JT20

Deutz® TD2.9L4

Operator's Manual

CE

CMW®

Issue 1.0
Original Instruction

053-3220

Overview

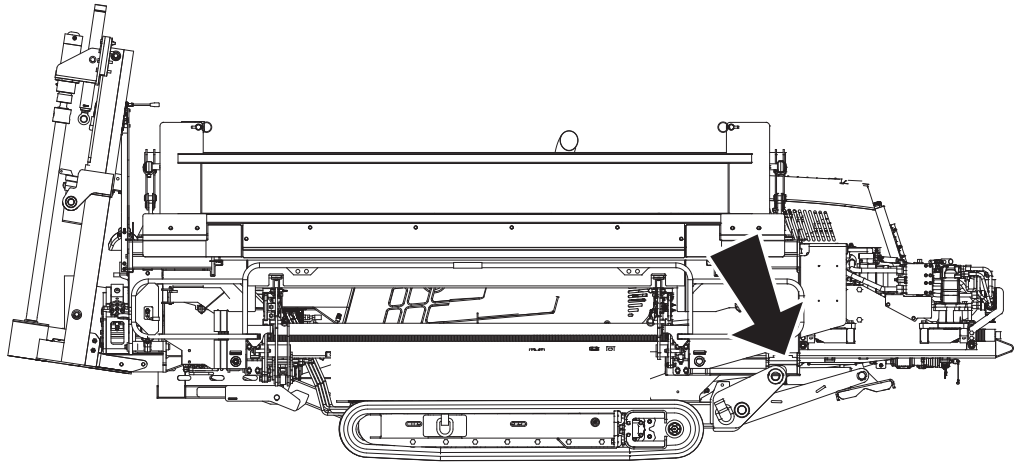
Chapter Contents

California Proposition 65

⚠WARNING Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm. www.P65warnings.ca.gov.

Serial Number Location

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



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Item	
Date of manufacture	
Date of purchase	
Machine serial number	

Intended Use

The JT20 is a self-contained horizontal directional drill designed to install buried cable and pipe to distances to 400' (122m) depending on diameter of drill pipe and soil conditions.

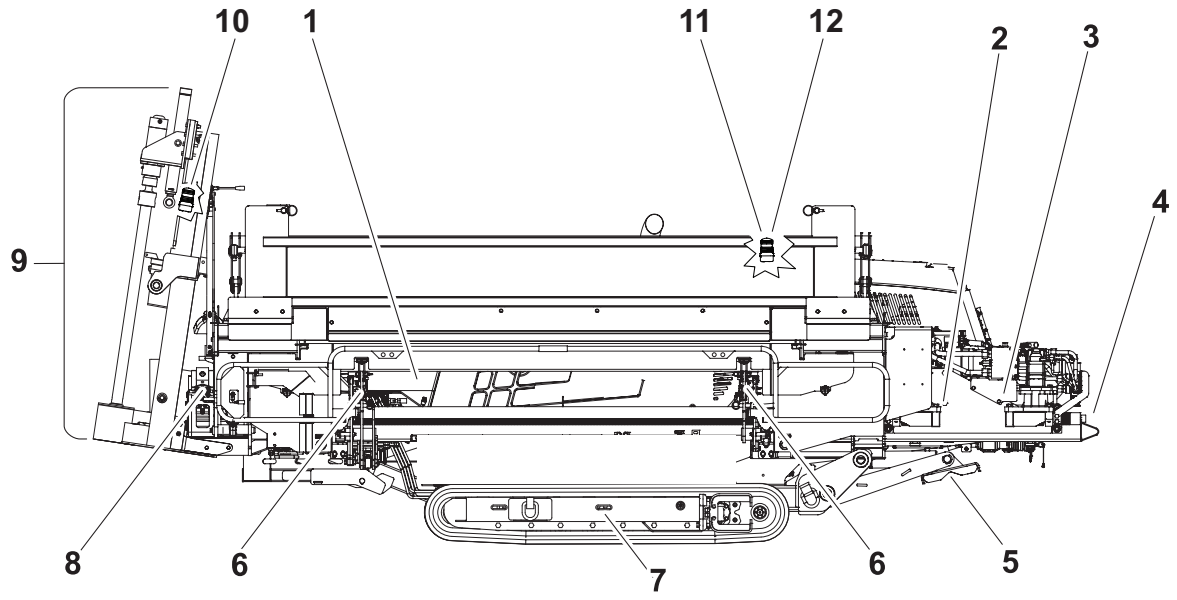
This machine is intended for operation only according to the instructions in this manual. Operate machine in ambient temperatures from 10° to 115°F (-12° to 46°C). Contact your Ditch Witch® dealer for provisions required for operating in extreme temperatures. Use in any other way is considered contrary to the intended use.

