damaged.



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**WARNING**

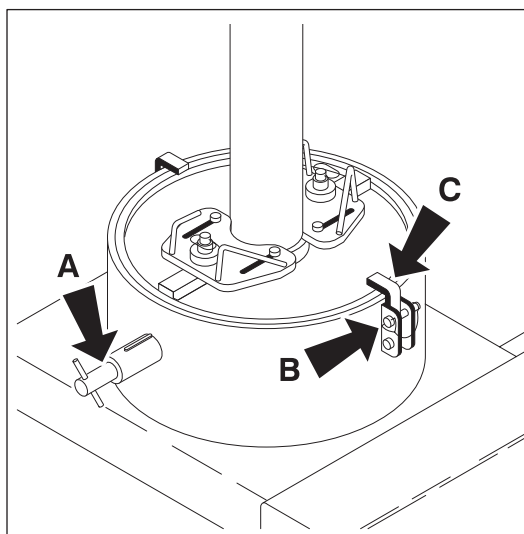
Moving parts could cut off hand or foot. Stay away.

**DANGER**

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

3. Ensure that anchor driver is attached to crane and slowly swing crane boom to front of drilling unit.
4. Attach anchor driver to auger shaft.
5. Using crane, raise auger shaft slightly and release spring loaded pin (A) on side of auger cap.
6. If pin will not release, pull snapper pin (B) and release cap retainer (C).
7. Use crane rotation and boom controls to slowly drive auger into ground.

IMPORTANT: Adjust outer boom while driving auger so that auger shaft maintains 90° angle with ground.



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8. If auger shaft does not drive all the way into ground, use nut driver to tighten nut against auger cap.
9. Detach anchor driver from auger shaft.
10. Lower nut driver onto auger shaft and over nut.
11. Attach anchor driver to nut driver.
12. Use crane rotation and boom controls to slowly rotate nut driver until nut is securely tightened against auger cap.
13. Detach anchor driver from auger shaft or nut driver and raise crane before drilling.

IMPORTANT: Ensure that the crane is not exerting up pressure or down pressure on auger shaft before detaching anchor driver. Excess pressure can cause anchor driver to jerk up suddenly when detached.

Remove Anchors



⚠ DANGER

Contacting electrical lines will cause death or serious injury. Know location of lines and stay away.

NOTICE: Maintain minimum clearance of 10' (3 m) between crane or load being lifted and energized power lines.



⚠ DANGER

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



⚠ WARNING

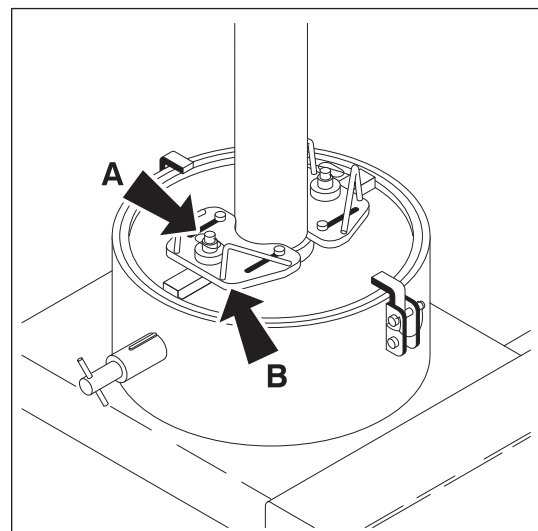
Crushing weight. If load falls or moves, it could kill or crush you. Use proper procedures and equipment or stay away.

1. Start drilling unit engine.
2. Ensure that anchor driver is attached to crane and slowly swing crane arm to front of drilling unit.
3. Attach anchor driver to auger shaft.
4. Use crane rotation and boom controls to slowly remove auger from ground.

IMPORTANT: Adjust outer boom while removing auger so that auger maintains 90° angle with ground.

5. Use latches (B) and pins (A) to secure augers to auger caps.
6. Detach anchor driver from auger shaft and raise crane to safe position.
7. Insert pull pins to connect ratchet binders to drill frame.
8. Rotate ratchet binders to fully raise anchor plate.
9. Put cap retainers in place and insert snapper pins.

IMPORTANT: Cap retainers must be securely in place before driving or transporting machine.



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Remove/Install Pipe Box

**WARNING**

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

NOTICE:

- Always walk around unit and check for obstructions before moving load.
- Keep objects and personnel clear of crane path during operation.
- Do not take your eyes off moving load. Always look in the direction load is moving.
- Never swing a load over people.

**DANGER**

Contacting electrical lines will cause death or serious injury. Know location of lines and stay away.

NOTICE: Maintain minimum clearance of 10' (3 m) between crane or load being lifted and energized power lines.

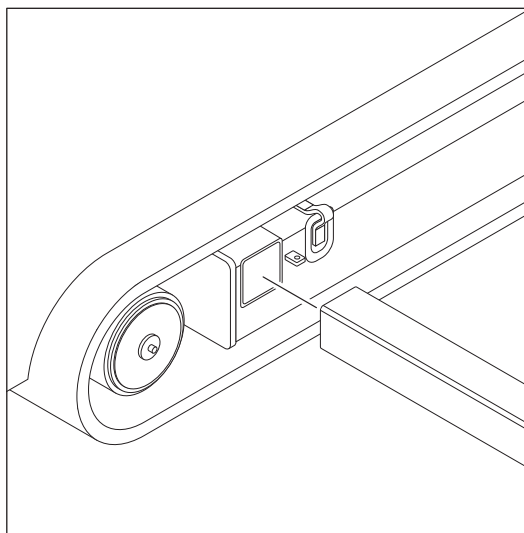
Prepare Crane Attachment

1. Set auxiliary stabilizer.

NOTICE:

- Auxiliary stabilizer is required for all crane use on engine side of unit.
- Due to the weight of the stabilizer, use caution when lifting or use a strap with crane to assist in the lifting.

- Remove bolt and remove tube cap on track frame (shown).
- Insert stabilizer fully into right track frame until hole on tab is lined up with tab on track frame.
- Insert bolt to maintain position of stabilizer but do not tighten nut/bolt.
- Rotate handle clockwise until all slack is removed from stabilizer arm and tube in track frame and load is supported on stabilizer..



j17om003t.eps

NOTICE: If stabilizer does not rest on ground due to holes or grades, it must be blocked up to provide level and firm support for the unit. When working in soft soil conditions, use wide pads under stabilizer foot to prevent sinking.

2. Start drilling unit engine.
3. Unstow crane remote control module and position yourself in full view of the path of the load.
4. Release crane stow strap.
5. Using crane remote control module, slowly swing crane arm to pipe box.

Remove Pipe Box



NOTICE: Lift only one pipe box at a time.

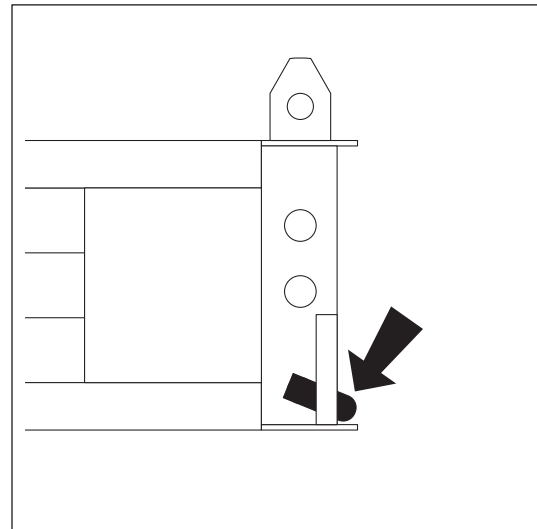
1. Attach crane hook to pipe box lift mount.

NOTICE: Before lifting, always inspect all lifting accessories, including pins, for cracks, bending or other signs of wear. If worn or damaged, do not use. See your Ditch Witch dealer for replacement parts.

2. Remove pin (shown) from each end of box.
3. Use crane boom and extension controls to lift and move one pipe box.

NOTICE:

- When lifting a heavy load, do not operate crane extension and lift controls simultaneously. Operate one at a time and at very slow speeds.
- When lifting fully-loaded AT pipe box, remember that its weight will limit crane reach. See page 21 for load chart capacities and "All Terrain Pipe" on page 234 for pipe box weight.



4. Return crane to stow position and secure with stow strap before transporting.

Install Pipe Box

NOTICE: Lift only one pipe box at a time.

1. Attach pipe box lift mount to center pin of pipe box and attach crane hook.

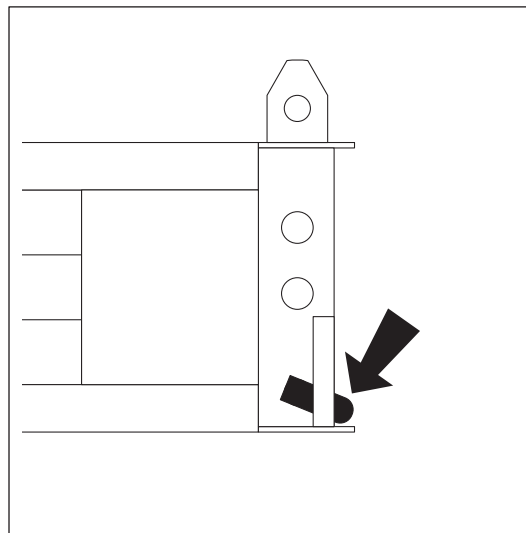
NOTICE: Before lifting, always inspect all lifting accessories, including pins, for cracks, bending or other signs of wear. If worn or damaged, do not use. See your Ditch Witch dealer for replacement parts.

2. Attach chains to vertical slots in each end of pipe box. Station one person at each end of box. Use chains to guide box into position.
3. Use crane extension and lift controls to lift and move box.

NOTICE:

- When lifting a heavy load, do not operate crane extension and lift controls simultaneously. Operate one at a time and at very slow speeds.
- When lifting fully-loaded AT pipe box, remember that its weight will limit crane reach. See page 21 for load chart capacities and "All Terrain Pipe" on page 234 for pipe box weight.

4. Insert pins (shown) into ends of box.
5. Detach crane hook and chains before drilling.



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Troubleshoot Crane System

Problem situations and their possible causes and solutions are listed in the charts below.

Crane Attachment



Problem	Possible cause	Possible solution
Crane won't move	Load too heavy	Check load chart.
	Low fluid level	Check and fill as needed.
	Suction line blocked	Remove hose and clear blockage.
	Pressure line blocked	Remove hose and clear blockage.
	Operator is in seat	Get out of seat.
	Enable switch not turned on	Turn on crane enable switch.
	Main relief valve setting too low or not working properly	Check and adjust.
Poor crane performance	Pump speed	Check pump size and engine speed for proper oil flow. Check oil flow with flow meter installed in pressure line.
	Low fluid level	Check and fill.
	Main relief valve setting	Check and adjust.
	Worn pump, motor or cylinder	Replace bad part.
	Blocked filters	Check suction and return filters.
	Low hydraulic fluid temperature	Circulate fluid to warm.
	Pressure or suction lines blocked	Check lines; clean and repair.
	Load too heavy	Check load chart.
Noise	Pump area	Circulate oil to warm; check suction line; fill reservoir.
	Cylinders	Check for damage to cylinders.
	Rotation	Check rotation bearing; lubricate bearing.

Problem	Possible cause	Possible solution
Cylinder drift	Overload	Remove overload.
	Holding valve relief set too low	Replace as required.
	Damaged cylinder	Repair.
	Dirt in holding or check valve	Cycle under no load to reset; clean and/or replace.
	Air in hydraulic system or entrapped in cylinder.	Cycle cylinder to remove air.

Optional Crane Remote Control

Problem	Possible cause	Possible solution
Crane operates at full speed/No trigger control	Proportional valve manual override screwed in	Unscrew manual override.
	Trigger potentiometer voltage too high	Adjust trigger voltage to 0.4-0.6V when trigger is released and/or replace.
Crane will not operate with remote pendant	No power	Check voltage at terminal 14.
	Blown fuse	Check wiring; replace 8A fuse.
	Amplifier not adjusted properly	Check amplifier setup and output.
	Trigger potentiometer voltage output not changing	Check trigger voltage output.
	Power relay not operating correctly	Check relay wiring.
Crane operation is erratic	Power build-up solenoid wiring loose	Check wiring at power build-up solenoid.
	Trigger potentiometer voltage erratic	Check voltage output for smooth, consistent change as trigger is pulled.
	Wiring connections at terminal strip, pendant, and receptacles	Check wiring connection; replace if required.
Two functions operate at the same time	Wires shorted together at terminal strip, pendant head, or receptacles.	Check wiring; replace wiring harness if required.
	Hydraulic contamination in solenoid cartridge.	Remove and clean cartridge; clean hydraulic system.



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 ANSI Z-41, 1991, when tested at 14,000 volts. Tuck legs of pants completely inside boots.
- Gloves must have 17,000 AC maximum use voltage, according to ASTM specification D120-87.

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 87. Review safety procedures before each job.

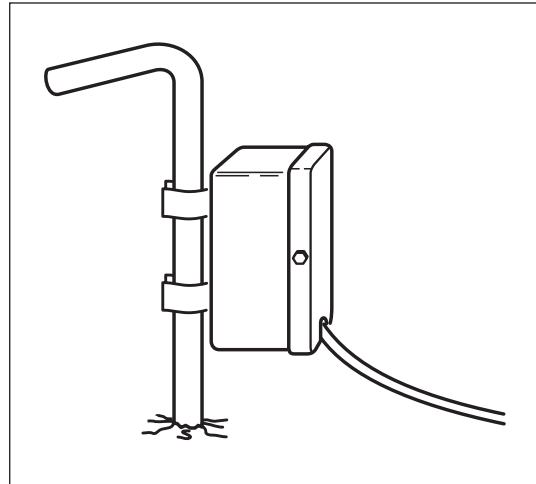
FCC Statement

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

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

Assemble Voltage Detector

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



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Test Strike System

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

1. Turn on drilling unit.
2. ESID control module will perform internal tests which check everything but alarms and strobe.
3. If green OK indicator and electrical power supply indicator lights remain on, press self test button to perform total test of strike system. During this test:
 - All lights should glow.
 - Alphanumeric readout should display numbers.
 - Alarms and strobes 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 152.

Troubleshoot Strike System

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

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

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

Problem	Possible cause	Possible solution
Strobe light on drilling unit does not work during total test	Improper connections with control module	Check connections and wiring harness
	Defective strobe light	1. Disconnect strobe and connect to external 12V power source. 2. If strobe does not work, replace it.
	Defective control module	Have control module checked or replaced
Alarm on drilling unit does not work during total test	Improper connections with control module	Check connections and wiring harness
	Defective alarm	1. Disconnect strobe and connect to external 12V power source. 2. If strobe does not work, replace it.
	Defective control module	Have control module checked or replaced
Strobe light and alarm on drilling unit do not work during total test	Improper connections with control module	Check connections and wiring harness
	Defective control module	Have control module checked or replaced
EC2 code displays and current problem indicator is on	Improper connections with control module	Check cable connections on control module and current transformer
	Defective current transformer	1. Disconnect current transformer. 2. Check for 20-40 ohms from pin 1 to pin 4, 20-40 ohms from pin 1 to pin 2, and less than 1 ohm from pin 2 to pin 4.
	Defective current transformer cable	1. Disconnect cable from transformer and control module. 2. Check continuity of cable. 3. If continuity is zero or cable is damaged, replace.
	Defective control module	Have control module checked or replaced
EV2 code displays and voltage problem indicator is on	Improper connections with control module	Check cable connection on control module
	Defective voltage limiter	Have voltage limiter checked or replaced
	Defective control module	Have control module checked or replaced



Use Electric Strike Simulator

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

Current Test

To test for current at normal levels:

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

To test for current at strike levels:

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

With two loops,

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

With three loops,

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

Voltage Test

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



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

Drilling Fluid

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

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

Guidelines

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

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

Polymer

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

There are two types of polymer:

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

Bentonite

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

Some things to remember when mixing bentonite:

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

For information on measuring funnel viscosity, see "Funnel Viscosity" on page 158.

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.

NOTICE:

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

General mixing order:

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

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



Basic Fluid Recipes

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

Drilling Fluid Requirements

1. Determine drilling conditions and choose appropriate drilling fluid mix.
2. Estimate amount of supplies needed and check availability.
 - Drilling fluid
 - Water supply. If more water than can be carried with the unit will be needed, arrange to transport additional water.
 - Bentonite and/or polymer
3. Check water quality.
 - Use meter or pH test strips to test pH of water. If pH is below 9.0, add 1 cup (.25 L) soda ash per tank. Test and repeat until pH is between 9 and 10.
 - Check water hardness using hardness test strips. Treat with soda ash if hardness exceeds 125 ppm.



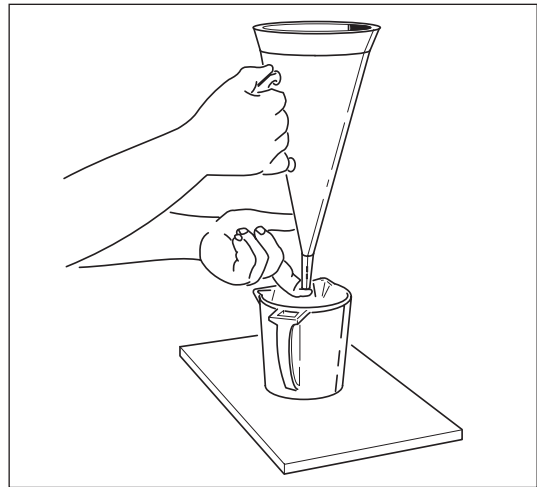
Funnel Viscosity

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

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

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

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



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Tracker Control

Overview



WARNING

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



This mode allows the 750/752 or 8500 Tracker operator to disable hydraulic power to drilling unit thrust and rotation.

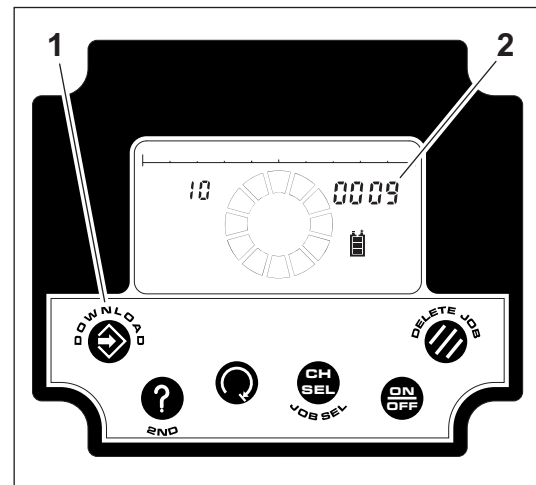
NOTICE: This mode does not disable thrust and rotation immediately. Functions are disabled within 16 seconds.

Use tracker control any time you change downhole tools or during other times when the drill string is exposed. Tracker control works by stopping communication between the tracker and the display. When this happens, the green tracker control light on the drilling unit comes on and thrust and rotation are disabled.

Operation

Enable Thrust and Rotation

1. Start drilling unit.
2. Turn off 750/752 or 8500 Display.
3. Press and hold DOWNLOAD (1) while turning on 750/752 or 8500 Display until a four-digit code (2) appears.



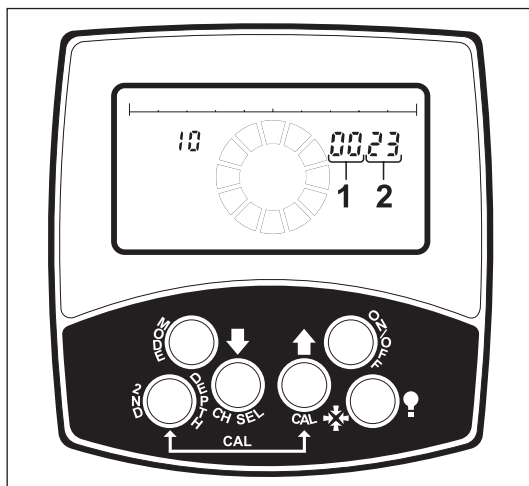
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4. Turn on 750/752 or 8500 Tracker and check four-digit code.

If codes on tracker and display match, thrust and rotation hydraulics on the drilling unit are enabled.