This machine should be used with genuine Ditch Witch fluid machines and Subsite® Electronics tracking equipment. It should be operated, serviced, and repaired only by professionals 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 training.

Machine Components



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1. Operator station
2. Spindle
3. Carriage
4. Drill frame
5. Stabilizer
6. Pipe loader
7. Tracks
8. Wrenches
9. Anchoring system
10. DrillLok® indicator/Control cycle light (green)
11. Wireless remote control indicator (clear)*
12. ESID strobe indicator (amber)

*If equipped

Regulatory Notices

United States

This device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Changes or modifications not expressly approved by **The Charles Machine Works, Inc.** could void the user's authority to operate the equipment.

This device 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 by **The Charles Machine Works, Inc.** could void the user's authority to operate the equipment.

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

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

Contains FCC ID: ITQ-TR2 & KQL-RM02410.

Canada

CAN ICES-2/NMB-2

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

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

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

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

RF Exposure Statement

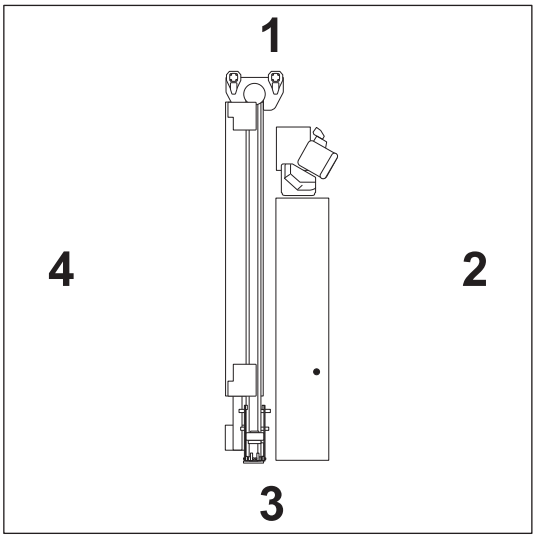
In order to comply with RF exposure requirements during normal operation, this device must be held in front of the body horizontally. The antenna must be vertical in line with the body with at least 4" (100mm) separation distance from the body.

This device complies with Health Canada's Safety Code Section 6.

Operator Orientation

IMPORTANT: Top view of machine is shown.

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



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Operating Area

When using remote to drive and set up, keep machine within sight at all times. Keep a safe distance away from machine when operating remote control. Operate drilling functions only from seat.

About This Manual

This manual contains information for the proper use of this machine. Cross references such as "See page 50" will direct you to detailed procedures.

Bulleted Lists

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

Numbered Lists

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

Foreword

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

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

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

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

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

Thank you for buying and using Ditch Witch equipment.

JT20
Operator's Manual

Deutz® TD2.9L4

Issue number 1.0/OM-02/20
Part number 053-3220

Contents

Safety Awareness

Chapter Contents

For additional precautions, see "Prepare" chapter.

Guidelines

⚠ WARNING Misuse of machine can cause death or serious injury. Read and understand operator's manual and all other safety instructions before use. Know how to use all controls.

Follow these guidelines before operating any jobsite equipment:

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

Emergency Procedures

WARNING Underground utilities. Contact can cause death or serious injury. Locate and verify underground utilities before digging or drilling.

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

EMERGENCY SHUTDOWN: Shut off machine or press remote engine stop button (if equipped).

Electric Strike Description

When working near electric cables, remember the following:

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

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

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

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

If an Electric Line is Damaged

If you suspect an electric line has been damaged, DO NOT MOVE. Take the following actions. The order and degree of action will depend on the situation.

- If you are **on machine or bonded equipment:**
  - REMAIN ON MACHINE.
  - Reverse drilling direction and try to break contact. Do not touch drill pipe with hands or hand-held tools.
  - Press electric strike system test button.
  - If alarm sounds again, stay where you are and wait for electric company to shut off power.
  - If alarm does not sound or 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.
- If you are **off the machine or bonded equipment,** DO NOT TOUCH ANY EQUIPMENT connected to machine**:**
  - If you must leave the area, take small steps with feet close together to reduce the hazard of being shocked from one foot to the other.
  - If you leave, do not return to area or allow anyone into area until given permission by electric company.
- Warn people nearby that an electric strike has occurred. Instruct them to leave the area.
- Have someone contact electric company to shut off power.
- Do not resume drilling or allow anyone into area until given permission by electric company.

If a Gas Line is Damaged

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.
- After warning others to leave the area, leave jobsite as quickly as possible.
- Immediately call your local emergency phone number and utility company.
- If jobsite is along street, stop traffic from driving near jobsite.
- Do not return to jobsite until given permission by emergency personnel and utility company.

If a Fiber Optic Cable is Damaged

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

If Machine Catches on Fire

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

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

Safety Alert Classifications

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

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

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

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

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

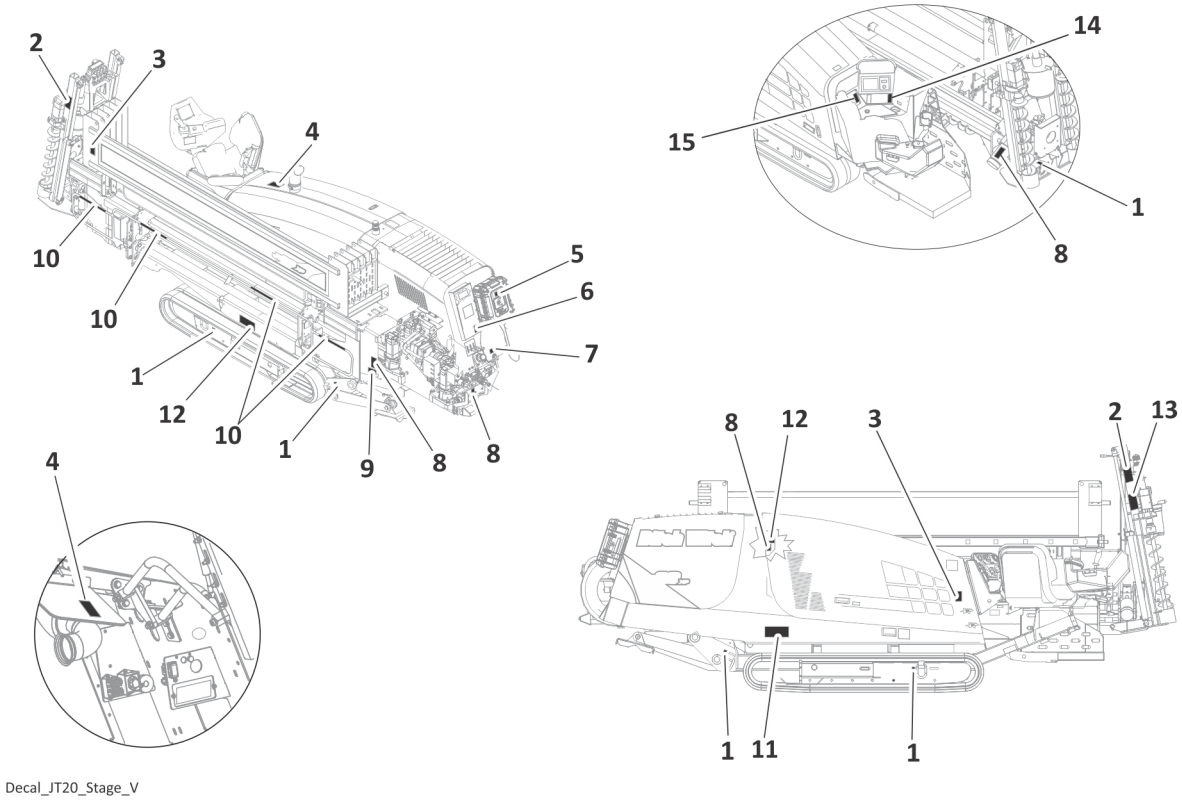
CAUTION indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

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

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

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

Machine Safety Alerts

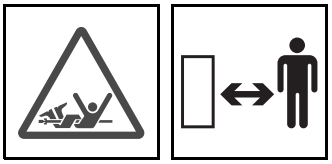


Decal_JT20_Stage_V

1

Tiedown location. See Transport chapter for more information.

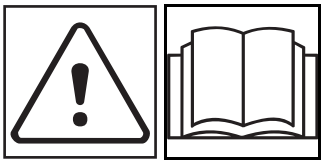
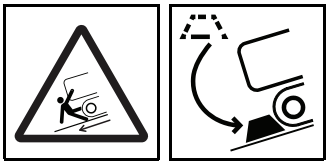
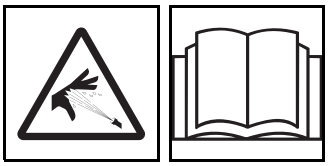
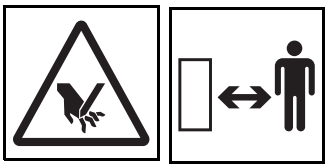
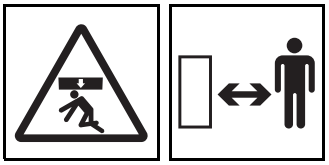
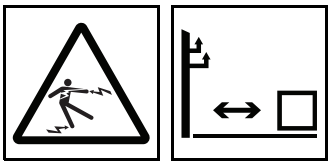
2