If codes on tracker and display do not match, adjust tracker code:

- Press and hold fore/aft/left/right button while making the following adjustments.
- Use ON/OFF to advance first two digits (1). Use DEPTH to lower first two digits.
- Use up arrow to advance last two digits (2). Use down arrow to lower last two digits.
- Press and hold each button to advance or lower value quickly.
- To start sending code from the tracker to the display, press and hold fore/aft/left/right button and press MODE. Thrust and rotation hydraulics on the drilling unit are now enabled.

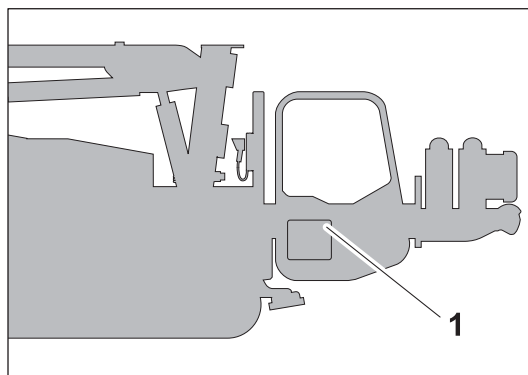


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Troubleshooting Tip: If thrust and rotation are not enabled:

- Check whether the green tracker control light located on drilling unit is on. If it is, communication has probably stopped between tracker and display, or tracker is set to incorrect code.
- If communication cannot be restored, install tracker control key (1) in drilling unit. Green tracker control light located on drilling unit will go off. Thrust and rotation will function.

5. Remove tracker control key (1) from compartment outside drilling unit cab. Keep in tracker operator's possession.
6. Drill and track bore.

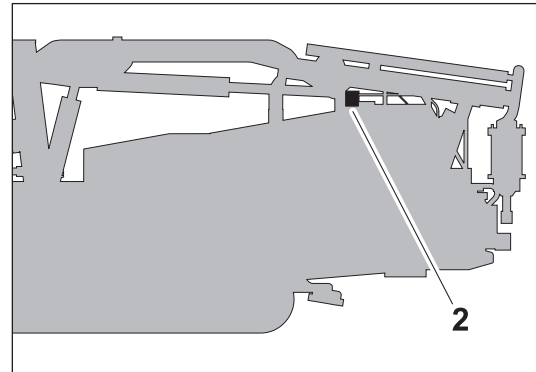


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Disable Thrust and Rotation

1. When drill head enters target pit or exits the ground, turn off tracker.

After 8-16 seconds, green tracker control light (2), located on drilling unit, will come on. Hydraulic power to thrust and rotation will be disabled.



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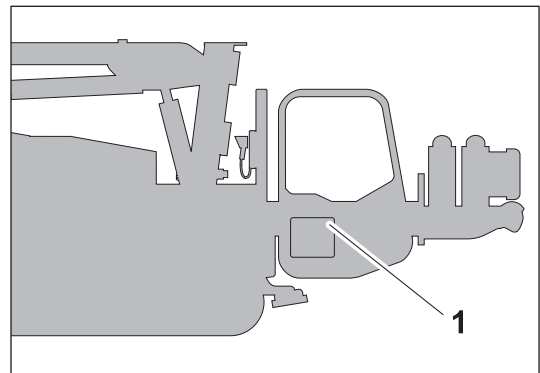
IMPORTANT: Tracker operator cannot disable thrust and rotation from tracker if tracker control key (1) is installed in drilling unit and turned to the disable position. See below for more information about tracker control key.



WARNING

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

NOTICE: If you are not using tracker control, turn off drilling unit before changing downhole tools.



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2. Change downhole tools.
3. **If you are tracking backreamer's path**, turn on tracker and enable code transmission. After 8-16 seconds, green tracker control light on drilling unit will go off and thrust and rotation will function.

If you are not tracking backreamer's path, install tracker control key (1) on drilling unit. Green tracker control light on drilling unit will go off and thrust and rotation will function.

Tracker Control Key Function

Item	Description	Notes
c00ic063h.eps	To allow tracker operator to stop thrust and rotation, move key to enable position (up). To override tracker control mode, move key to disable position (right).	IMPORTANT: Remove key and keep in tracker operator's possession.

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.

Beacon Housings

Beacon Installation

To ensure beacon is installed correctly in housing, see beacon information.

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/min.
2. Multiply this number by distance per minute you plan to backream. The answer is an estimate of amount of fluid you will need for each minute of backreaming.	U.S. 1.5 gal x 2 ft/min = 3 gal for each minute of backreaming.
	Metric 18 L x .5 m/min = 9 L for each minute of backreaming

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

Backream Fluid Requirements

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

Hydratong Wrenches

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

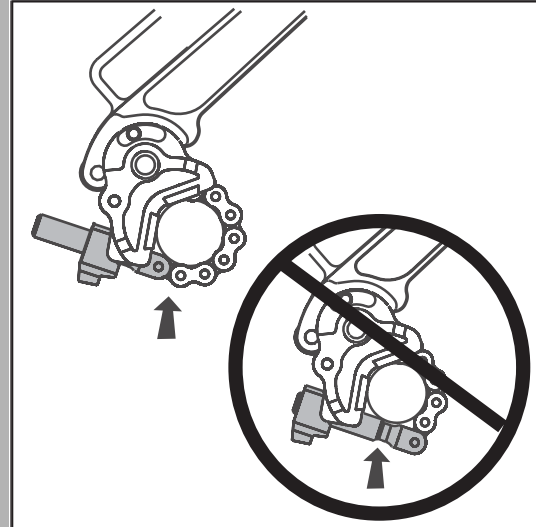


WARNING

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

NOTICE:

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



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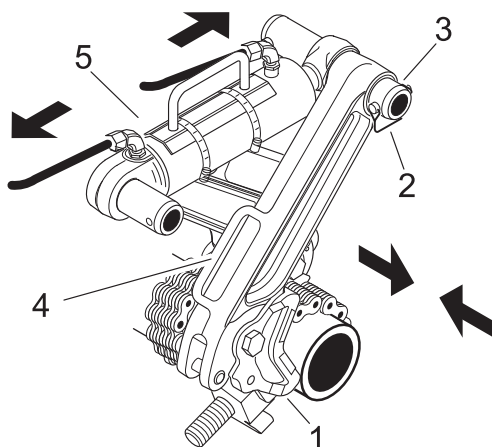


DANGER

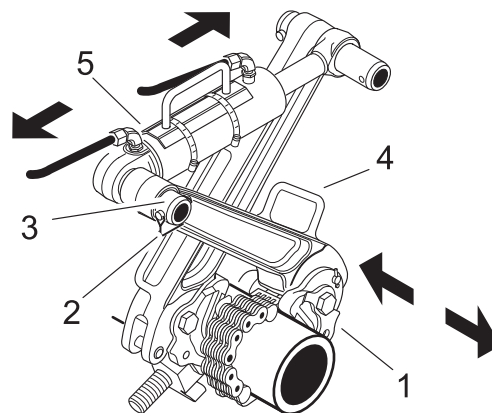
Moving tools will kill or injure. Shut off drill string power when anyone can be struck by moving or thrown tools. Never use pipe wrenches on drill string.



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



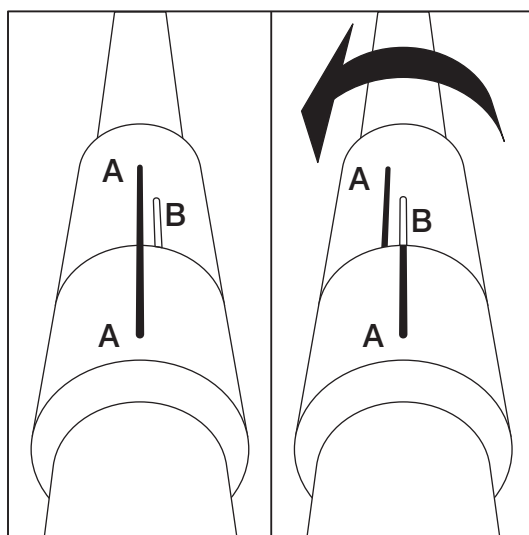
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Join**Break**

IMPORTANT: Ensure arms are crossed before using wrench.

- Attach chain tongs (1) to both sides of joint. Place tongs as close to joint as possible.
 - Remove snapper pins (2) from slide pins (3), and insert slide pins into wrench handles (4).
 - Attach each end of hydraulic cylinder (5) to slide pins and insert snapper pins.
3. Remove all slack from wrench and joint.
 4. To join, scribe straight line across joint on both sides of separating line (A).
 5. To join, scribe second line (B) on moveable side of joint in the opposite direction of tightening action. Refer to table for correct dimension.

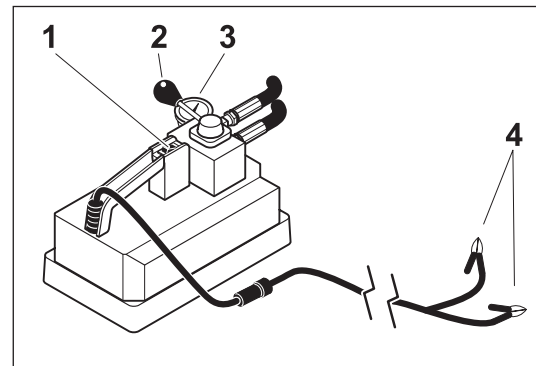
Connection	Dimension
transition sub to JT100 Mach 1 pipe	3/8" (9.5 mm)
transition sub to beacon housing	3/8" (9.5 mm)
transition sub to JT100 All Terrain pipe	7/16" (11 mm)
transition sub to back reamer	3/8" (9.5 mm)



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6. Connect Hydratong power pack.
 - Attach hoses from power pack to cylinder.
 - Attach leads (4) to 12V battery.
7. To tighten or loosen joint, move shuttle valve handle (2) toward gauge (3) and press power switch (1).
8. To reposition chain tongs and continue tightening or loosening joint, move handle away from gauge, then back toward gauge, and then press power switch.
9. Monitor gauge and refer to decal to achieve approximately 4000 ft•lb (5420 N•m) of torque. Then tighten joint until second line (B) meets first (A).

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



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10. Move handle to center (neutral) position to relieve pressure.
11. Disconnect hoses and remove Hydratong 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 "Recommended Lubricants/Service Key" on page 192 for correct lubricant.
2. Join pipe and tighten joint.
3. Break joint.
4. Move pipe back to box.

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

Lubricate Joints Before Each Use

Lubricate threads and shoulders of male joints with copper base tool joint compound. This prevents rust and reduces wear on shoulders and threads. See "Recommended Lubricants/Service Key" on page 192 for correct lubricant.

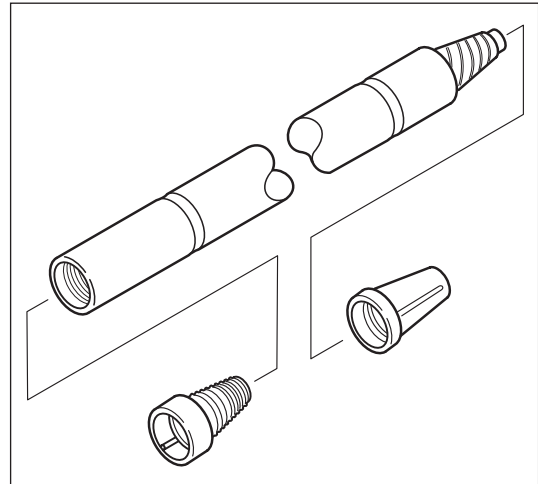
Clean the Threads

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

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

Use Caps and Plugs

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



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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 "Replace Saver Sub" on page 221 for replacement procedure.

Precondition a new saver sub the same way you do new pipe. See "Precondition New Pipe" on page 170.

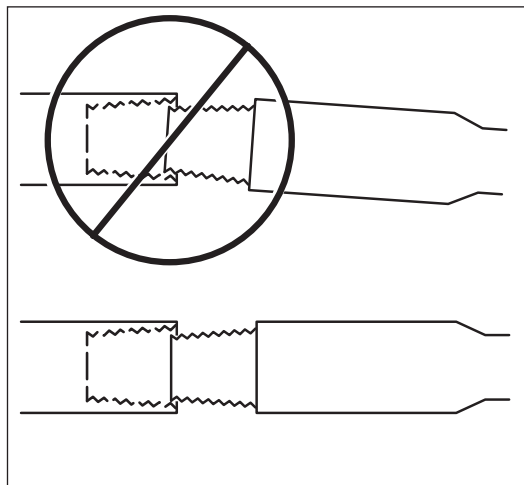
Rotate Pipe Order

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

Use Drill Pipe Correctly

Align the Joints

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

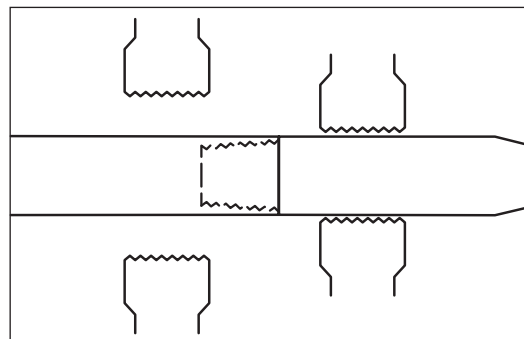


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Clamp Pipe Correctly

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

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



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See "Clamp Pipe" on page 120 for more information.

Make Up and Break Out Joints Correctly

Assisted Makeup protects threads by automatically matching carriage movement speed to rotation during makeup and breakout. Operator controls **rotation speed** while the unit controls carriage travel.

- To connect pipes together and fully tighten joint, slowly rotate pipe as threads come in contact. Carriage will move forward automatically as threads engage. Continue rotation until spindle stops turning and full pressure is developed. Improperly tightened joints will damage the shoulder faces and threads, and will cause joints to leak or break while drilling or backreaming.
- To disconnect pipes, slowly rotate spindle counterclockwise. Carriage will move back automatically until threads fully separate.



If assisted makeup is not functioning, thrust and rotation will stop upon reaching the front or rear thrust home positions. Operator controls **carriage travel** while unit controls rotation speed. To continue to make up or break out, press and hold dual speed carriage control switch and follow these two steps:

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

Do not Overwork the Pipe

Never exceed the bend radius for your pipe. See “Plan Bore Path” on page 89. Do not oversteer.

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

Cruise Control

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

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

Engage

Thrust/Pullback and Rotation Control	Thrust/Pullback Control Only
1. Position joystick so that thrust or pullback and rotation are at desired speeds. 2. Press set. Green control cycle light will come on. 3. Release joystick.	1. Position joystick to desired thrust or pullback setting. 2. Press set. Green control cycle light will come on. 3. Release joystick. 4. Operator controls rotation with joystick.

Adjust Settings

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

Override

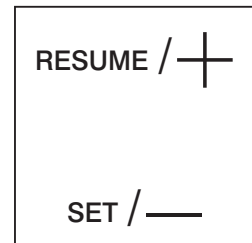
- To override settings, move joystick out of neutral and beyond current setting. Unit will increase to new setting.
- To return to previous setting, release joystick.

Disengage

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

Resume

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



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Diagnostic Codes

Diagnostic Light

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

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

Code Severity Levels

Diagnostic codes are given one of two levels of severity.

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



Review Modes

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

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

Diagnostic Code Interpretation

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

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

Tips for interpreting codes:

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

Diagnostic Codes

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

Code	Condition	Result	Severity
12	normal review mode entry	code is not stored	n/a
13	no 12V power to controller	drill and drive are blocked	essential
14	no 5V power from controller	drill and drive are blocked	essential
15	unknown output driver continuity problem	code is stored	non-essential
21	no continuity to front wrench clamp solenoid	code is stored	non-essential
22	no continuity to front wrench unclamp solenoid	code is stored	non-essential
23	no continuity to thrust brake solenoid	code is stored	essential
25	no continuity to wrench cw rotate solenoid	code is stored	non-essential
31	no continuity to wrench ccw rotate solenoid	code is stored	non-essential
34	no continuity to pipe lift solenoid	add pipe or remove pipe is aborted and code is stored	non-essential
35	no continuity to pipe lower solenoid	add pipe or remove pipe is aborted and code is aborted	non-essential
41	no continuity to pipe grip solenoid	add pipe or remove pipe is aborted and code is stored	non-essential
42	no continuity to pipe release solenoid	add pipe or remove pipe is aborted and code is stored	non-essential
44	no continuity to lube front solenoid	add pipe or remove pipe is aborted and code is stored	non-essential
45	no continuity to carriage two speed solenoid	code is stored	non-essential
51	no continuity to rotation cw solenoid	cruise control is blocked	essential
52	no continuity to rotation ccw solenoid	cruise control is blocked	essential
53	no continuity to thrust forward solenoid	cruise control is blocked	essential
54	no continuity to thrust backward solenoid	cruise control is blocked	essential



Code	Condition	Result	Severity
55	no continuity to left track forward solenoid	drive is blocked	essential
66	6V internal supply is bad	drill and drive are blocked	essential
111	no continuity to left track reverse solenoid	drive is blocked	essential
112	no continuity to right track forward solenoid	drive is blocked	essential
113	no continuity to right track reverse solenoid	drive is blocked	essential
114	no continuity to drilling fluid pump solenoid	code is stored	essential
115	no continuity to variable rotation solenoid	code is stored	non-essential
122	no continuity to check valve solenoid	code is stored	non-essential
131	no continuity to thrust rear home switch	add pipe and remove pipe are blocked	non-essential
132	no continuity to thrust front home switch	add pipe and remove pipe are blocked	non-essential
133	no continuity to shuttle home switch	add pipe and remove pipe are blocked	non-essential
134	no continuity to front wrench switch	add pipe and remove pipe are blocked	non-essential
144	drive joystick left/right out of range	drive is blocked	essential
145	drive joystick forward/backward out of range	drive is blocked	essential
151	drill joystick left/right out of range	rotation and cruise control are blocked	essential
152	drill joystick forward/backward out of range	thrust and cruise control are blocked	essential
153	inner rot jog pot	add pipe and remove pipe are blocked	non-essential
154	drilling fluid potentiometer out of range	code is stored	essential
155	rotation potentiometer is out of range	code is stored	non-essential
166	no continuity to thrust rear stop switch	add pipe and remove pipe are blocked	non-essential

Code	Condition	Result	Severity
215	no continuity to float position sensor	assisted makeup is blocked and code is stored	non-essential
221	system voltage is below 12.5V	code is stored	non-essential
233	drill and drive inputs both on	drill and drive are blocked	essential
234	add pipe and remove pipe inputs both on	add pipe and remove pipe are blocked	non-essential
235	front home and rear home inputs both on	add pipe and remove pipe are blocked	non-essential
241	shuttles not responding correctly	add pipe or remove pipe is aborted and code is stored	non-essential
242	front wrench not responding correctly	add pipe or remove pipe is aborted and code is stored	non-essential
245	controller is wrong or unidentifiable	all functions are blocked	essential
251	float sensor is reading out of range	assisted makeup is blocked and code is stored	non-essential
253	internal controller error	code is stored	non-essential
254	error reading setup table information	add pipe and remove pipe are blocked	essential
255	undefinable diagnostic code reported	code is stored	non-essential



Tier 3 Engine

Overview

This Tier 3 engine has a self-diagnostic computer-controlled fuel management system. A variety of sensors send input data to an ECU (Electronic Control Unit) that compares inputs with pre-programmed memory and sends output voltage to a variety of actuators to adjust and operate the engine within specified parameters.

Warning indicators on the diagnostic gauge and engine diagnostic indicator tell the operator when critical and non-critical faults develop. Non-critical faults occur when engine sensors detect moderate trouble. Non-critical faults cause the engine diagnostic indicator and diagnostic gauge to light. Critical faults cause the engine diagnostic indicator to flash and engine diagnostic gauge to light (red). In both cases, a fault code is stored in the ECU. If the fault causes the engine to derate power but is able to correct itself, the engine will gradually return to normal power. The engine diagnostic indicator will continue to flash until the trouble goes away, but a diagnostic code will remain stored.

Engine shutdown will occur due to critical faults in engine oil pressure.

Engine Diagnostic Codes

Problems with the Tier 3 engine usually are indicated by the diagnostic gauge on the right control console and by a diagnostic code displayed on the diagnostic gauge.

IMPORTANT: For more information on the operator alert indicator and how to operate and read the diagnostic gauge, see page 35.

Operator Alert Indicator

When a non-critical engine fault occurs, the operator alert indicator on the gauge cluster will light. A fault code will be stored in the diagnostic gauge.



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Diagnostic Gauge

The diagnostic gauge displays two types of codes:

Code type	Display	Definition
active (service) code	SRVCCODE	indicates an error that is occurring immediately
stored code	STORCODE	indicates an error that has occurred previously



For code explanations, see the following pages.