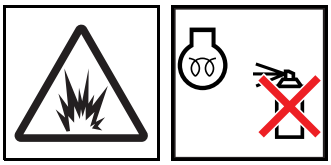
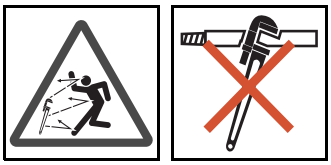


DANGER Rotating shaft. Crushing will cause death or serious injury. Stay away.

3

CAUTION Remote-controlled equipment. Impact can cause death or serious injury. Stay away.

4		**⚠ CAUTION** Hot parts. Contact can cause burns. Only touch when cool or wear gloves.
5		**⚠ WARNING** Misuse of machine can cause death or serious injury. Read and understand operator's manual and all other safety instructions before use. Know how to use all controls.
6		**⚠ WARNING** Runaway machine. Impact can cause death or serious injury. Chock or block machine when parking on slopes.
7		**⚠ WARNING** Pressurized fluid or air. Contact can cause death or serious injury. Refer to operator's manual for correct use.
8		**⚠ WARNING** Moving parts. Contact can cause serious injury. Stay away.
9		**⚠ WARNING** Lifted load. Crushing can cause death or serious injury. Stay away from lifted load and its range of movement.
10		DANGER stripe decal. See Parts Manual for replacement part numbers.
11		**⚠ DANGER** Buried electrical lines. Contact will cause death or serious injury. Know location of lines. Stay away.

12		**WARNING** Pre-heater. Fire or explosion can cause death or serious injury. Never use starter fluid.
13		**DANGER** Moving or thrown tools. Impact will cause death or serious injury. Never use pipe wrenches on drill string. Follow procedure in operator's manual.
14		**WARNING** Underground utilities. Contact can cause death or serious injury. Locate and verify underground utilities before digging or drilling.
15		**CAUTION** High noise levels. Exposure can cause hearing loss. Wear hearing protection.

Prepare

Chapter Contents

For additional precautions, see "Safety Awareness" chapter.

Prepare Jobsite

WARNING Underground utilities. Contact can cause death or serious injury. Locate and verify underground utilities before digging or drilling.

To help avoid injury:

- Expose lines by careful hand digging or soft excavation before operating equipment. Use appropriate equipment and procedures for exposing utility lines.
- All vegetation near operator's station must be removed. Contact with trees, shrubs, or weeds during electrical strike could result in electrocution.
- Classify jobsite and follow precautions based on classification.
- Follow local regulations for digging near utilities.

A successful job begins before working. 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.

Select Start and End Points

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

Slope

Equipment should be parked on a level site. Consider how slope will affect setup and operation. Assess the risks on each slope to determine if factors affecting risks create an unsafe condition for working. See "Slope Guidelines" on page 82.

Space

Check that starting and ending points allow enough space for working. See "Minimum Setback" on page 33.

Comfort

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

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

Identify Hazards

Inspect jobsite before transporting equipment. Check for the following:

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

> ***NOTICE:*** All tracking equipment is subject to magnetic interference. The presence of interference can cause inaccuracies in both location and depth calculations. See tracker or locator operator's manual for more information.

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

Locate Utilities

Notify One-Call Services

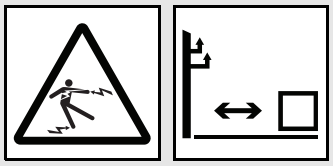
Mark proposed path with white paint and have underground utilities located before working.

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

Verify Underground Utilities

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

Locate Overhead Lines



DANGER Overhead electrical lines. Contact will cause death or serious injury. Know location of lines. Stay away.

Note location and height of all overhead lines in jobsite and ensure that equipment maintains proper distance from live lines.

Classify Jobsite

Select a Classification

Jobsites are classified according to underground hazards present, not by line being installed. Jobsite may have more than one classification.

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

Classify jobsite as electric if jobsite is in question or if the possibility of unmarked electric utilities exists.

Apply Precautions

⚠WARNING Underground utilities. Contact can cause death or serious injury. Locate and verify underground utilities before digging or drilling.