Active Codes

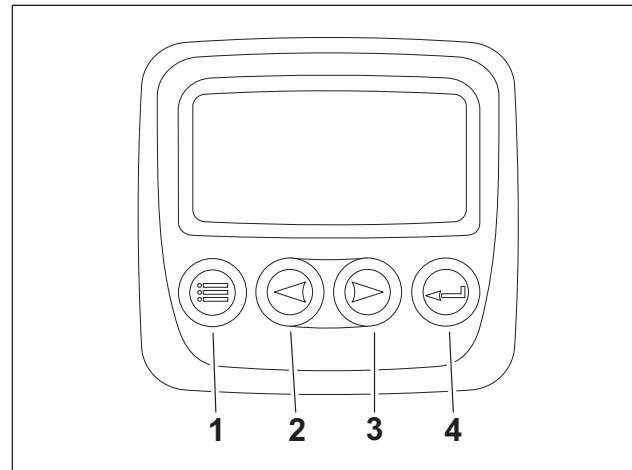
Active codes are displayed when active.

Stored Codes

1. Push menu button (1).
2. Scroll down to stored codes with right arrow button (3).
3. Push enter button (4).

To clear codes:

1. Hold down the diagnostic button and then turn ignition switch on.
2. Continue to hold down diagnostic button for 10 seconds until code clears.



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- | | |
|----------------------|-----------------------|
| 1. Menu button | 3. Right arrow button |
| 2. Left arrow button | 4. Enter button |

Engine Diagnostic Codes

Two-line diagnostic code	Fault Code	Description	Possible Cause
SPN 94, FMI 3, 4, 11	90	Fuel low pressure sensor	Cable break or short circuit
SPN 94, FMI 2, 11	91	Fuel low pressure	Below target range with system reaction
SPN 97, FMI 3, 4, 11	87	Fuel filter water level sensor	Cable break or short circuit
SPN 97, FMI 11, 12	89	Water level in fuel filter	Above target range
SPN 100, FMI 0, 2, 3, 4	196	Oil pressure sensor	Cable break or short circuit
SPN 100, FMI 1, 11	197	Oil pressure sensor	Pressure value implausible low
SPN 100, FMI 0, 11	198	Oil pressure	Above target range
SPN 100, FMI 1, 11	199	Oil pressure	Below target range
SPN 102, FMI 2, 3, 4	32	Charge air pressure sensor	Cable break or short circuit
SPN 102, FMI 2, 11	33	Charge air pressure	Outside target range with system reaction
SPN 105, FMI 2, 3, 4, 11	149	Charge air temperature sensor	Cable break or short circuit
SPN 105, FMI 0, 11	150	Charge air temperature	Above target range with system reaction
SPN 108, FMI 2, 3, 4, 11	16	ECU internal error	Ambient pressure sensor defective
SPN 110, FMI 2, 3, 4	55	Coolant temperature sensor	Cable break or short circuit
SPN 110, FMI 0, 11	56	Coolant temperature	Outside target range with system reaction
SPN 157, FMI 3, 4, 11	209	Rail pressure sensor	Cable break or short circuit
SPN 157, FMI 0, 1, 11	210	Rail pressure sensor	Deviation of signal during start or after-run above target range
SPN 168, FMI 0, 1, 11	22	Battery	Voltage below target range
SPN 168, FMI 2, 11	23	Battery voltage	Above target range with system reaction
SPN 174, FMI 3, 4, 11	133	Fuel temperature sensor	Cable break or short circuit
SPN 174, FMI 0, 11	134	Fuel temperature	Above target range with system reaction
SPN 175, FMI 2, 3, 4	201	Oil temperature sensor	Cable break or short circuit
SPN 175, FMI 0, 11	203	Oil temperature	Below target range with system reaction

Two-line diagnostic code	Fault Code	Description	Possible Cause
SPN 190, FMI 11, 12	75	Engine speed sensor	Engine running with cam-shaft speed signal only
SPN 190, FMI 8, 11, 12	76	Engine speed sensor	Speed signal from cam-shaft bad or missing
SPN 190, FMI 8, 11, 12	77	Engine speed sensor	Speed signal from crank-shaft bad or missing
SPN 190, FMI 2, 11	78	Engine speed sensor	Speed signal from crank-shaft and cam-shaft are phase shifted
SPN 190, FMI 0, 11	79	Over speed	Engine overspeed with system reaction
SPN 190, FMI 11, 14	80	Overrun conditions	Overrun conditions with system reaction
SPN 520, FMI 11, 12	126	CAN message	Missing (message "TSC1-TR")
SPN 563, FMI 7, 11, 12	187	Main relay	Short circuit to ground or emergency shut-off (relay 3)
SPN 624, FMI 2, 3, 4, 5	225	Diagnostic lamp	Cable break or short circuit, disable by ECU
SPN 630, FMI 11, 12	142	ECU internal error	EEPROM memory access
SPN 639, FMI 11, 14	192	CAN buss off-state	Cable break or short circuit, off-state (CAN bus A)
SPN 651, FMI 3, 4, 11, 13	159	Single injector	Short circuit (injector 1)
SPN 651, FMI 5, 13	160	Single injector	Cable break (injector 1)
SPN 652, FMI 3, 4, 11, 13	161	Single injector	Short circuit (injector 2)
SPN 652, FMI 5, 13	162	Single injector	Cable break (injector 2)
SPN 653, FMI 3, 4, 11, 13	163	Single injector	Short circuit (injector 3)
SPN 653, FMI 5, 13	164	Single injector	Cable break (injector 3)
SPN 654, FMI 3, 4, 11, 13	165	Single injector	Short circuit (injector 4)
SPN 654, FMI 5, 13	166	Single injector	Cable break (injector 4)
SPN 655, FMI 3, 4, 11, 13	167	Single injector	Short circuit (injector 5)
SPN 655, FMI 5, 13	168	Single injector	Cable break (injector 5)
SPN 656, FMI 3, 4, 11, 13	169	Single injector	Short circuit (injector 6)
SPN 656, FMI 5, 13	170	Single injector	Cable break (injector 6)
SPN 676, FMI 4, 11	19	Air heater relay	Cable break or wrong connection



Two-line diagnostic code	Fault Code	Description	Possible Cause
SPN 676, FMI 2, 5, 11	20	Air heater relay	Inoperable during shut-off
SPN 703, FMI 2, 3, 4, 5	81	Engine operating signal lamp	Cable break or ECU internal error
SPN 704, FMI 11	54	Coolant temperature warning lamp	Cable break or short circuit
SPN 705, FMI 2, 3, 4, 5	195	Oil pressure warning lamp	Cable break or short circuit
SPN 729, FMI 3, 4, 5, 11	17	Air heater relay	Cable break or short circuit
SPN 730, FMI 3, 4, 5, 11	18	Air heater magnetic valve	Cable break or short circuit
SPN 898, FMI 11, 12	125	CAN message	Missing (message "TSC1-TE")
SPN 923, FMI 2, 3, 4, 5	74	Engine power output	Cable break or short circuit
SPN 1079, FMI 3, 4, 11	219	ECU internal error	Wrong voltage of internal 5V reference source 1
SPN 1080, FMI 3, 4, 11	221	ECU internal error	Wrong voltage of internal 5V reference source 2
SPN 1081, FMI 2, 3, 4, 5	53	Preheating signal lamp	Cable break or short circuit
SPN 1109, FMI 2, 11	48	Shut-off request	Shut-off request ignored by operator
SPN 1322, FMI 11, 12	46	Multiple cylinder	Misfire detected
SPN 1323, FMI 11, 12	38	Single cylinder	Misfire detected (cylinder 1)
SPN 1324, FMI 11, 12	39	Single cylinder	Misfire detected (cylinder 2)
SPN 1325, FMI 11, 12	40	Single cylinder	Misfire detected (cylinder 3)
SPN 1326, FMI 11, 12	41	Single cylinder	Misfire detected (cylinder 4)
SPN 1327, FMI 11, 12	42	Single cylinder	Misfire detected (cylinder 5)
SPN 1328, FMI 11, 12	43	Single cylinder	Misfire detected (cylinder 6)
SPN 1346, FMI 0, 11	47	Misfire	Misfire detected with system reaction
SPN 2634, FMI 3, 11	182	Main relay	Short circuit to Ubatt (relay1)
SPN 2634, FMI 4, 11	183	Main relay	Short circuit to ground (relay 1)
SPN 2634, FMI 7, 11, 12	186	Main relay	Short circuit to ground or emergency shut-off (relay 2)
SPN 2634, FMI 7, 11, 12	188	Main relay	Short circuit to ground or emergency shut-off (relay 3)

Complete the Job

Chapter Contents

Antifreeze Drilling Unit 186

Rinse Equipment 187

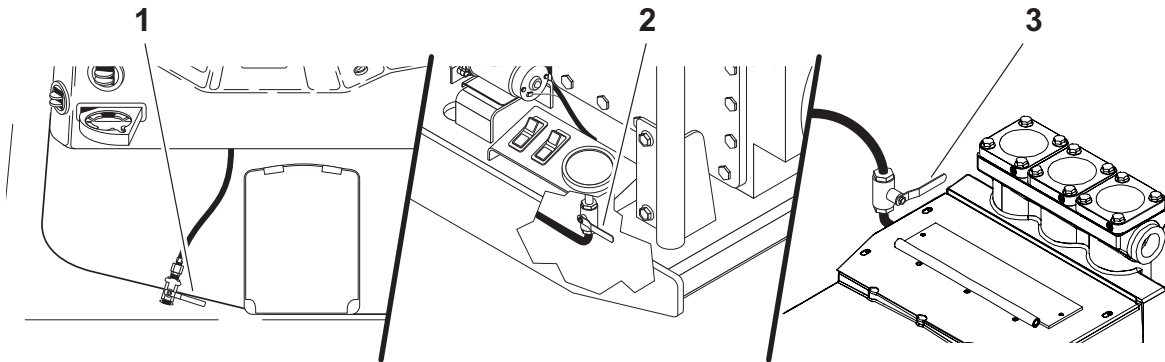
Disconnect 188

Stow Tools 188



Antifreeze Drilling Unit

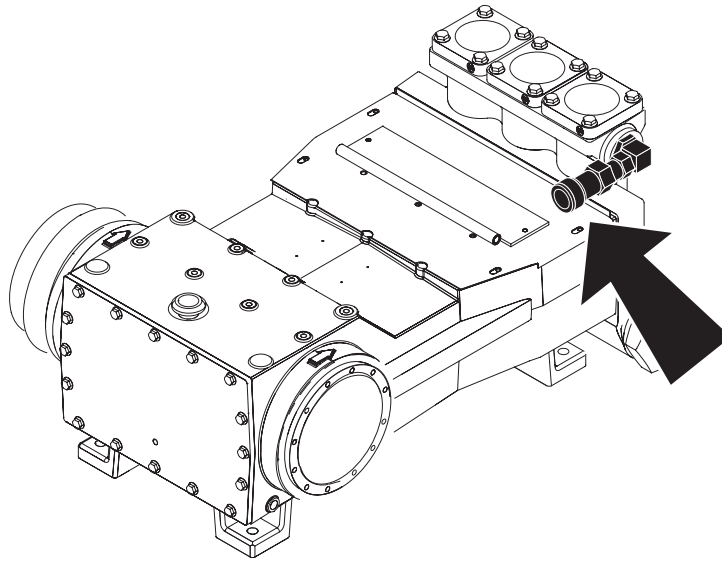
Your drilling unit can be left overnight in freezing conditions by circulating a polypropylene-based antifreeze (p/n 265-644) through unit before shutdown.



j280m130t.eps

1. Fill antifreeze tank with 27 gal (102 L) of approved antifreeze.
2. Install plug on suction side of drilling fluid pump.
3. Open valve (3) between antifreeze tank and drilling fluid pump.
4. Open valves under water pressure gauges in cab (1) and on fluid pump (2).
5. Turn drilling fluid potentiometer counterclockwise to zero position.
6. Start unit and set throttle to slow position.
7. Set drilling fluid pump switch to on position.
8. Slowly turn drilling fluid potentiometer clockwise until indicator light comes on.
9. Run drilling fluid pump until antifreeze comes out of spindle.
10. Turn drilling fluid pump switch to off position.
11. Close valve (1) between antifreeze tank and drilling fluid pump.
12. Close water pressure gauge valves (1,2).

Rinse Equipment



j170m091h.eps

Connect wash wand at fluid pump (shown) and spray water onto equipment to remove dirt and mud. Some pressure might be needed to remove dried mud from wrench area.

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



Disconnect

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

- electric cable
- electric strike system voltage stake
- fluid hose

Stow Tools

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

Prepare Drilling Unit to Load

Ensure that crane is in stow position, operator's station is in driving position, pipelader guard is up, and fuel tank is at least half full.

Service

Chapter Contents

Service Precautions 190

- Working Under Drilling Unit190
- Welding191
- Jump Starting191
- Washing191

Recommended Lubricants/Service Key 192

- Engine Oil Selection Chart193
- Approved Coolants193
- Approved Fuel193
- Fuel Sulfur Information193

Each Use 194

10 Hour 195

25 Hour 203

50 Hour 204

100 Hour 210

500 Hour 213

1000 Hour 214

2000 Hour 219

As Needed 221



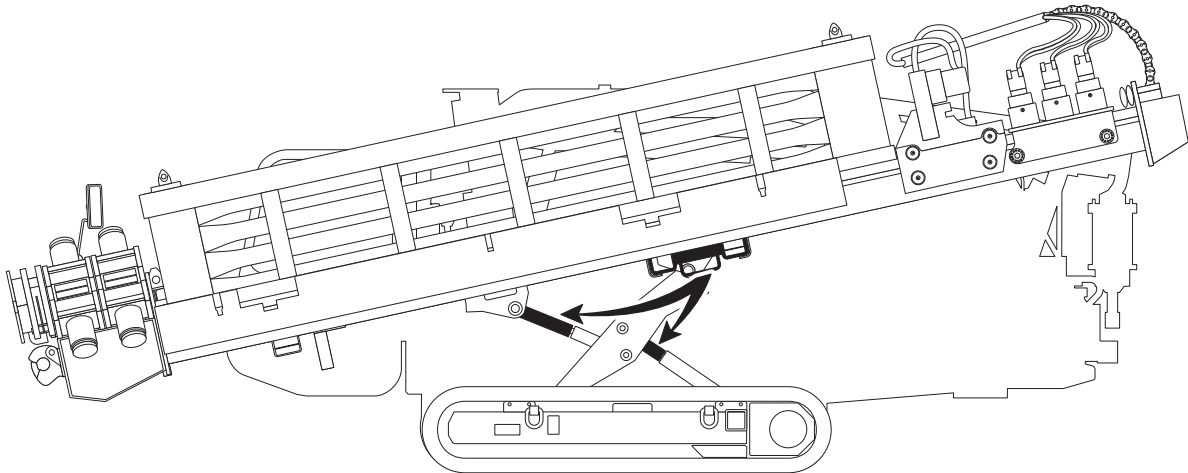
Service Precautions

**⚠ WARNING**

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

NOTICE: Unless otherwise instructed, all service should be performed with engine off.

Working Under Drilling Unit



j28om001h.eps

**⚠ 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 cylinder**, make sure drilling unit is parked on hard surface.

1. Remove cylinder locks from storage at rear of pipe box.
2. Place over extended cylinder rods (shown) with curved ends toward rod ends of cylinders.

Replace cylinder locks or drill frame support if damaged.

Welding

NOTICE: Welding can damage electronics.

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

Jump Starting



⚠ WARNING

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

NOTICE:

- Sparks can cause battery to explode.
- Electronic components can be easily damaged.
- Jump starting is not recommended except in extreme circumstances. Follow procedures on page 229 if jump starting is necessary.

Washing

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

Recommended Lubricants/Service Key

Item	Description
 DEO	Diesel engine oil meeting or exceeding Deutz DQC-II-05, API CI-4, ACEA E4, or Global DHD-1. Use viscosity grade SAE 15W40 unless ambient temperatures below 5°F (-15°C) are expected. Lower viscosity oils must meet the performance specifications shown above. See "Fuel Sulfur Information" on page 193 for additional guidelines.
 NDO	30WT non-detergent oil
 MPG	Multipurpose grease meeting ASTM D217 and NLGI 5
 MPG	Pump seal grease, similar to 94050 Philube blue multipurpose
 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)
	Check level of fluid or lubricant
	Check condition
	Filter
	Change, replace, adjust, service or test

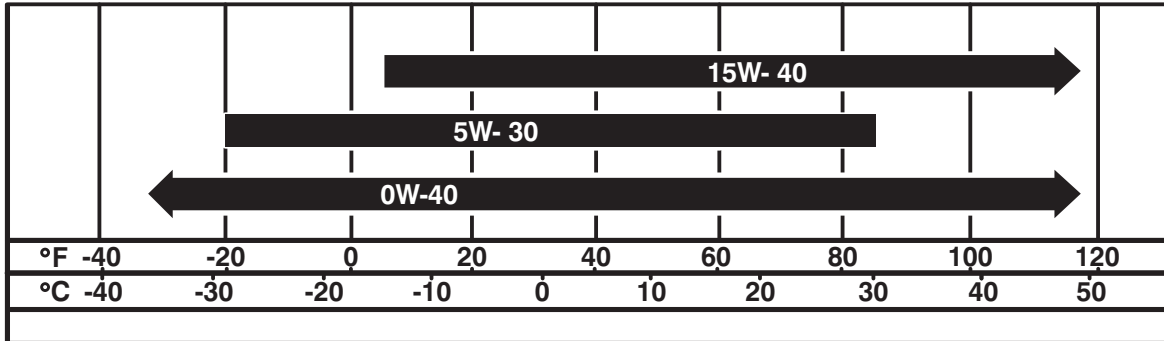
Proper lubrication and maintenance protects Ditch Witch equipment from damage and failure. Service intervals listed are for minimum requirements. In extreme conditions, service machine more frequently. Use only recommended lubricants. Fill to capacities listed in "Fluid Capacities" on page 237.

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

NOTICE:

- Use only genuine Ditch Witch parts, filters, approved lubricants, TJC, and approved coolants to maintain warranty.
- Use the "Service Record" on page 243 to record all required service to your machine.

Engine Oil Selection Chart



j28om132t.eps

Select oil based on ambient temperature expected before next oil change



Approved Coolant

This unit was filled with John Deere Cool-Gard coolant before shipment from factory. Add only John Deere Cool-Gard (p/n 255-006) or any fully-formulated, ethylene glycol based, low-silicate, heavy-duty diesel engine coolant meeting ASTM specification D6210 or D4985.

NOTICE: Do not use water or high-silicate automotive-type coolant. This will lead to engine damage or premature engine failure.

Approved Fuel

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

Fuel Sulfur Information

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. Do not use lube oil meeting API CJ-4 (or other low-SAPS equivalent) if fuel sulfur content is above 500 ppm (0.05%, low sulfur diesel in the U.S.).

Each Use

Location	Task	Notes
DOWNHOLE TOOLS	Lube drill head	pump seal grease (p/n 256-036)

NOTICE: See "Drill Pipe" on page 170 for information and precautions regarding drill pipe.

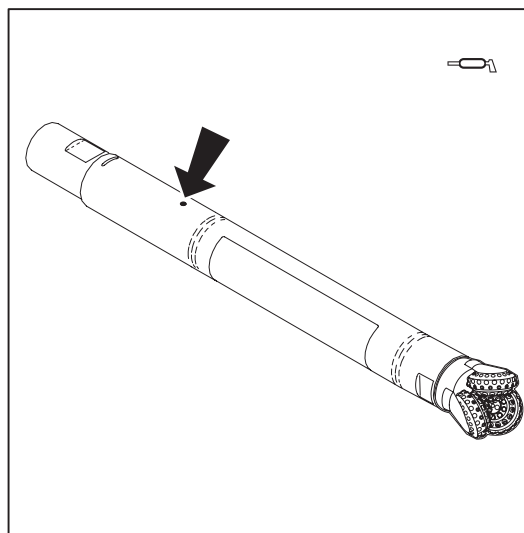
Downhole Tools

Lube Drill Head

Lube drill head with pump seal grease (p/n 256-036) every 8 hours and after every bore.

To lube:

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



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10 Hour

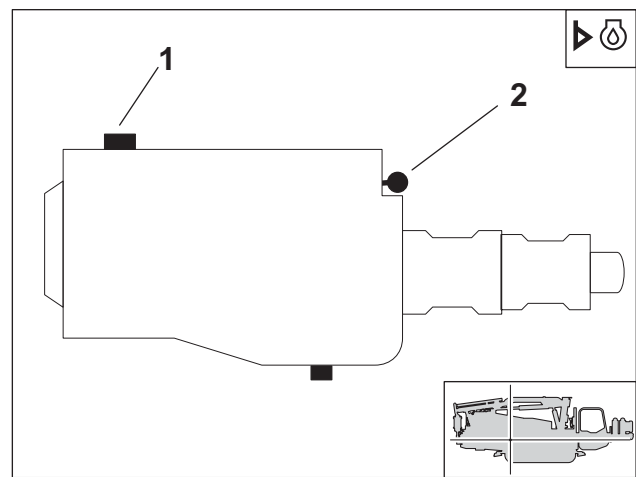
Location	Task	Notes
DRILLING UNIT	Check engine oil level	
	Check fuel prefilter	
	Lube carriage rollers	MPG
	Check JT fluid pump oil level	NDO
	Check AT fluid pump oil level	NDO
	Check hydraulic fluid level	
	Check pipe lube system	
	Check hydraulic hoses	
	Check JT fluid pump liner wash level	
	Check fluid pump y-strainer	
	Check pipeloader control switches	
	Check pipe auto lubricator spray nozzle	
	Check pipe auto lubricator TJC level	
	Check engine coolant level	
	Check air filter service indicator	
	Check dust ejector valve	



Drilling Unit

Check Engine Oil Level

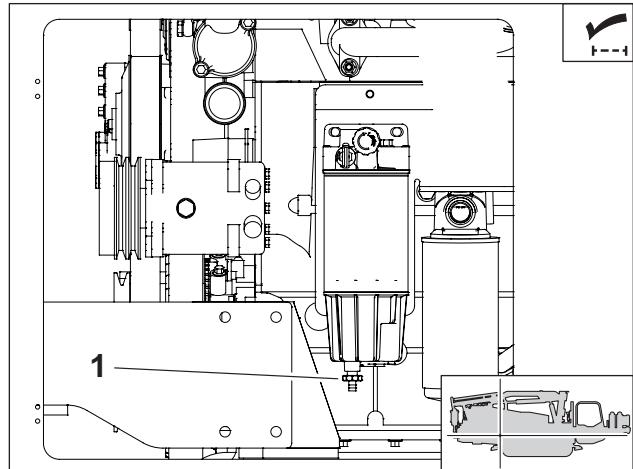
Check oil level at dipstick (2) every 10 hours. If low, add DEO at fill (1).



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Check Fuel Prefilter

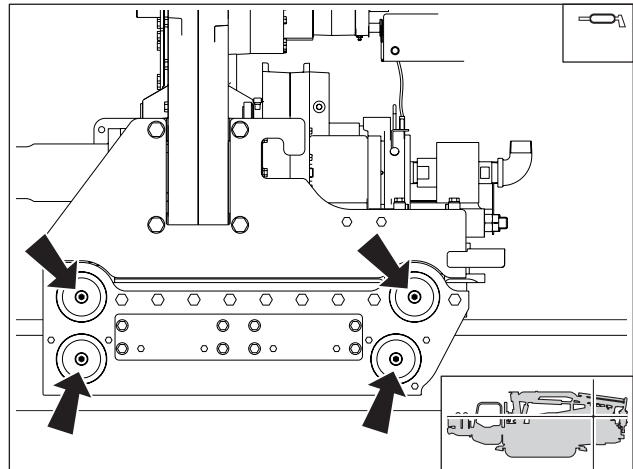
Check fuel prefilter every 10 hours. Empty water separator (1) as needed.



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Lube Carriage Rollers

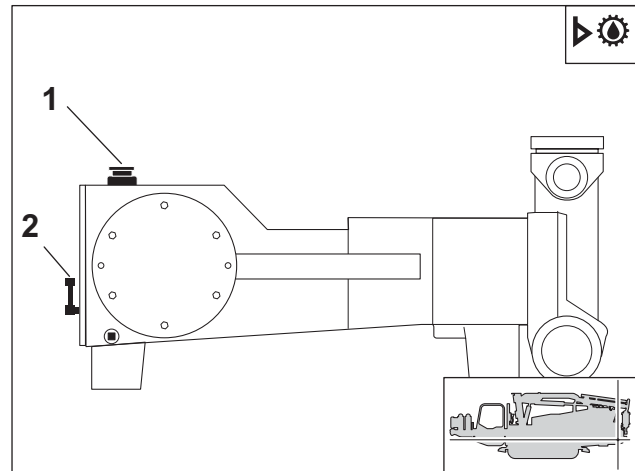
Lube 8 fittings (4 on each side) with MPG every 10 hours.



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Check JT Fluid Pump Oil Level

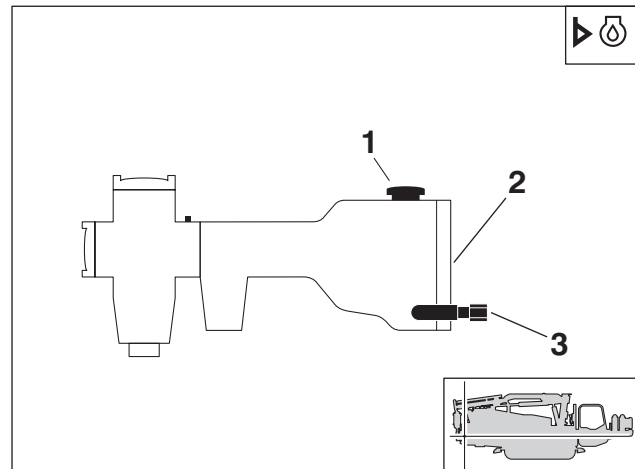
Check oil level at sight tube (2) every 10 hours. Add NDO at plug (1) as needed to maintain oil level at halfway point on sight tube.



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Check AT Fluid Pump Oil Level

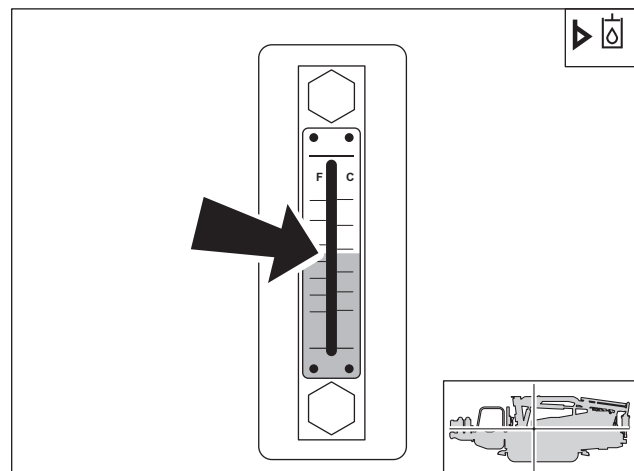
Check fluid pump oil level at sight glass or petcock (2) every 10 hours. Maintain fluid level at halfway point on sight glass or at petcock level. Add NDO at cap (1).



j28om141t.eps

Check Hydraulic Fluid Level

Check hydraulic fluid level every 10 hours. Maintain fluid level at halfway point on sight glass (shown), when unit is on level ground, engine is off and fluid is cool. Add THF at hydraulic fluid fill as needed.



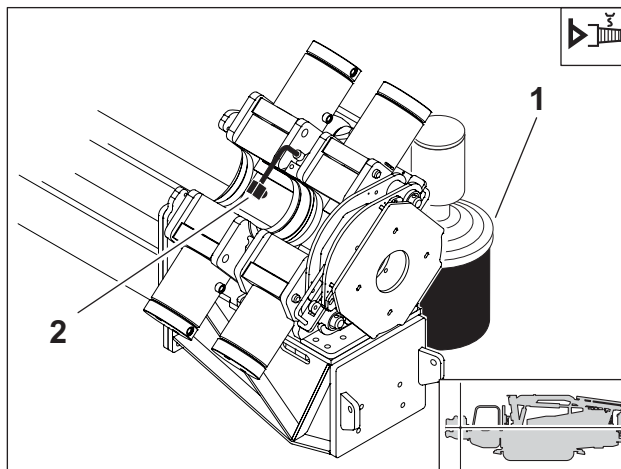
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Check Pipe Lube System

Check pipe auto lubricator TJC level every 10 hours. Change pail (1) as needed. See "Change Auto Lubricator TJC Pail" on page 226 for procedure. Check pipe auto lubricator spray nozzles (2) every 10 hours. Ensure that nozzles are free of obstructions and operate properly. Clean as needed.

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



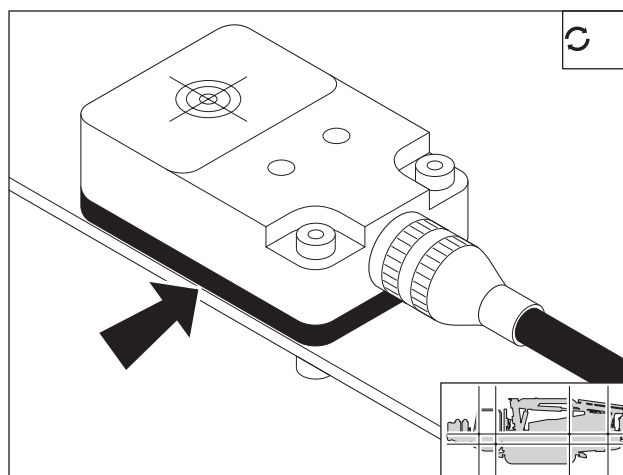
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Test Pipeloader Control Switches

Check control proximity switches every 10 hours and clean or replace as needed.

To test

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



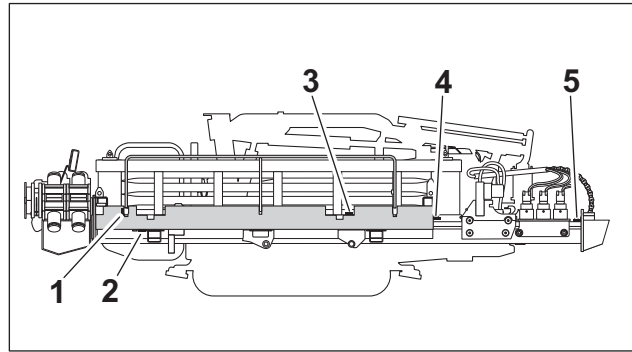
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To adjust switch position

1. Remove two nuts and screws from switch.
2. Insert one or more shims (shown) under switch until yellow light comes on when switch passes under row select pin.
3. Reinstall screws and nuts.

Switch locations

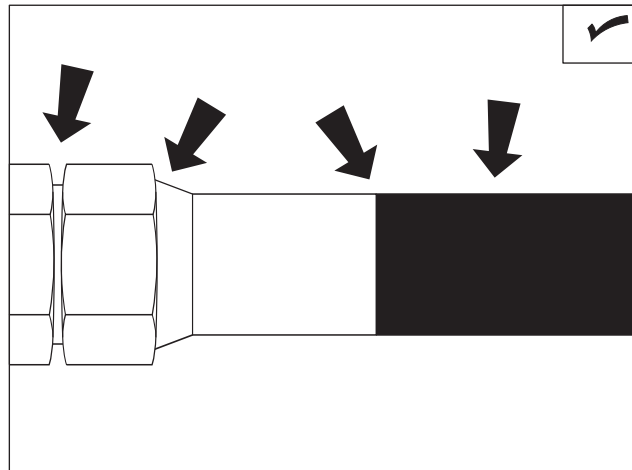
1. Pipe guard switch
2. Front home switch
3. Shuttle home switch
4. Rear home switch
5. Rear stop switch



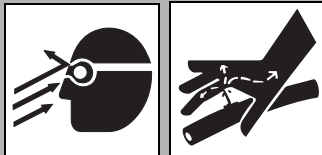
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Check Hydraulic Hoses

Check hydraulic hoses for leaks every 10 hours.



CheckHoses.eps



WARNING

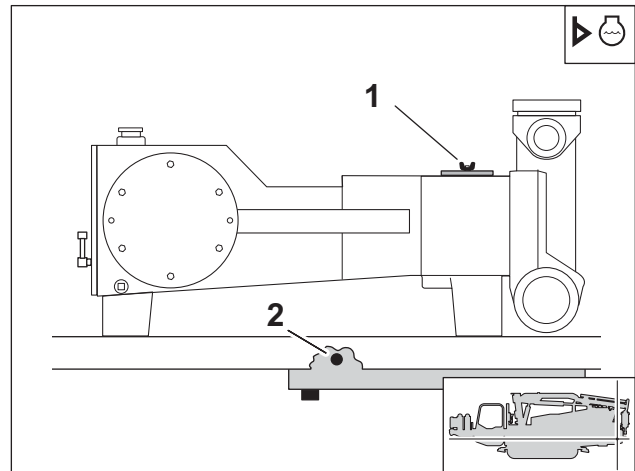
Fluid or air pressure could pierce skin and cause injury or death. Stay away.

NOTICE: Escaping pressurized fluid can cause injury or pierce skin and poison.

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

Check JT Fluid Pump Liner Wash Level

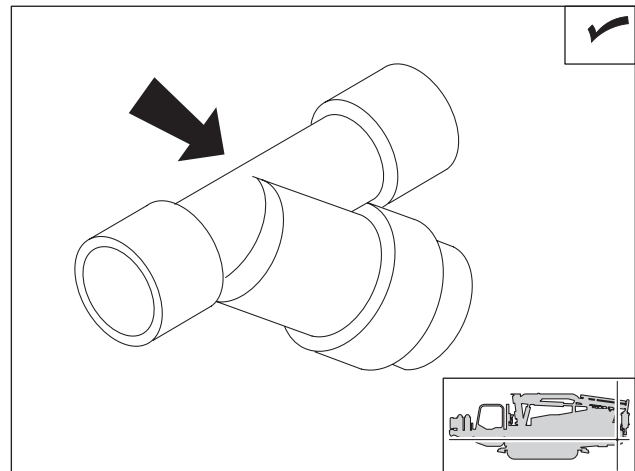
Check fluid level at petcock (2) every 10 hours. Add antifreeze and fresh water as needed at fill (1).



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Check Fluid Pump Y-Strainer

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

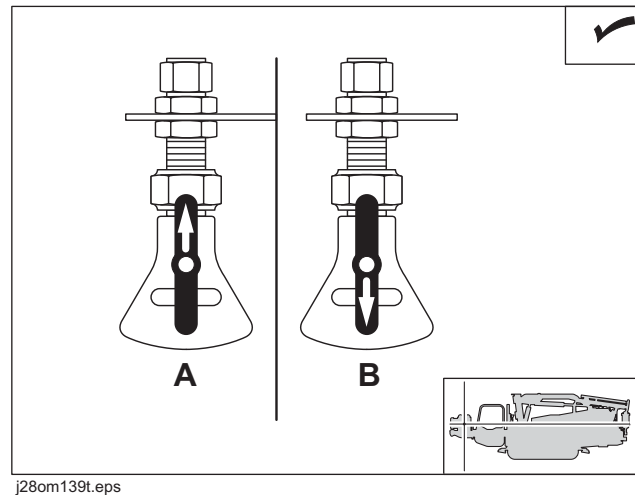


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Check Pipe Auto Lubricator Spray Nozzle

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

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



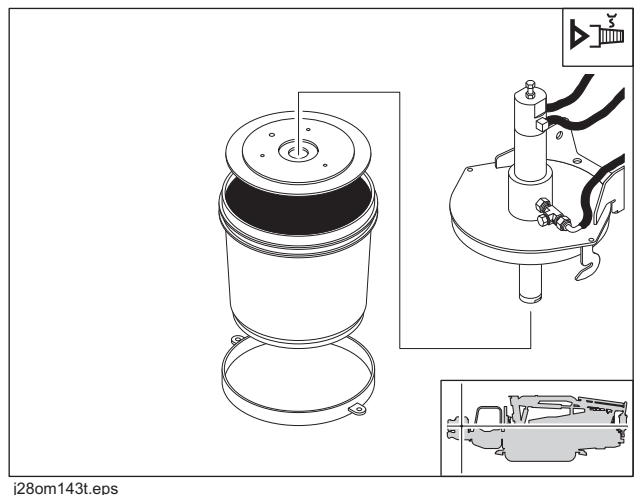
To clean:

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

Check Pipe Auto Lubricator TJC Level

Check pipe auto lubricator TJC level every 10 hours. Change pail as needed. See "Change Auto Lubricator TJC Pail" on page 226 for procedure

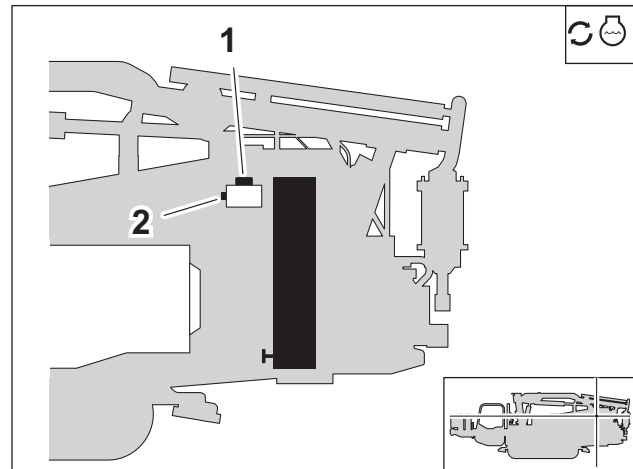
NOTICE: Ditch Witch tool joint compound is specially formulated to work with Ditch Witch pipe lubrication system. Use of other tool joint compounds will clog system. See "Recommended Lubricants/Service Key" on page 192 for more information.



Check Engine Coolant Level

Check coolant level, with unit on level ground and engine cool, at expansion tank (2) every 10 hours. Maintain coolant level to site glass. If low, add approved coolant at fill (1) according to instructions on page 220.

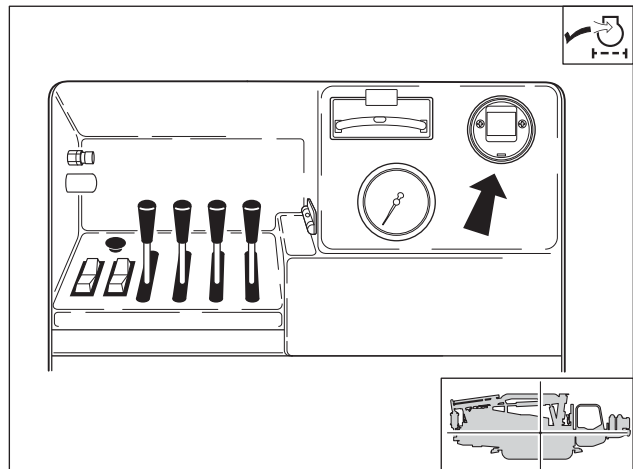
IMPORTANT: See "Approved Coolant" on page 193 for information on approved coolants.