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

Electric Jobsite Precautions

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

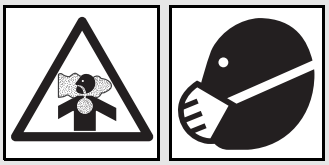
- Expose line by careful hand digging or soft excavation. Use beacon to track bore path. If utility must be crossed, tracker operator must watch the drill head during drilling and backreaming. The tracker operator must have communication with the drill operator or DrillLok® system must be enabled with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

Natural Gas Jobsite Precautions

Position equipment upwind from gas lines and use one or both of these methods:

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

Crystalline Dust Jobsite Precautions



⚠ CAUTION Silica dust. Exposure can cause lung disease or cancer. Use breathing protection.

Crystalline silica dust is a naturally occurring substance found in soil, sand, concrete, granite, and quartz.

To reduce exposure when cutting, drilling, or working these materials:

- Use water spray or other means to control dust.
- Refer to US Occupational Safety and Health Administration (OSHA) guidelines or other applicable regulating guidelines for appropriate breathing protection or dust control methods.

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.

Clear objects such as landscaping fabric, cable, and wire from the work area. These objects may be underground or partially buried.

Arrange for Traffic Control

Vehicle and pedestrian traffic must be a safe distance from equipment. Evaluate jobsite and allow an appropriate buffer zone around equipment. If working near a road or other traffic area, contact local authorities about safety procedures and regulations.

Plan Bore Path

Plan the bore path, from entry to end, before drilling begins. Subsite® Electronics bore planning software is available for planning your bore path. This special software can be run in the field using a laptop computer or mobile device. See your Ditch Witch® dealer for details.

NOTICE: If not using bore planning software, see "Bore Path Calculator" on page 34.

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

Recommended Bend Limits

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

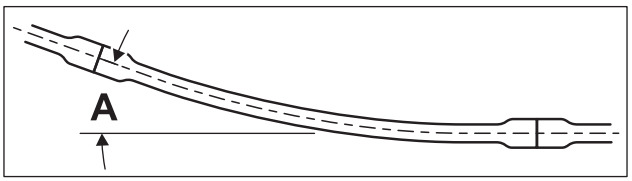
Ditch Witch® drill pipes are designed to bend slightly during operation. Slight bending allows for steering and correcting direction. Bending beyond recommended limits will cause damage that might not be visible. This damage adds up and will later lead to sudden drill pipe failure.

Pipe Pitch

NOTICE: Bending drill pipe more sharply than recommended will damage pipe and cause failure over time. Maximum changes in pitch within 1-2' (300-600m) of pipe create sharp bends that will damage pipe.

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

Ensure pitch (A) changes no more than the following percentages over the full length of each pipe. Monitor the pitch of each pipe with tracker remote display on the operator's console. See tracking system operator's manual.



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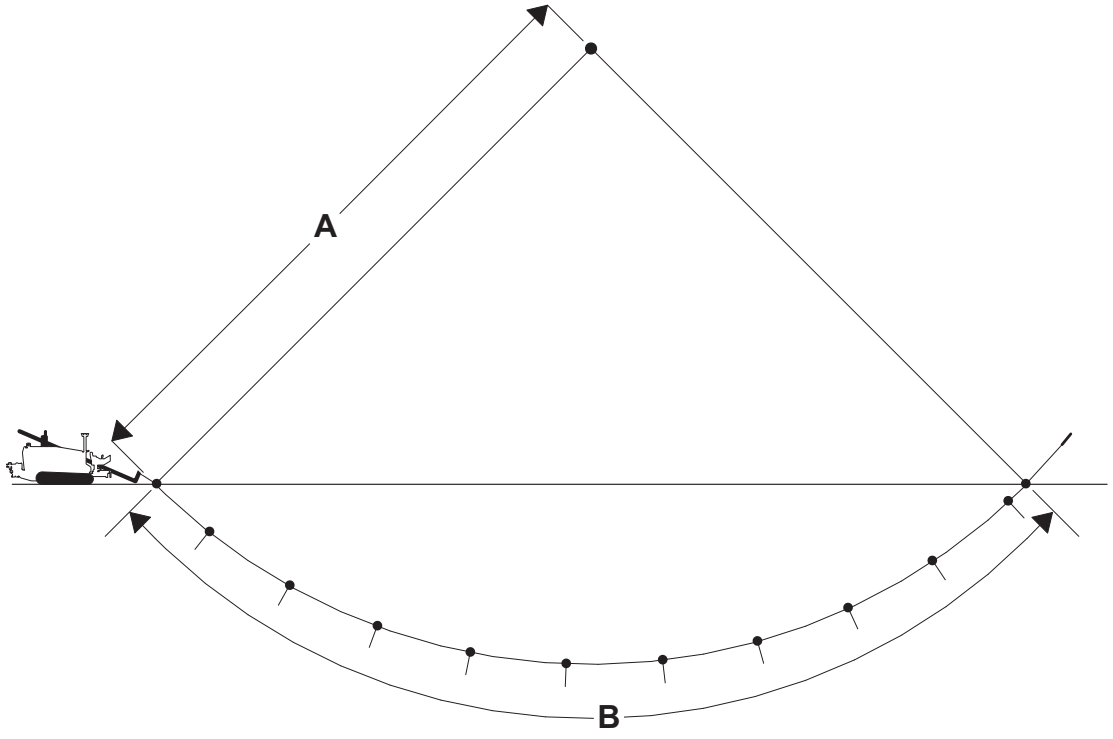
Drill Pipe	Percentage
JT20 Power Pipe® HD	9.4%
Ditch Witch® Forged HD	9.2%
JT20 Forged HDX	8.0%