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Check Air Filter Service Indicator

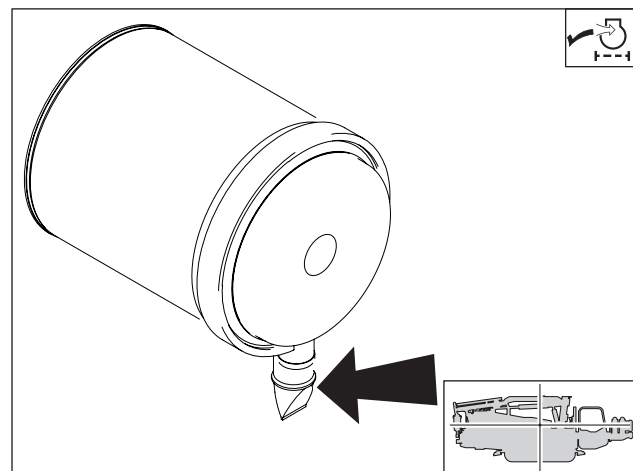
Check air filter indicator and change air filter when yellow mark on reaches the red line at 20 in H₂O (5.0 kPa). See "Change Air Filter" on page 222.



j28om119t.eps

Check Dust Ejector Valve

Check dust ejector valve (shown) every 10 hours. Ensure that valve is not inverted, damaged, plugged or cracked.



j28om118t.eps

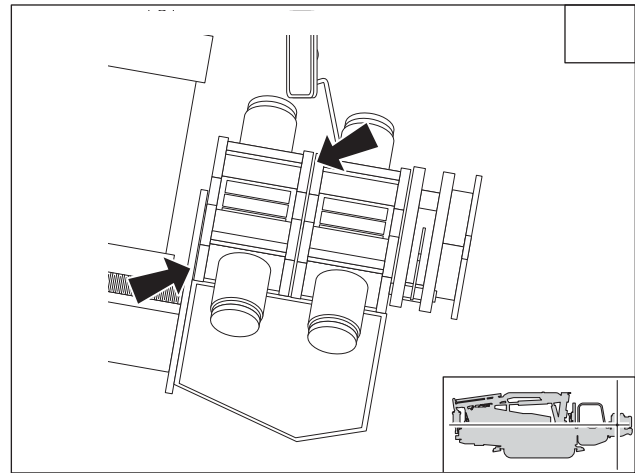
25 Hour

Location	Task	Notes
DRILLING UNIT	Lube rear wrench	MPG
DOWNHOLE TOOLS	Rebuild 2° tool	2500' (760 m)

Drilling Unit

Lube Rear Wrench

Lube two fittings (one on each side) with MPG every 25 hours.



j28om021t.eps



Downhole Tools

Rebuild 2° Tool

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

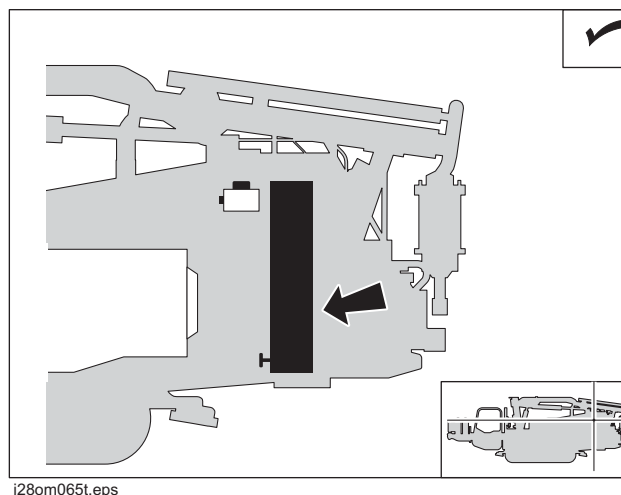
50 Hour

Location	Task	Notes
DRILLING UNIT	Check radiator	
	Check rotation gearbox oil level	MPL
	Check thrust drive gearbox oil level	MPL
	Check ground drive gearbox oil level	MPL
	Inspect thrust rollers	
	Check anchor driver gearbox oil level	MPL
	Check batteries	
	Check drive belt	
	Check compressor belt	
	Change hydraulic filters	Initial
	Change remote charge filter	
	Check JT drilling fluid planetary oil level	MPL
	Change AT fluid pump oil (initial)	NDO
	Lube saver sub wrench collar and sliding output shaft	EPL
	Check hex (AT only)	
DOWNHOLE TOOLS	Rebuild 1.5° and grade tools	

Drilling Unit

Check Radiator

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.

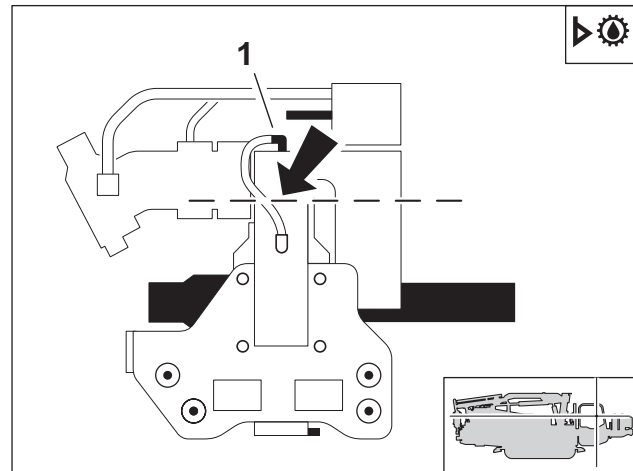


Check Rotation Gearbox Oil Level

Check gearbox oil level at sight tube (shown) every 50 hours. Park unit on level surface and move carriage down drill frame until it is even with cab. Swing cab out for access to gearbox.

JT: Add MPL at fill (1) as needed to maintain level approximately 1/3 of the way up the sight tube.

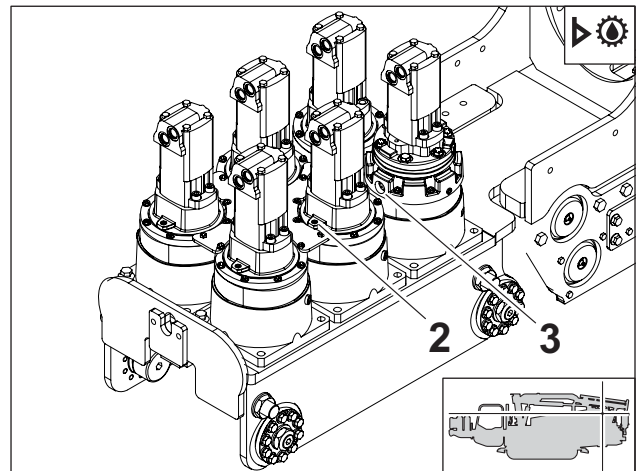
AT: Add MPL at fill (1) as needed until 1" of MPL is visible in the sight tube.



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Check Thrust Drive Gearbox Oil Level

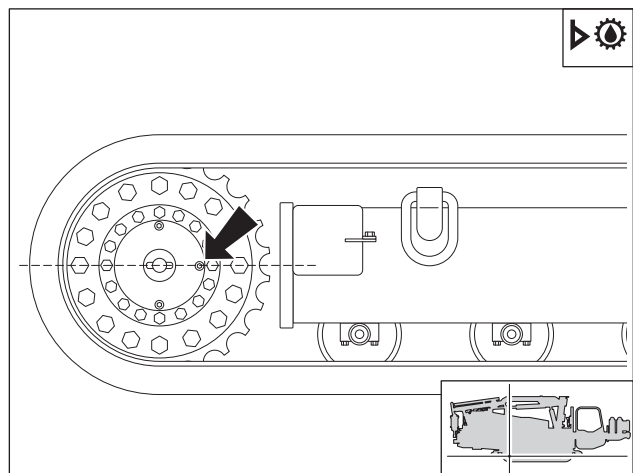
Check thrust drive gearbox oil level at six fill plugs (2, 3) every 50 hours. Add MPL at fill plugs as needed until oil is visible at plugs.



j28om127t.eps

Check Ground Drive Gearbox Oil Level

Park unit on a level surface and check oil level in both gearboxes every 50 hours. Rotate plug (shown) until level with center of gearbox (see dotted line). Open plug. If oil does not come out, add MPL. Never fill more than halfway.

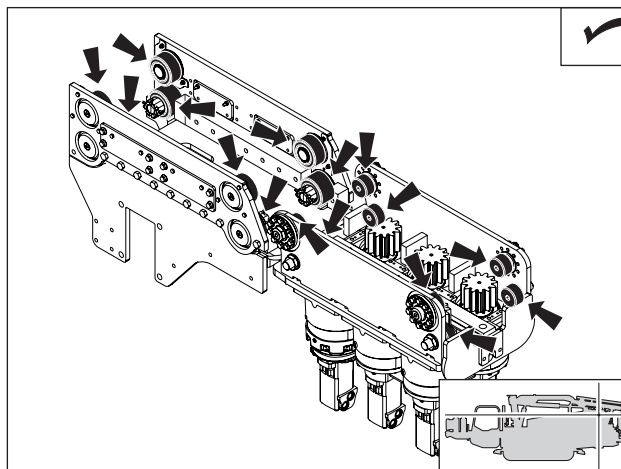


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Inspect Thrust Rollers

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



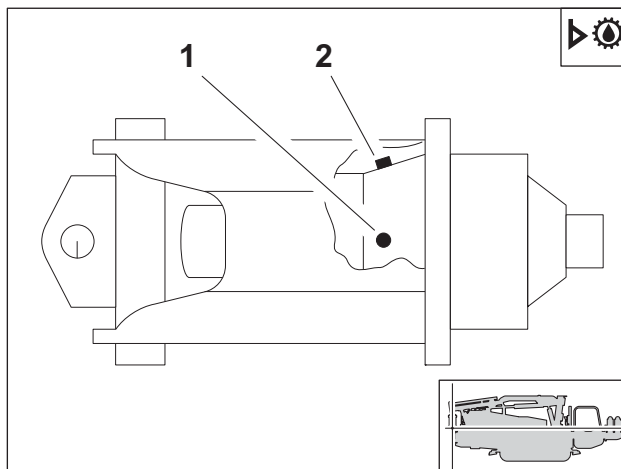
j28om126t.eps

Check Anchor Driver Gearbox Oil Level

Check oil level every 50 hours.

To check

Lay anchor driver on its side. Oil should be level with plug (1). Add MPL at fill plug (2) as needed.

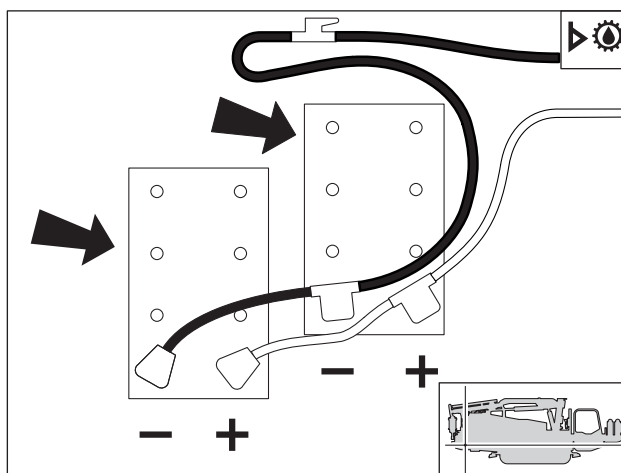


j28om058t.eps

Check Batteries

Check battery every 50 hours. Keep batteries clean and free of corrosion. Apply coat of grease to cable clamps after cleaning. In cold weather, batteries lose some starting ability. Closely watch voltmeter for signs of battery discharge. If batteries will not hold charge, see your Ditch Witch dealer for replacement batteries. Refer to wiring diagram (shown) when replacing batteries.

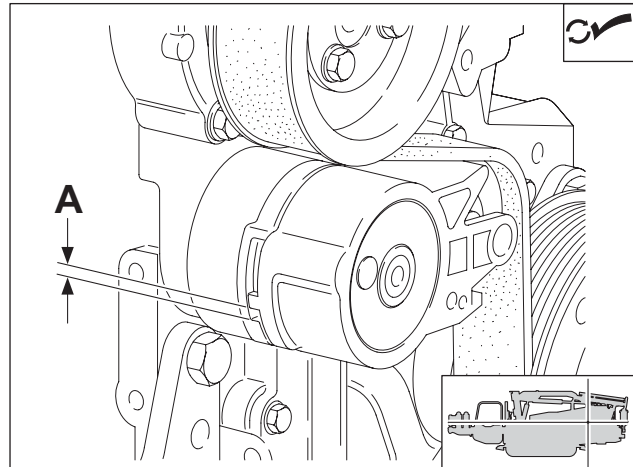
IMPORTANT: Use battery disconnect switch located at rear of unit when servicing, welding, and during long-term storage.



j28om068t.eps

Check Drive Belt

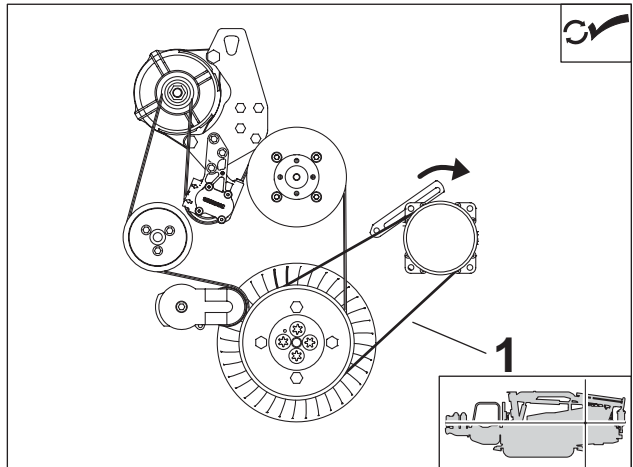
Check belt tension every 50 hours. Check the distance between the projection of the moving tension arm and the contact with the fixed tensioner housing. If distance (A) is less than 1/8" (3 mm), change the V-rib belt. See "Change Drive Belt" on page 223.



j28om114t.eps

Check Compressor Belt

Check compressor belt (1) tension every 50 hours. Adjust tension of compressor belt as shown.

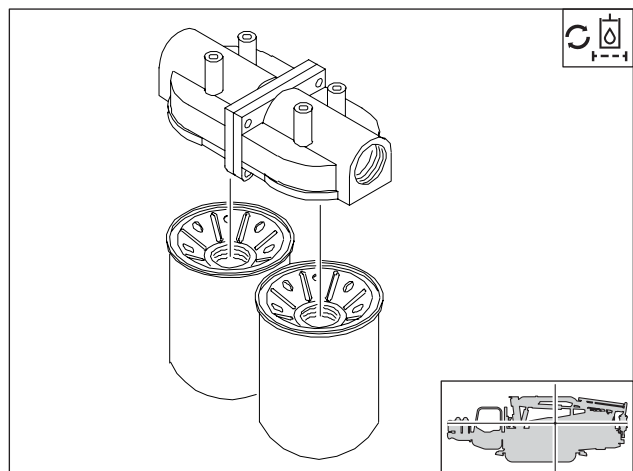


j28om106t.eps

Change Hydraulic Filters (Initial)

Remove break-in filters after 50 hours. Install standard filters (p/n 153-792).

IMPORTANT: If hydraulic system must be opened for repair, install new filters (p/n 153-791) for first 25 hours of operation. If these filters become plugged in fewer than 20 hours, replace with clean filters. After 25 hours of normal operation, replace with clean filters (p/n 153-792).

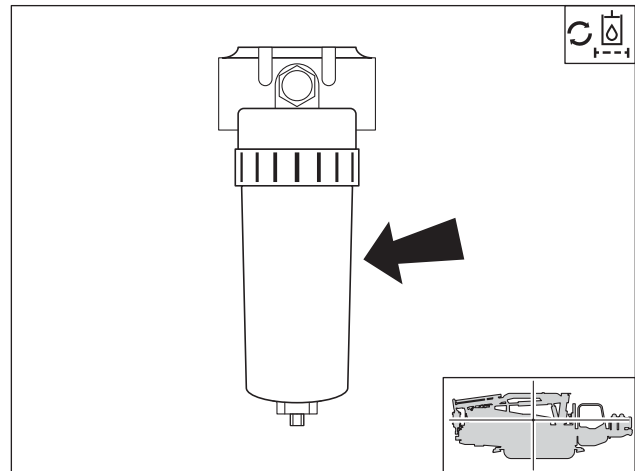


j28om043t.eps



Change Remote Charge Filter

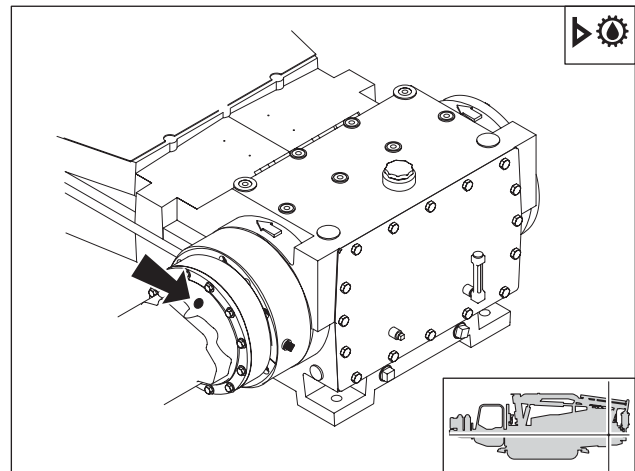
Change after 50 hours.



j28om005h.eps

Check JT Drilling Fluid Planetary Oil Level

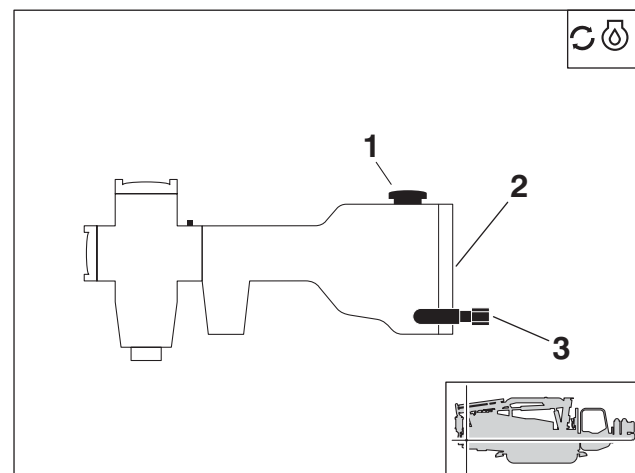
Check every 50 hours. Add MPL as needed.



j28om004h.eps

Change AT Fluid Pump Oil (initial)

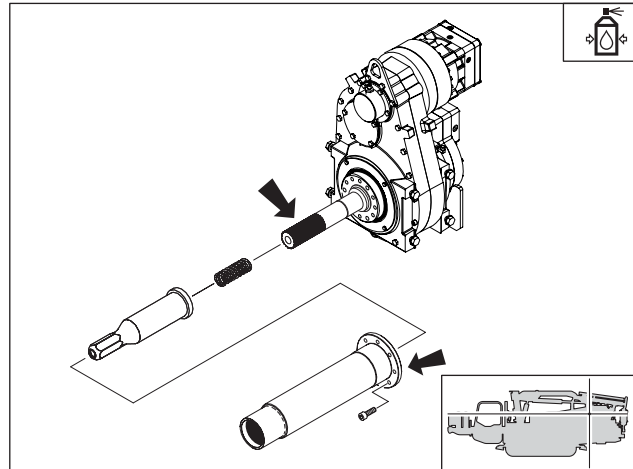
Change fluid pump oil after first 50 hours and every 1000 hours thereafter. Maintain fluid level at halfway point on sight glass or at petcock level (2). Drain at plug (3). Add NDO at fill (1). Capacity for 70 gpm pump is 4 qt (3.8 L).



j28om140t.eps

Lube Saver Sub Wrench Collar and Sliding Output Shaft

Lube with EPL spray every 50 hours.



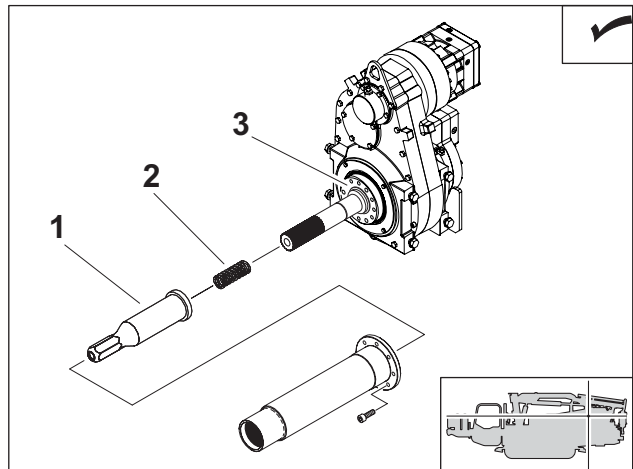
j28om144t.eps

Check Hex

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

To replace:

1. Remove saver sub. Do not remove indexing dowels from spindle.
2. Slide hex (1) and spring (2) off of drive shaft.
3. Check condition of drive pin (3) and replace if needed.
4. Check o-ring on inner water swivel (seal kit) and replace if needed.
5. Install new spring and hex.
6. Install saver sub. See page 221.