Bend Radius

NOTICE: Bending drill pipe more sharply than recommended will damage pipe and cause failure over time. If bend radius is reduced, drill pipe life is reduced.

IMPORTANT: Use following charts to keep bends within safe limits.



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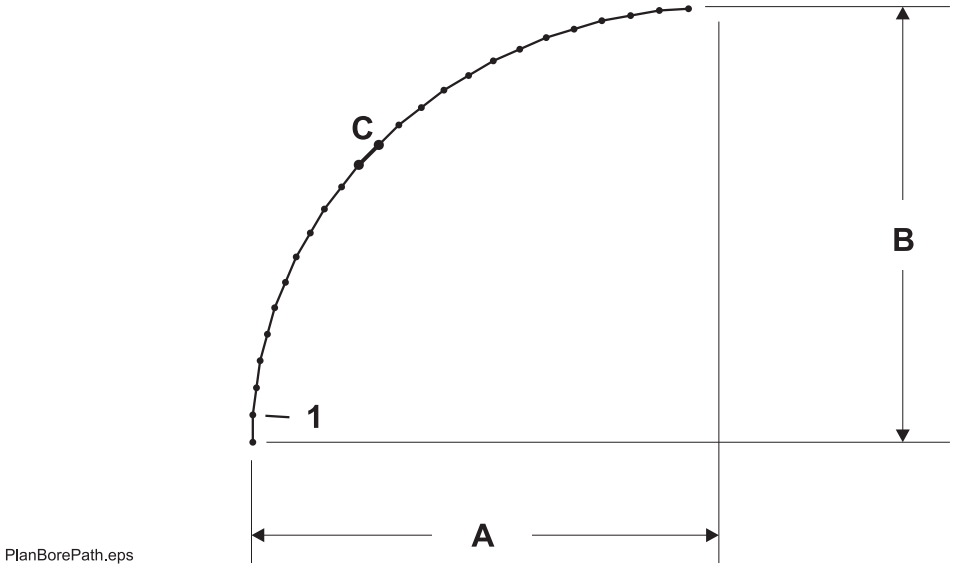
Drill Pipe	Tested Minimum Bend Radius	Radius (A)*	Length Needed (B)*
JT20 Power Pipe® HD	107' (32.6m)	107' (32.6m)	168' (51.2m)
Ditch Witch® Forged HD	109' (33.2m)	109' (33.2m)	171' (52.1m)
JT20 Forged HDX	123' (37.5m)	123' (37.5m)	194' (59.1m)

*Measurements are based on a 90° bend in the bore path.

Pipe-By-Pipe Bend Limits



JT20 Power Pipe® HD				
Pipe (C)	**Forward (B)**		**Deflection (A)**	
1	10' 0"	3.0m	0' 5.6"	0.1m
2	19' 11"	6.1m	1' 10"	0.6m
3	29' 7"	9m	4' 2"	1.3m
4	39' 1"	11.9m	7' 5	2.2m
5	48' 2"	14.7m	11' 6"	3.5m
6	56' 11"	16m	16' 5"	5m
7	65' 1"	19.8m	22' 1"	6.7m
8	72' 9"	22.2m	28' 7"	8.7m
9	79' 9"	24.3m	35' 8"	10.9m
10	86' 1"	26.2m	43' 5"	13.2m
11	91' 8"	27.9m	51' 9"	15.8m
12	96' 5"	29.4m	60' 6"	18.4m
13	100' 4"	30.6m	69' 9"	21.3m
14	103' 4"	31.5m	79' 3"	24.2m
15	105' 6"	32.1m	89'	27.1m
16	106' 8"	32.5m	98' 11"	30.2m
17	107'	32.6m	107'	32.6m

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

JT20 Forged HDX				
Pipe (C)	**Forward (B)**		**Deflection (A)**	
1	9’ 11.9”	2.1m	0’ 4.9”	0.1m
2	19’ 11.0”	6.1m	1’ 7.4”	0.5m
3	29’ 8.5”	9.1m	3’ 7.5”	1.1m
4	39’ 3.6”	12.0m	6’ 5.1”	2.0m
5	48’ 7.7”	14.8m	9’ 11.9	3.1m
6	57’ 8.0”	17.6m	14’ 3.6”	4.4m
7	66’ 3.7”	20.2m	19’ 3.99”	5.9m

JT20 Forged HDX				
Pipe (C)	**Forward (B)**		**Deflection (A)**	
8	74' 6.2"	22.7m	25' 0.4"	7.6m
9	82' 2.8"	25.1m	31' 4.7"	9.6m
10	89' 4.9"	27.3m	38' 4.2"	11.7m
11	96' 0.0"	29.3m	45' 10.4"	14.0m
12	101' 11.5"	31.1m	53' 10.7"	16.4m
13	107' 3.0"	32.7m	62' 4.5"	19.0m
14	111' 10.1"	34.1m	71' 3.1"	21.7m
15	115' 8.3"	35.3m	80' 5.8"	24.5m
16	118' 9.5"	36.2m	89' 11.8"	27.4m
17	121' 1.3"	36.9m	99' 8.5"	30.4m
18	122' 7.5"	37.4m	109' 7.1"	33.4m
19	123' 4.1"	37.6m	119' 6.8"	36.4m
20	123'	37.5m	123'	37.5m

Entry Pitch

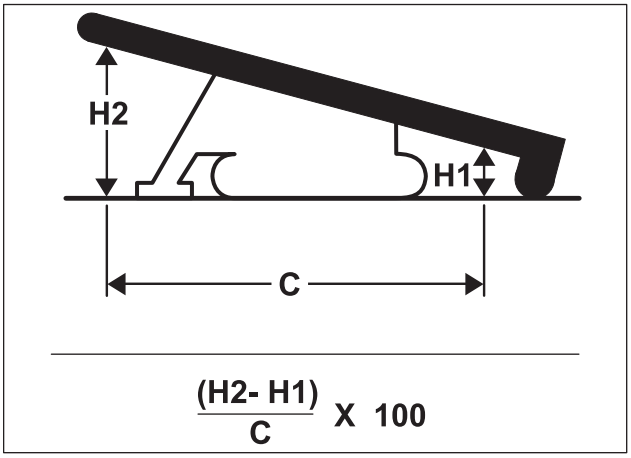
Entry pitch is the slope of the drill frame compared with the slope of the ground. Determine entry pitch one of the two following ways.

With Pitch Beacon

1. Lay pitch beacon on ground and read pitch. Record this number.
2. Lay pitch beacon on drill frame and read pitch. Record this number.
3. Subtract ground pitch from drilling unit pitch.

With Measurements

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



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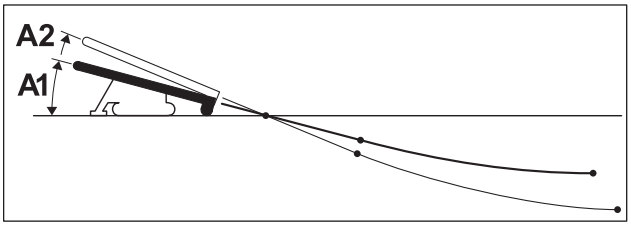
Minimum Setback

Minimum setback is the distance from the entry point to where pipe becomes horizontal (A1).

IMPORTANT: If setback is too small (A2), bend limits of the pipe will be exceeded and the pipe will be damaged.

A shallow entry pitch (B1) allows pipe to become horizontal sooner and with less bending. Increasing entry pitch (B2) creates a longer and deeper minimum setback.



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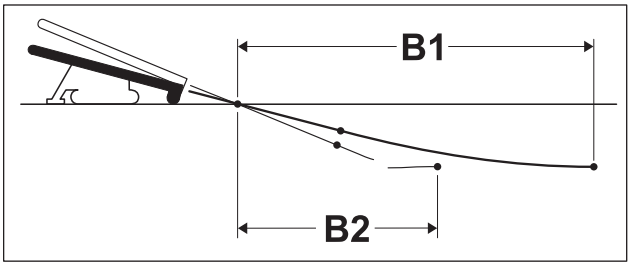

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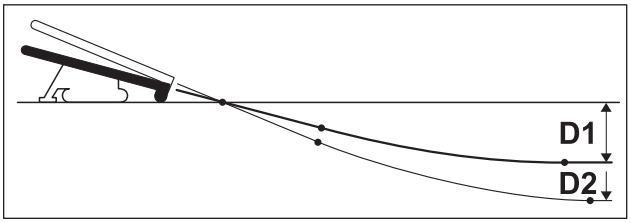
Minimum Depth

Minimum depth is how deep the pipe will be when it becomes horizontal. Because pipe must bend gradually, entry pitch and bend limits determine this measurement.