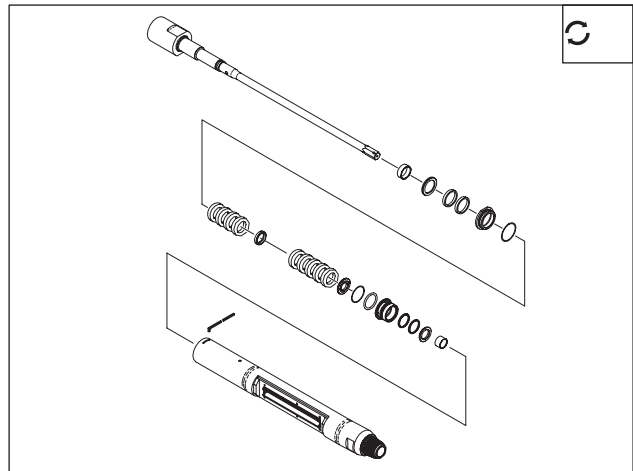
j28om145t.eps



Downhole Tools

Rebuild 1.5° and Grade Tools

Rebuild downhole tool every 50 hours as measured by inner rotation hourmeter. Use rebuild kit or seal kit available at your Ditch Witch dealer.



j29om030h.eps

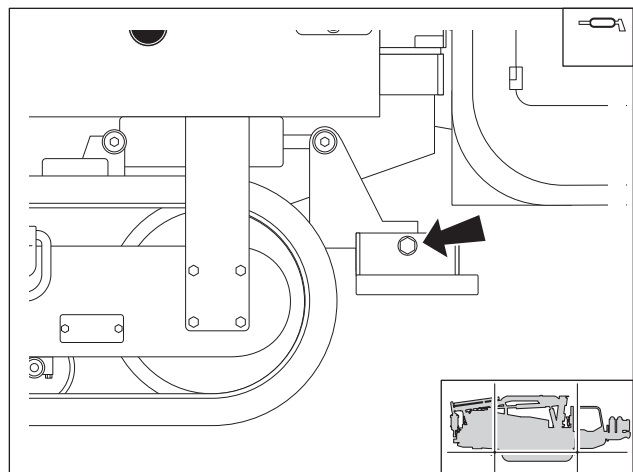
100 Hour

Location	Task	Notes
DRILLING UNIT	Lube stabilizers	MPG
	Check track sprocket bolts	350 ft•lb (475 N•m)
	Check track sprockets	1 3/16" (30 mm)
CRANE	Lube rotation bearing	MPG
	Lube rotation bearing gear teeth	EPS

Drilling Unit

Lube Stabilizers

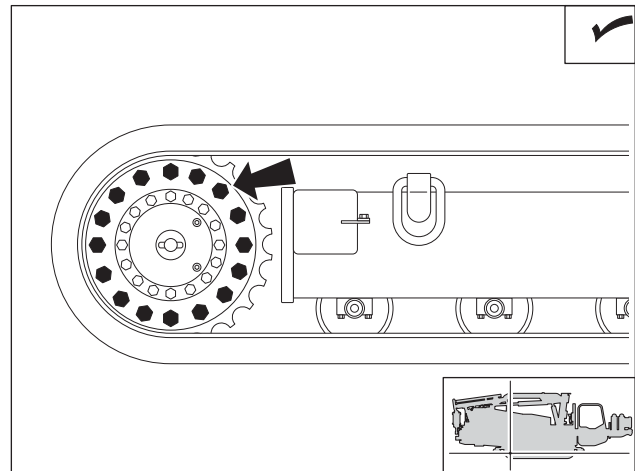
Lube zerk on each stabilizer with MPG every 100 hours.



j28om022t.eps

Check Track Sprocket Bolts

Check track sprocket bolts every 100 hours.
Tighten to 350 ft•lb (475 N•m). Apply Loctite® 242 any time bolts are removed.

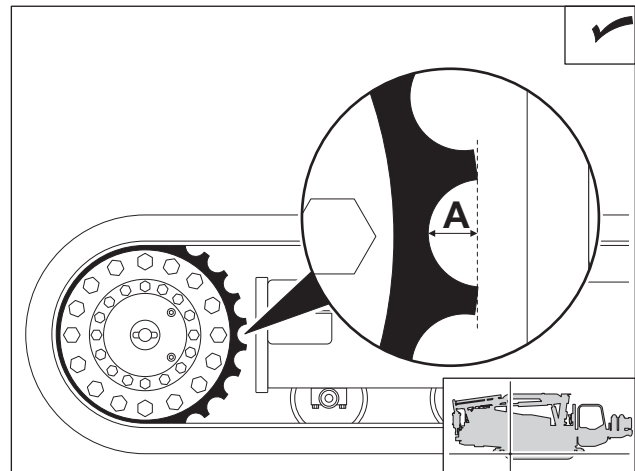


j28om030t.eps

Check Track Sprockets

Check track sprockets for wear every 100 hours.

Replace sprocket when dimension A is 1 3/16" (30 mm) or less. Tighten bolts to 350 ft•lb (475 N•m). Apply Loctite® 242 any time bolts are removed.

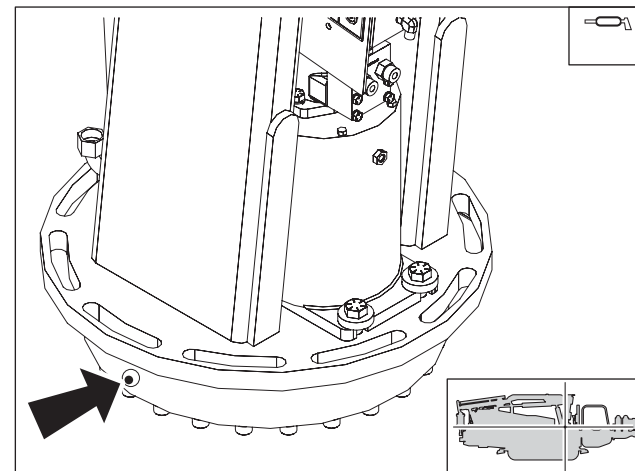


j28om032t.eps

Crane

Lube Rotation Bearing

Lube zerk with MPG every 100 hours of crane operation. To access zerk, remove cover from side of unit. If zerk is not visible, slowly rotate crane until it is. Turn bearing at least two rotations during lubrication.

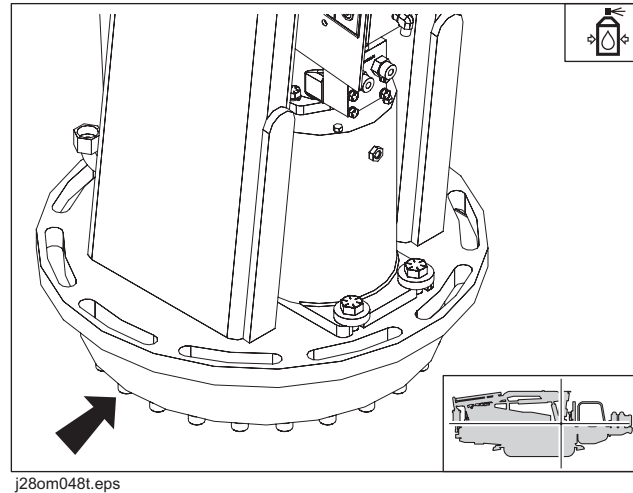


j28om047t.eps



Lube Rotation Bearing Gear Teeth

Lube teeth and pinion with EPS every 100 hours of crane operation.



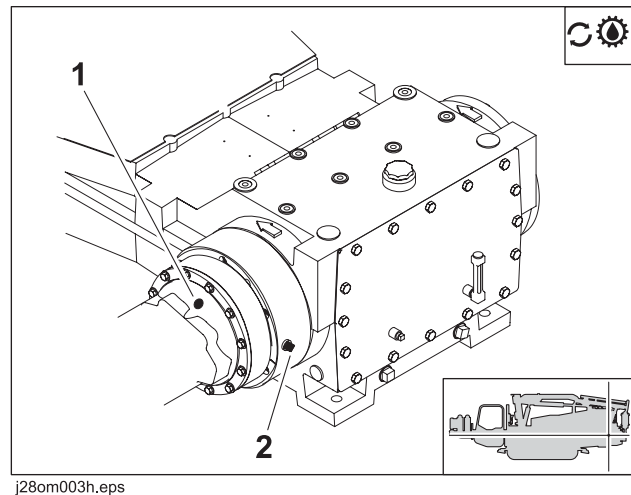
250 Hour

Location	Task	Notes
DRILLING UNIT	Change JT drilling fluid planetary oil	MPL
CRANE	Check swing drive gearbox oil level	MPL

Drilling Unit

Change JT Drilling Fluid Planetary Oil

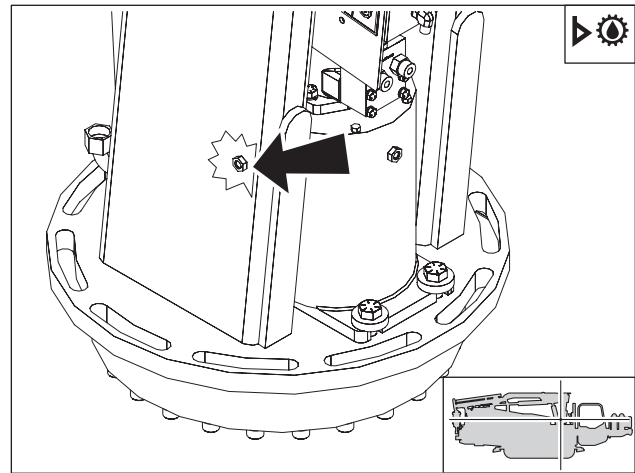
Change every 250 hours. Remove oil at fill (1). Add MPL until oil comes out level plug (2). Replace plugs.



Crane

Check Swing Drive Gearbox Oil Level

Check oil level every 250 hours. Park unit on a level surface and remove plug (shown). Oil should be level with plug. Add MPL as needed.



j28om045t.eps



500 Hour

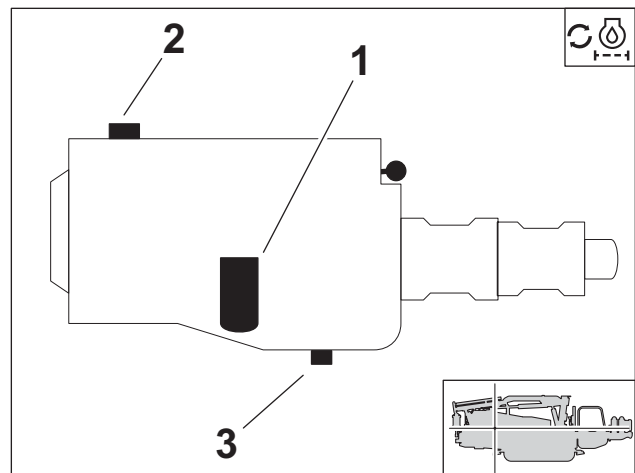
Location	Task	Notes
DRILLING UNIT	Change engine oil and filter	
CRANE	Change swing drive gearbox oil	MPL

Drilling Unit

Change Engine Oil and Filter

Change engine oil and filter every 500 hours. Drain oil (3), change filter (1), and add DEO at fill (2).

IMPORTANT: Use oil specified in temperature chart found in "Recommended Lubricants/Service Key" on page 192.

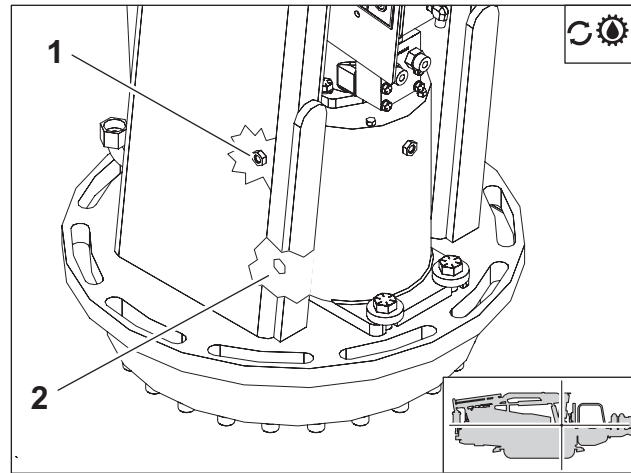


j28om115t.eps

Crane

Change Swing Drive Gearbox Oil

Drain oil at plug (2) every 500 hours. Add MPL at fill plug (1) until oil is level with plug.



j28om046t.eps

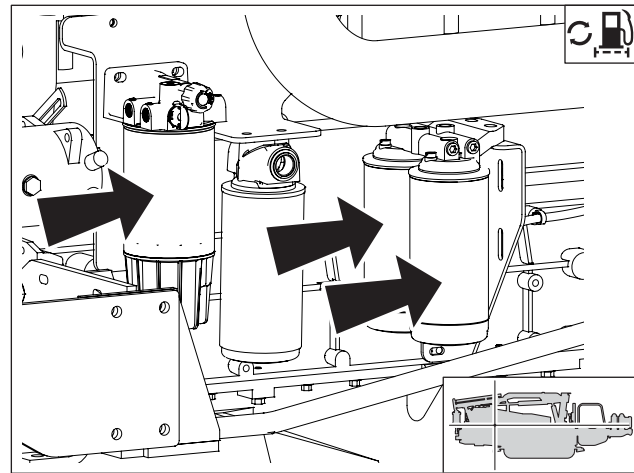
1000 Hour

Location	Task	Notes
DRILLING UNIT	Change fuel filters	
	Change hydraulic fluid and filters	
	Change JT ground drive gearbox oil	2 gearboxes, MPL
	Change AT rotation gearbox oil	2 gearboxes, MPL
	Change thrust drive gearbox oil	MPL
	Drain spindle brake oil	THF
	Change AT fluid pump oil	NDO
	Lube AT saver sub wrench collar and sliding output shaft	EPS
	Change rotation, thrust, and fluid pump remote charge filter	

Drilling Unit

Change Fuel Filters

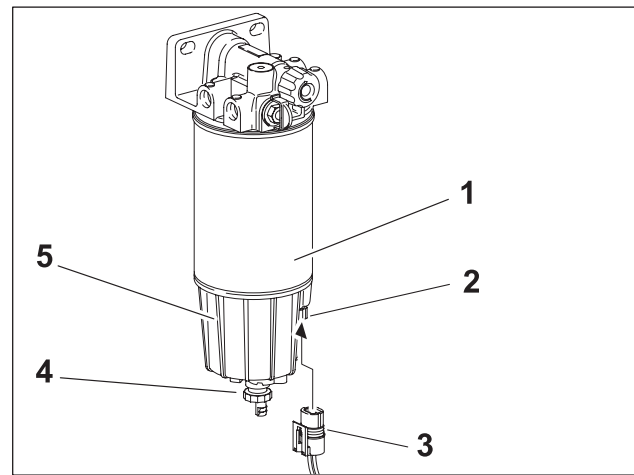
Replace filters every 1000 hours. If you refuel from cans, replace filters more often.



j28om110t.eps

Primary fuel filter:

1. Place drain pan beneath filter.
2. Loosen drain cock (4).
3. Drain off water and fuel completely.
4. Disconnect WIF sensor (3).
5. Unscrew filter (1) with water bowl (2).
6. Remove water bowl (2) from old filter (1).
7. Clean water bowl (3) and install on new filter (1).
8. Wet sealing surface of new filter cartridge with fuel and install. Ensure drain cock (4) is closed.
9. Connect WIF sensor (3).



j28om122t.eps

Secondary fuel filters:

1. Loosen fuel filter cartridge with standard tool and unscrew.
2. Collect any fuel.
3. Clean the sealing surface of the filter support for any dirt.
4. Lightly oil the sealing surface of fuel filter cartridge or wet with diesel fuel.
5. Screw on the cartridge by hand until the seal makes contact.
6. Tighten the fuel filter cartridge with a three-quarter turn.
7. Check for tightness.

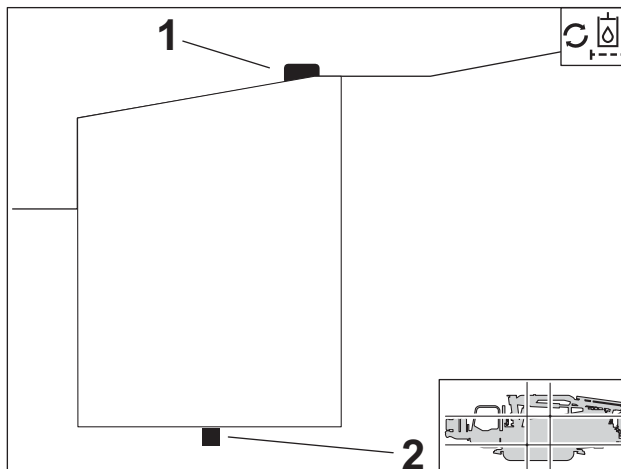


Change Hydraulic Fluid and Filters

Change hydraulic fluid and filters every 1000 hours. Drain hydraulic fluid (2), change filters, and add THF at fill (1).

IMPORTANT:

- If ambient temperature exceeds 100°F (37°C) for 50% of time, change oil and filter every 500 hours.
- If hydraulic system must be opened for repair, install new filters (p/n 153-791) for first 25 hours of operation. If these filters become plugged in fewer than 20 hours, replace with clean filters. After 25 hours of normal operation, replace with clean filters (p/n 153-792).



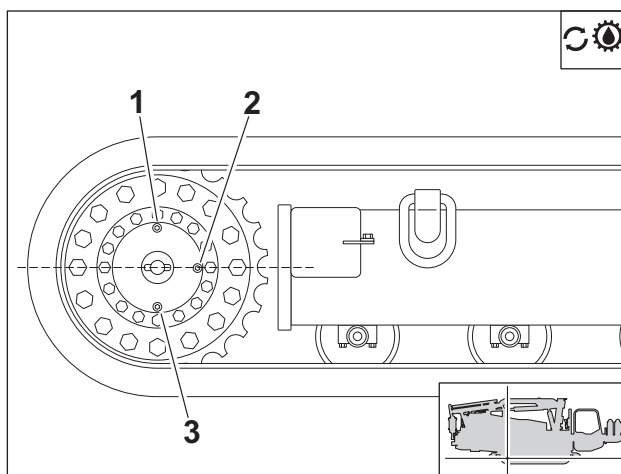
j28om044t.eps

Change Ground Drive Gearbox Oil

Change oil in both ground drive gearboxes every 1000 hours.

To change

1. Rotate tracks until gearbox plugs are aligned as shown. Position 2 can also be on the other side but it must be level with center of gearbox (see dotted line).
2. Remove plug 3 and drain oil.
3. Install plug 3 and remove plugs 1 and 2.
4. Add MPL at plug 1 until oil comes out plug 2.
5. Install plugs 1 and 2.



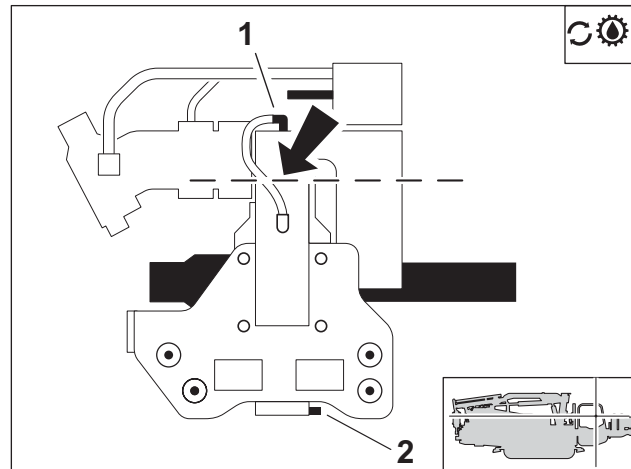
j28om055t.eps

IMPORTANT:

- Drill frame must be parked on level surface for accurate reading.
- Use helper to assist in positioning gearbox plugs.
- Do not overfill.

Change JT Rotation Gearbox Oil

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

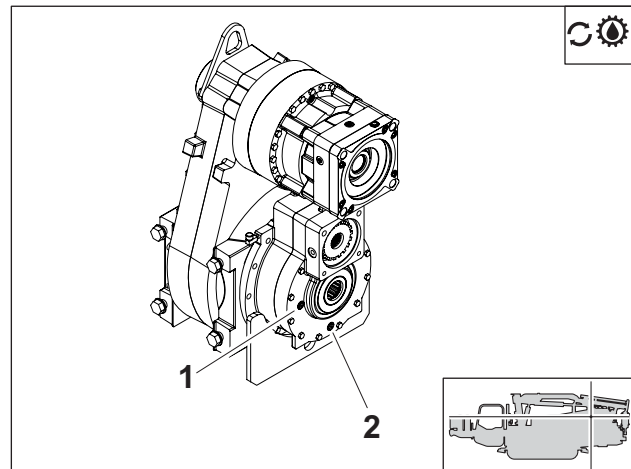


j28om024t.eps

Change AT Rotation Gearbox Oil

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

IMPORTANT: Drill frame must be level for accurate reading.



j28om147t.eps

Change Thrust Drive Gearbox Oil

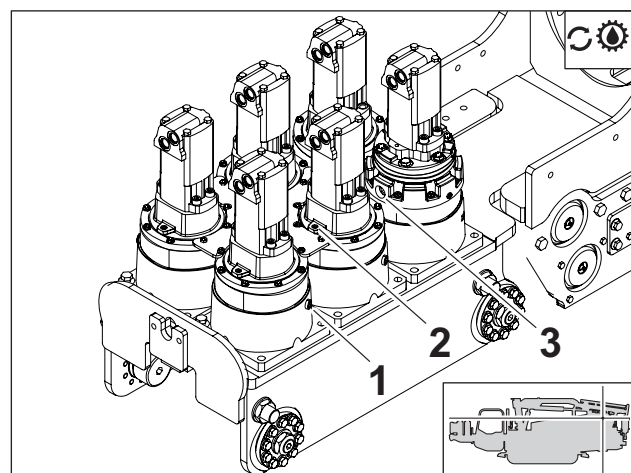
Change thrust drive gearbox oil every 1000 hours. Capacity is 26 oz (0.77 L) of MPL per gearbox.

To change:

1. Ensure that drill frame is level.

IMPORTANT: Gearbox must be level for accurate reading.

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

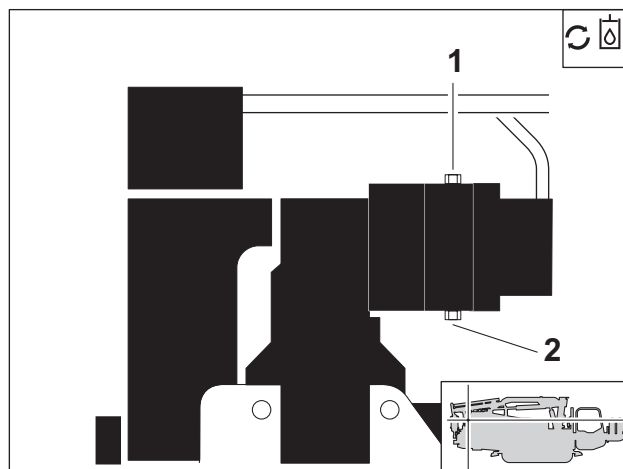


j28om128t.eps



Change Spindle Brake Oil

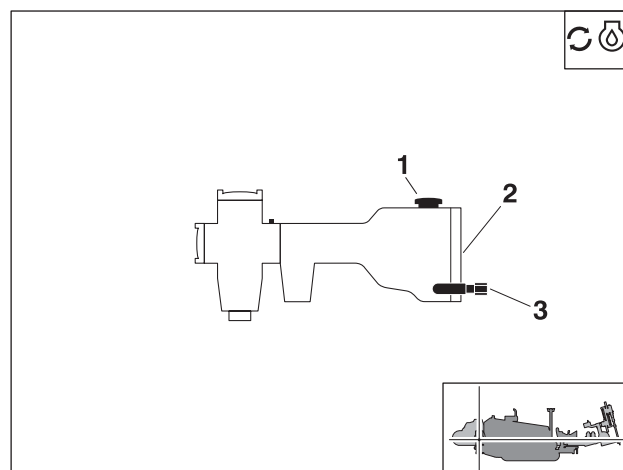
Drain (2) oil at brake every 1000 hours. Add THF at fill (1). Capacity is 5 oz (148 mL).



j28om040t.eps

Change AT Fluid Pump Oil

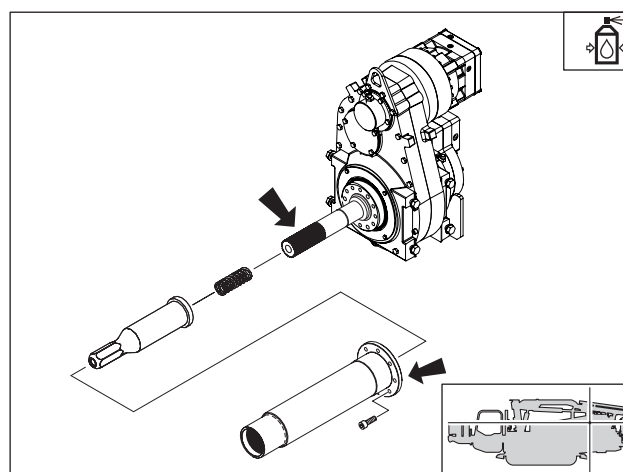
Change oil after first 50 hours and every 1000 hours thereafter. Maintain fluid level at halfway point on sight glass or at petcock level (2). Drain at plug (3). Add NDO at fill (1). Capacity for 70 gpm pump is 4 qt (3.8 L).



j29om014h.eps

Lube AT Saver Sub Wrench Collar and Sliding Output Shaft

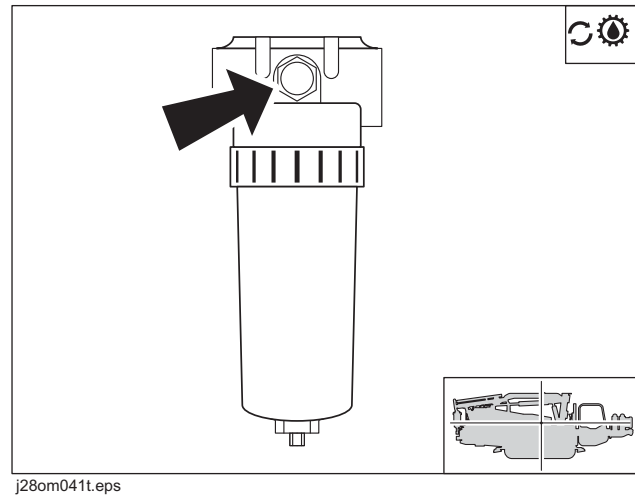
Lube with EPS every 1000 hours.



j28om144t.eps

Change Rotation, Thrust, and Fluid Pump Remote Charge Filter

Change remote charge filter every 1000 hours, when changing hydraulic fluid, or when indicated by visual indicator (shown).



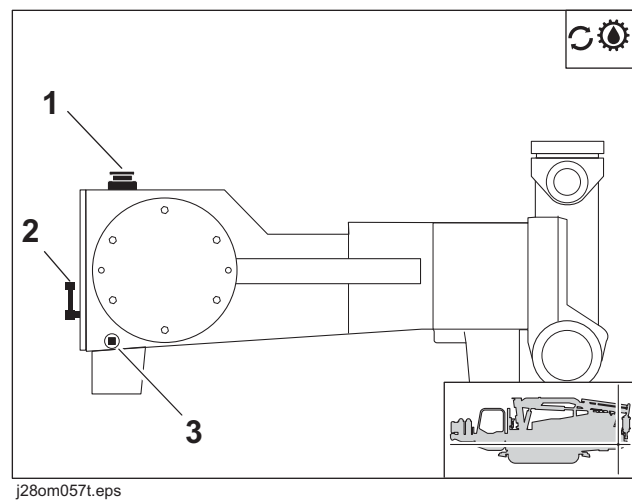
2000 Hour

Location	Task	Notes
DRILLING UNIT	Change JT fluid pump oil	NDO
	Change engine coolant	DEAC
CRANE	Change anchor driver gearbox oil	MPL

Drilling Unit

Change JT Fluid Pump Oil

Drain oil at plug (3). Add 12 qt (11.3 L) of NDO at fill (1) until oil level is at middle of sight tube (2).

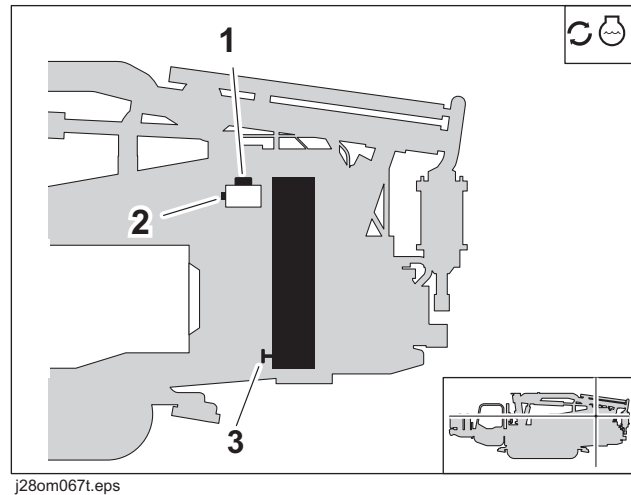


Change Engine Coolant

Drain cooling system at drain (3) every two years or 2000 hours. Add DEAC at fill (1) according to instructions below until fluid level is visible in sight glass (2).

NOTICE:

- The use of non-approved coolant may lead to engine damage or premature engine failure and will void engine warranty.
- See "Approved Coolant" on page 193 for list of approved coolants.



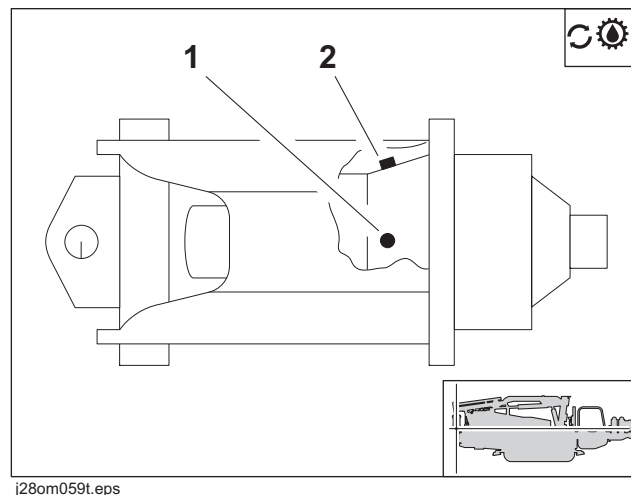
To fill

1. Remove fill cap (1) on expansion tank.
2. Disconnect high looped radiator hose at the engine water pump inlet.
3. Add coolant through radiator hose until full.
4. Reconnect radiator hose.
5. Add coolant at expansion tank until fluid is visible in sight glass (2).
6. Run engine with thermostat open (>195°F/90°C engine temperature) for 10 minutes.
7. Stop engine and let cool.
8. Add coolant at expansion tank until visible in sight glass.
9. Install fill cap on expansion tank.

Crane

Change Anchor Driver Gearbox Oil

Drain oil every 2000 hours of crane operation. Lay anchor driver on its side and add MPL at fill plug (2) until oil level is at plug (1).



As Needed

Location	Task	Notes
DRILLING UNIT	Replace saver sub	TJC
	Check muffler	
	Change air filter	
	Change drive belt	
	Drain fuel prefilter	
	Vent fuel system	
	Check JT fluid pump rotation speed	
	Check fluid pump ball valve	
	Check pipeloader inserts	
	Replace wrench jaw inserts and hardware	
	Change auto lubricator TJC pail	
	Adjust rubber track tension	
	Change AT inner water swivel (seal kit)	THF
	Jump start unit	
CRANE	Lube boom extensions	MPG



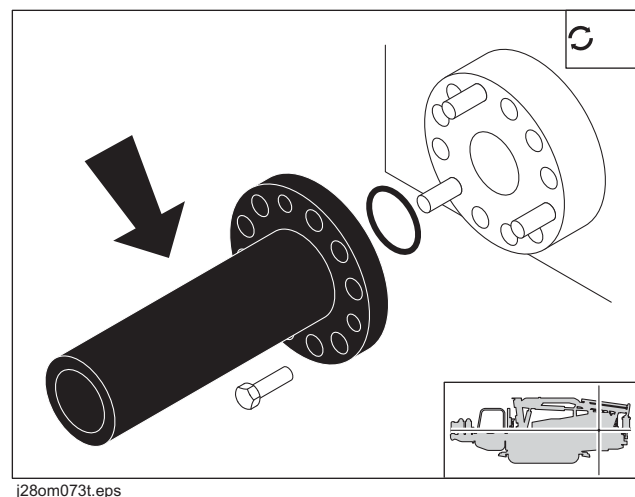
Drilling Unit

Replace Saver Sub

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

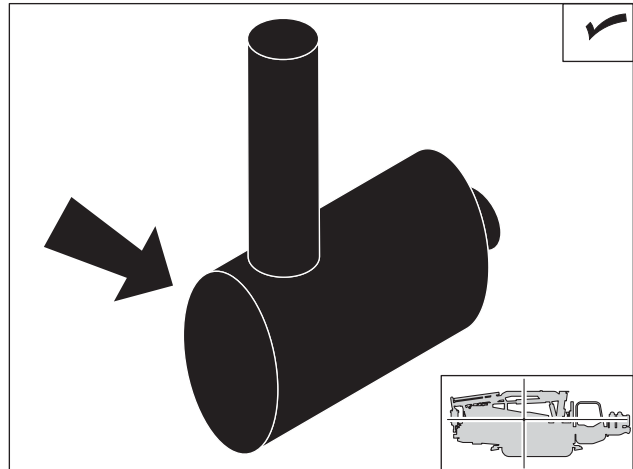
To replace

1. Remove bolts that attach saver sub to spindle. Do not remove three dowel pins in gearbox output shaft.
2. Install new o-ring and grease lightly with MPG.
3. Install saver sub.
4. Tighten bolts to 140 ft•lb (190 N•m).



Check Muffler

Check muffler and replace as needed.



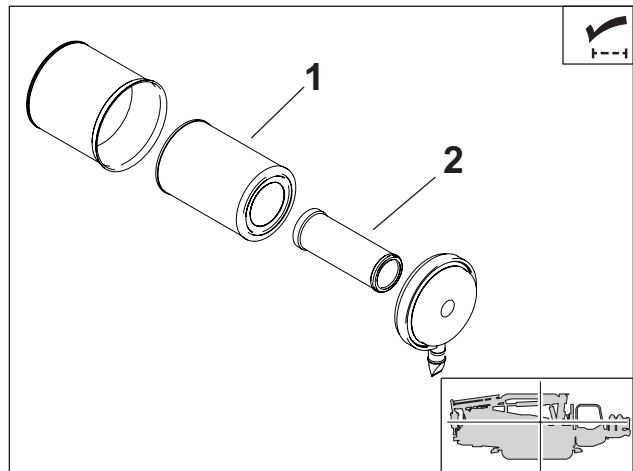
j28om074t.eps

Change Air Filter

Change air filter when the yellow band on the air filter service indicator reaches the red line at 20 in H₂O (5.0 kPa). Replace safety element (2) every third change of primary filter (1).

To change

1. Open air filter case.
2. Remove paper element.
3. Wipe inside of housing and wash end cup.
4. Install new element.
5. Close air filter case.
6. Reset air filter service indicator.



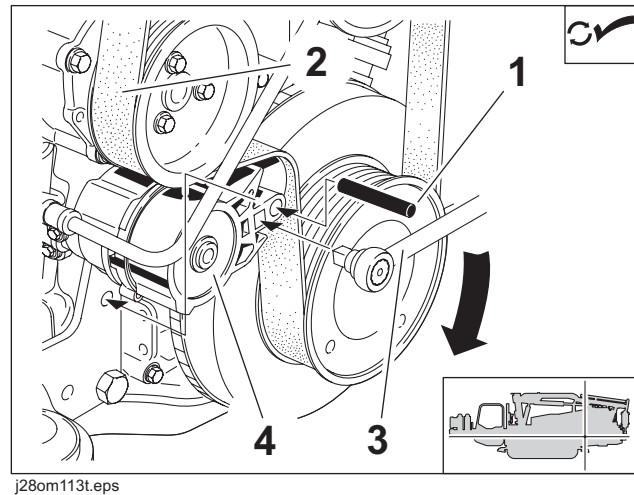
j28om112t.eps

Change Drive Belt

Change drive belt as needed.

To change

1. Push tension roller (1) with ratchet (3) in direction of arrow until locking pin (4) can be fixed in the mounting hole. Drive belt (2) is now tension-free.
2. First pull the drive belt (2) from the smallest roller or from the tension roller.
3. Fit new drive belt (2).
4. Hold ratchet (3) in the opposite direction from the arrow and remove pin (4).
5. Loosen the tension pulley in the opposite direction from the arrow until the drive belt is tight, at the same time checking that the drive belt is positioned correctly in its guides.

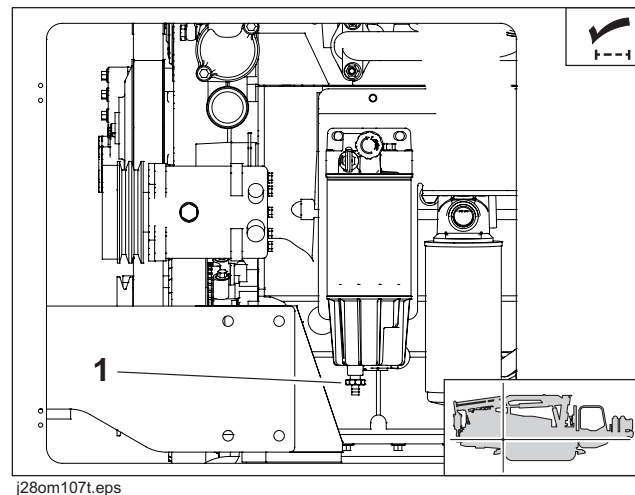


Drain Fuel Prefilter

Drain prefilter (1) as needed.

To Drain Water

1. Place drain pan beneath filter.
1. Loosen drain cock (2) to drain water and fuel mixture.
2. Tighten drain cock.

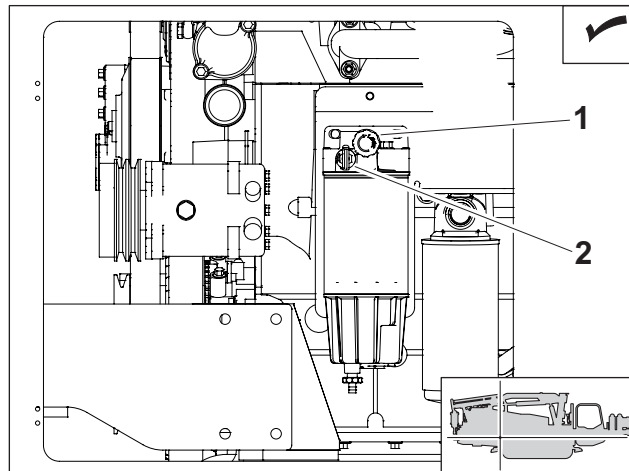


Vent Fuel System

Vent air from fuel system as needed. Unit will not start if it has run out of fuel until air has been vented from fuel system.

To vent

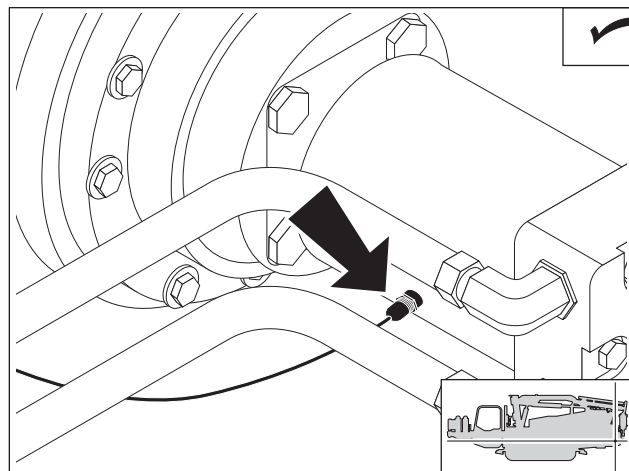
1. Fill fuel tank with diesel fuel.
2. Set engine controller to stop position.
3. Place container under filter housing to catch any spilled fuel.
4. Open vent screw (2).
5. Press and turn bayonet plug counterclockwise to primer pump (1). The pump is now pushed out through the spring.
6. Pump primer pump (1) until fuel escapes from vent screw without air bubbles.
7. Tighten vent screw to 11 ft•lb (15 N•m).
8. Continue pumping primer pump (1) until a strong resistance is felt. Lock the bayonet plug of the primer pump by pressing and turning clockwise at the same time.
9. Set engine controller to start position and crank engine.
10. Check for leaks after engine has started.



j28om120t.eps

Check JT Fluid Pump Rotation Speed

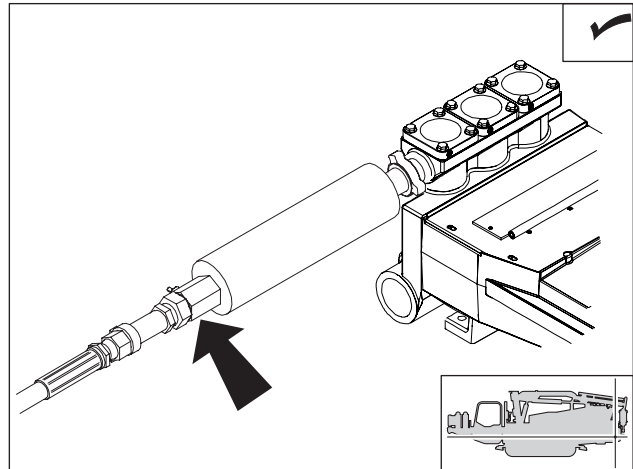
Check rotation speed at speed sensor (shown) when pump flow increases dramatically or after rebuild. Check maximum pump flow by capping saver sub to deadhead drilling fluid flow and measuring pressure. Reading should be no more than 6450 ± 50 psi (445 ± 3 bar). Adjust pressure at hydraulic pump as needed. Replace packing when pressure can no longer be adjusted into range. See your Ditch Witch dealer for replacement packing.



j28om063t.eps

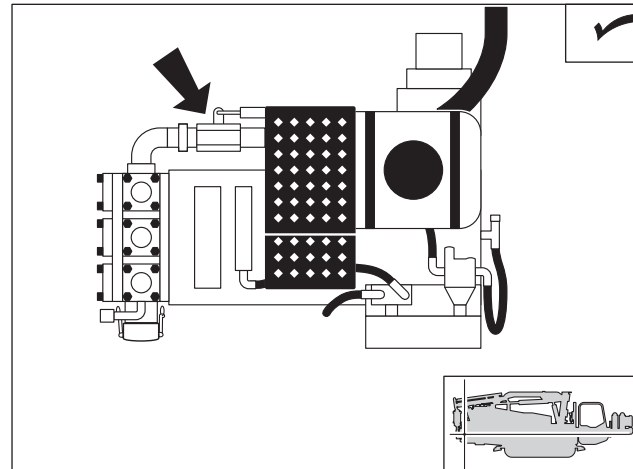
Check Fluid Pump Ball Valve

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



j28om098t.eps

JT



j28om142t.eps

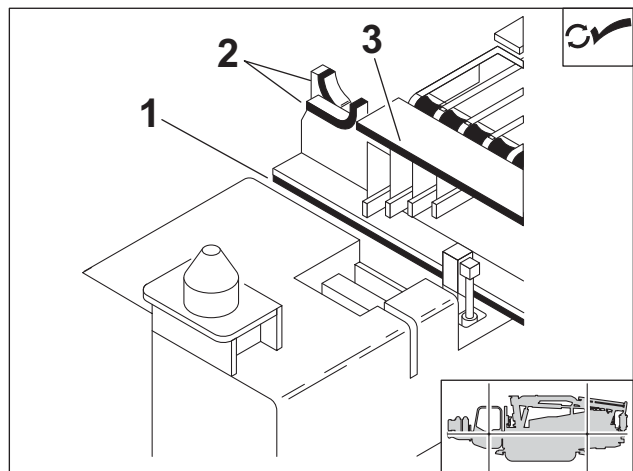
AT

Check Pipeloader Gripper Inserts

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

1. bottom slide bar
2. gripper inserts
3. shuttle wear pads

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

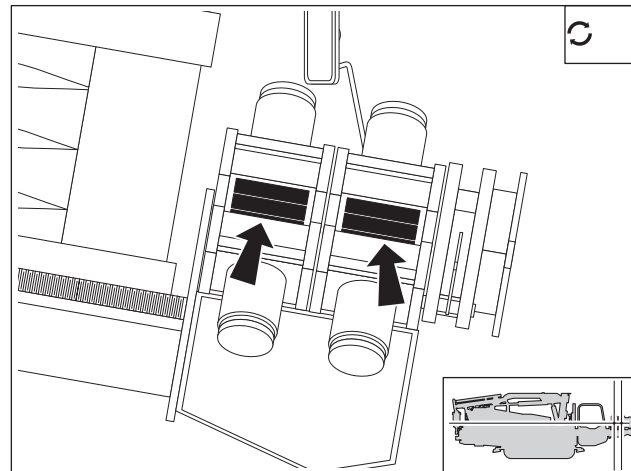


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Replace Wrench Jaw Inserts and Hardware

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



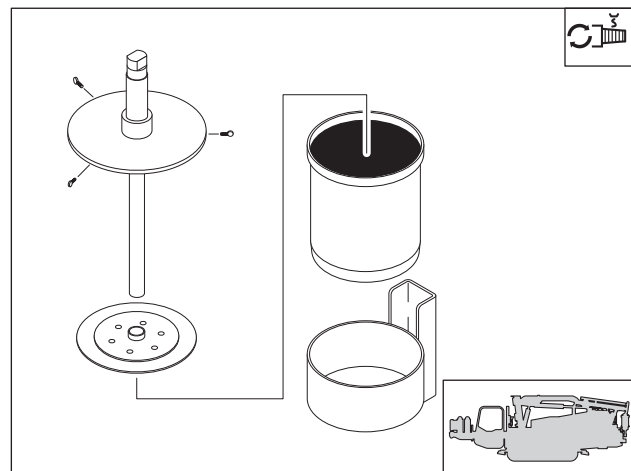
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Change Auto Lubricator TJC Pail

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

To change pail

1. Remove thumb screws attaching pump bracket (1) to bucket.
2. Lift pump off of pump bracket.
3. Remove follower plate (2) from empty pail and install into new pail. Press firmly on follower plate until TJC comes up in center opening.
4. Remove empty pail from TJC pail holder.
5. Install new pail into TJC pail holder.
6. Insert pump dip tube through hole in follower plate.
7. Install thumb screws.



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

Adjust Rubber Track Tension

Rubber track tension may not require adjustment except when excessively worn or damaged, and in need of replacement. See repair guide for replacement procedure. Should rubber track tension ever need adjusting, follow procedure below.



WARNING

Fluid pressure could pierce skin and cause injury or death. Stay away.

NOTICE: Service track grease cylinder only while standing away from zerk. Wear gloves and safety glasses, and cover zerk with cloth when relieving pressure in cylinder.



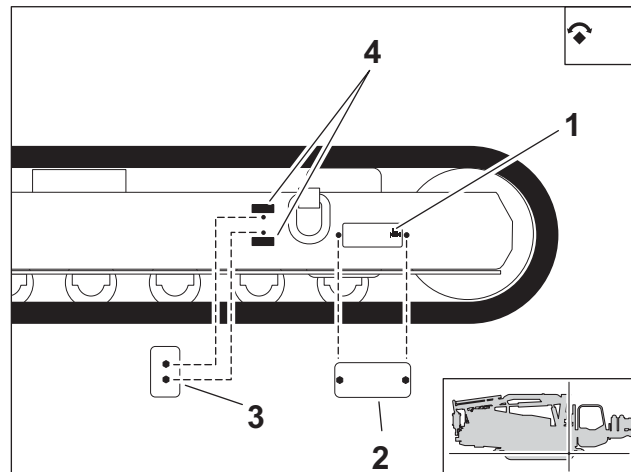
WARNING

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



To adjust:

1. Raise and support unit as if to remove tracks.
2. Remove covers (2, 3) from track frame to expose idler cylinder zerk and recoil stop bars.
3. Clean track cylinder zerk (1).
4. Use 7/8" button head coupler on grease gun.
5. Add MPG to increase track tension until recoil stop bars (4) can be removed.
6. Re-insert recoil stop bars.
7. Replace covers.
8. Repeat for other track.



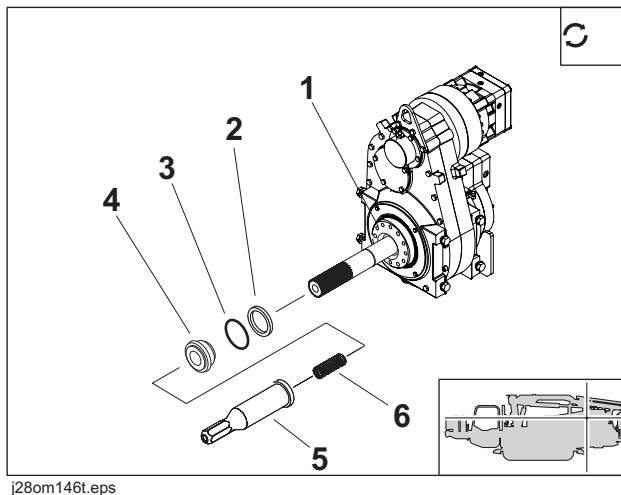
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Change Inner Water Swivel (Seal Kit)

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

To replace:

1. Remove saver sub. Do not remove indexing dowels from spindle.
2. Remove hex (6) and spring (7) from drive shaft.
3. Remove snap ring (5).
4. Remove seal (4) and main body (2).



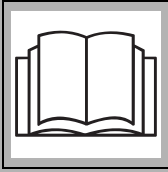
IMPORTANT: Use care when handling main body to avoid seal contamination. Do not allow grease to touch inner seals during installation.

5. Inspect dowel pin (1). To replace, drive new pin into different hole until top of pin is flush with shaft larger diameter.
6. Slide new main body (1) onto drive shaft. Check o-ring (3) and replace if needed.
7. Lightly coat seal (3) with THF and install onto main body.

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

8. Slide snap ring (4) onto main body.
9. Compress seal kit until snap ring is properly seated.
10. Install hex (5) and spring (6).
11. Install saver sub. See page 221.

Jump Start Unit



WARNING

Incorrect procedures could result in death, injury, or property damage. Use equipment correctly.

NOTICE:

- Park on level area.
- Put all drive controls in neutral and lower all unstowed attachments.
- Turn off all electrical loads.
- Turn off engine and remove key from ignition.
- Block wheels or tracks.



WARNING

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

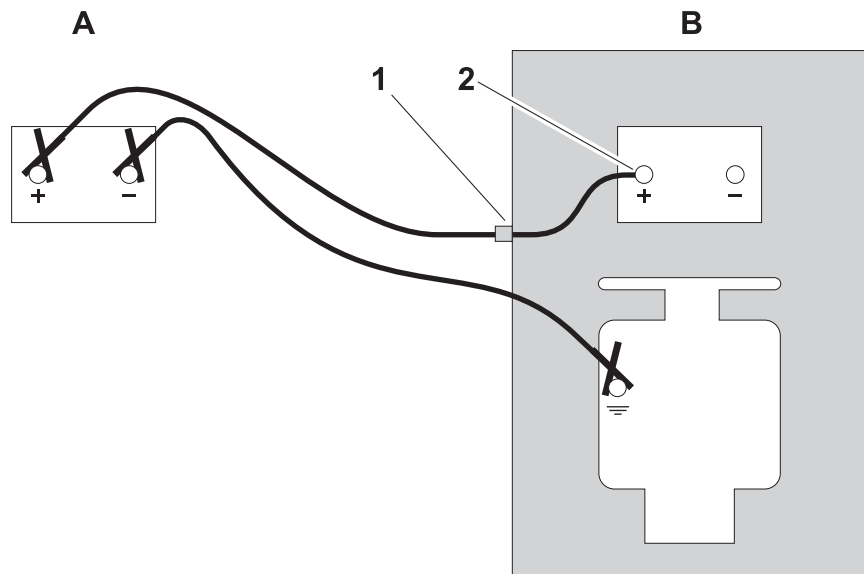
NOTICE:

- Lead-acid batteries vent explosive hydrogen gas when charging.
- Do not smoke, create sparks, or use flames around batteries.
- NEVER lean over battery when making connections.
- Do not allow vehicles to touch when jump starting.
- Wear eye protection and remove metal jewelry and watches.
- Do not attempt to jump start a battery that is leaking, bulging, heavily corroded, frozen, or otherwise damaged.
- NEVER short-circuit battery terminals for any reason.
- NEVER hammer on battery posts or cable terminals.

Before You Start

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

Read all steps thoroughly and review illustration before performing procedure.

Jump Start Procedure (Engine Off)

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

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

5. Connect the other red positive (+) jumper cable clamp to positive (+) post of battery (A) in the service vehicle.



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

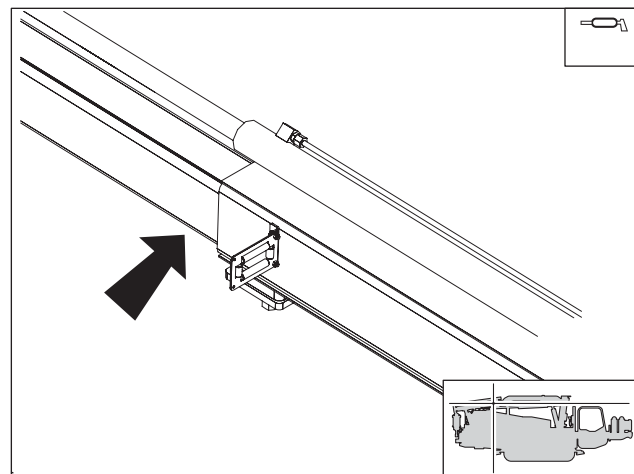
If the disabled vehicle did not start, check for loose or corroded battery cable connections. Poor connections will prevent current from charging the failed battery. Clean terminals and posts if necessary and repeat steps above. If a running jump is necessary, repeat steps above with engine running.

NOTICE: Jumping with engine running can damage the alternator and electronic components on both vehicles, and should be performed only if necessary.

Crane

Lube Boom Extensions

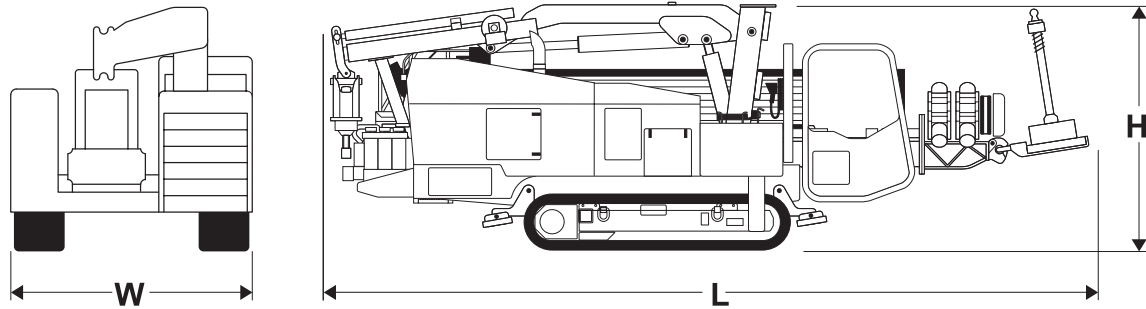
Lube top and bottom of entire length of boom extensions with MPG as needed for smooth operation.



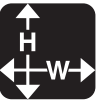
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Specifications



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Dimensions	U.S.	Metric
L, overall machine length (per SAE J2022)	368 in	9.35 m
W, overall machine width (per SAE J2022)	101 in	2.57 m
H, overall machine height (per SAE J2022)	110 in	2.79 m
Entry angle (per SAE J2022)	10-15°	10-15°
Angle of approach	13°	13°
Angle of approach with cab step removed	18°	18°
Angle of departure	17°	17°
Ground clearance	16.7 in	424 mm
Operating mass		
JT mode (per SAE J2022)	45,300 lb	20 500 kg
AT mode (per SAE J2022)	47,260 lb	21 400 kg

Mach 1 Power Pipe	U.S.	Metric
Length (per SAE J2022), nominal	177 in	4.5 m
Tool joint diameter (per SAE J2022)	4.0 in	102 mm
Tubing diameter (per SAE J2022)	3.63 in	92 mm
Minimum bend radius	230 ft	70 m
Weight (per SAE J2022)	229 lb	104 kg
Weight, 12 drill pipe and box	3760 lb	1710 kg

All Terrain Pipe	U.S.	Metric
Length, without inner pipe (per SAE J2022)	169.5 in	4.3 m
Joint diameter (per SAE J2022)	4.5 in	114 mm
Tubing diameter (per SAE J2022)	3.63 in	92 mm
Minimum bend radius	205 ft	63 m
Weight, with inner pipe (per SAE J2022)	284 lb	130 kg
Weight, with pipe box and 12 drill pipe	4430 lb	2010 kg

Operational		U.S.	Metric
Maximum spindle speed			
	inner pipe (per SAE J2022)	270 rpm	270 rpm
	outer pipe (per SAE J2022)	210 rpm	210 rpm
Maximum spindle torque			
	inner pipe, max	2000 ft•lb	2700 N•m
	outer pipe, max	12,000 ft•lb	16 300 N•m
Thrust force			
	actual, All Terrain mode (per SAE J2022)	70,000 lb	311 kN
	actual, JT and AT dirt modes (per SAE J2022)	70,000 lb	311 kN
Pullback force		100,000 lb	445 kN
Carriage thrust travel speed (per SAE J2022)		150 fpm	46 m/min
Carriage pullback travel speed (per SAE J2022)		150 fpm	46 m/min
Minimum bore diameter			
	All Terrain	6.25 in	159 mm
	JT with soil bit	6 in	152 mm
Backream diameter		soil dependent	
Ground travel speed			
	forward (per SAE J2022)	3.6 mph	5.8 km/h
	reverse (per SAE J2022)	3.6 mph	5.8 km/h
Ground bearing pressure			
	All Terrain (per ISO 16754)	13.4 psi	.94 kg/cm ²
	JT (per ISO 16754)	12.8 psi	.90 kg/cm ²



Power		U.S.	Metric
Engine: Deutz TCD 2013 L06-2V			
Fuel: diesel			
Cooling medium: liquid			
Injection: direct			
Aspiration: turbocharged & charge air cooled			
Cylinders: 6			
Displacement		436 in ³	7.15 L
Bore		4.25 in	108 mm
Stroke		5.1 in	130 mm
Power			
	manufacturer's gross power rating (SAE J1995)	268 hp	200 kW
	estimated net power rating (per SAE J1349)	251 hp	187 kW
	rated speed	2300 rpm	2300 rpm
Emissions compliance		EPA Tier 3	EU Stage IIIA

Drilling Fluid System (Onboard)		U.S.	Metric
Maximum drilling fluid flow			
	JT mode (per SAE J2022)	230 gpm	870 L/min
	AT mode (per SAE J2022)	120 gpm	450 L/min
Maximum drilling fluid pressure (per SAE J2022)		1000 psi	69 bar

Fluid Capacities	U.S.	Metric
Fuel tank	97 gal	370 L
Hydraulic reservoir	47 gal	180 L
Engine oil, including filter	21 qt	20 L
Engine cooling system	11 gal	42 L
Fluid pump liner wash tank	3.5 gal	13 L
Antifreeze tank	27 gal	102 L

Battery (2 used)

SAE reserve capacity rating 450 min, SAE cold crank rating @ 0°F (-18°C), 1400 amps.

Noise Levels

Operator < or = 87 dBA sound pressure per ISO 6396 (in enclosed operator station)
 Operator < or = 92 dBA sound pressure per ISO 6396 (in open operator station without heat and AC)
 Exterior < or = 113 dBA sound power per ISO 6395

Vibration Level

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.
 Operator's seat complies with ISO 7096

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



Support

Procedure

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

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

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

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

Resources

Publications

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



Ditch Witch Training

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

Warranty

Ditch Witch Equipment and Replacement Parts Limited Warranty Policy

Subject to the limitation and exclusions herein, free replacement parts will be provided at any authorized Ditch Witch dealership for any Ditch Witch equipment or parts manufactured by The Charles Machine Works, Inc. (CMW) that fail due to a defect in material or workmanship within one (1) year of first commercial use (Exception: 2 years for all SK5 attachments). Free labor will be provided at any authorized Ditch Witch dealership for installation of parts under this warranty during the first year following "initial commercial" use of the serial-numbered Ditch Witch equipment on which it is installed. The customer is responsible for transporting their equipment to an authorized Ditch Witch dealership for all warranty work.

Exclusions from Product Warranty

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

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

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

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

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

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

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

First version: 1/91; Latest version: 7/05

**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.

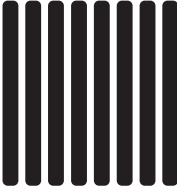
This will enable you to receive updates on this equipment as well as information on new products of interest.

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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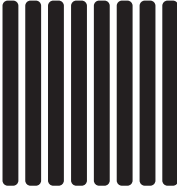
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POSTAGE WILL BE PAID BY

**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

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