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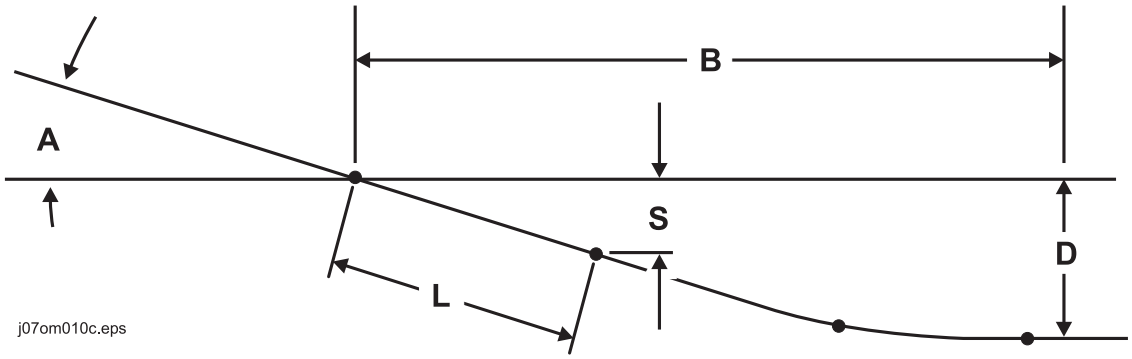
- To reduce minimum depth (D1), reduce entry pitch. This also decreases setback.
- To increase minimum depth (D2), increase entry pitch. This also increases setback.

Bore Path Calculator



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JT20 Power Pipe® HD*			
Depth to Begin Steering (S)	**Entry Pitch (A)**	**Setback (B)**	**Minimum Depth (D)**
1’ 7” (0.48m)	-18%	27’ 6” (8.4m)	3’ 3” (1m)
1’ 9” (0.53m)	-20%	29’ 6” (9m)	3’ 10” (1.2m)
1’ 11” (0.58m)	-22%	31’ 6” (9.6m)	4’ 5” (1.3m)
2’ 1” (0.64m)	-24%	33’ 5” (10.2m)	5’ (1.5m)
2’ 3” (0.69m)	-26%	35’ 4” (10.8m)	5’ 8” (1.7m)

*Numbers in table based on 107’ (32.6m) minimum bend radius and beacon housing, EZ-Connect connector, transition sub, and one-third of first drill pipe (L, totaling 8’ 8” [2.6m]) in the ground before steering.

Ditch Witch® Forged HD*			
Depth to Begin Steering (S)	**Entry Pitch (A)**	**Setback (B)**	**Minimum Depth (D)**
1’ 7” (0.48m)	-18%	27’ 11” (8.5m)	3’ 4” (1m)
1’ 9” (0.53m)	-20%	29’ 11” (9.1m)	3’ 10” (1.2m)
1’ 11” (0.58m)	-22%	31’ 11” (9.7m)	4’ 5” (1.3m)
2’ 1” (0.64m)	-24%	33’ 11” (10.3m)	5’ 1” (1.5m)
2’ 3” (0.69m)	-26%	35’ 10” (10.9m)	5’ 9” (1.8m)

*Numbers in table based on 109’ (33.2m) minimum bend radius and beacon housing, EZ-Connect connector, transition sub, and one-third of first drill pipe (L, totaling 8’ 8” [2.6m]) in the ground before steering.

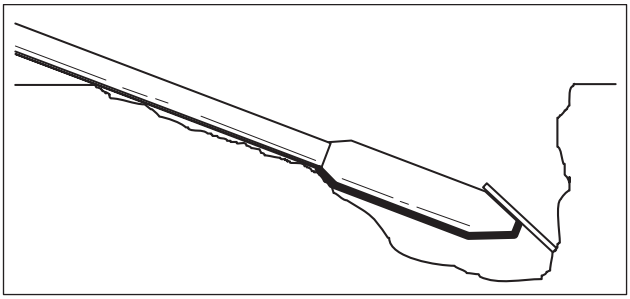
JT20 Forged HDX*			
Depth to Begin Steering (S)	**Entry Pitch (A)**	**Setback (B)**	**Minimum Depth (D)**
1’ 8” (0.51m)	18%/10°	30’ 10” (9.3m)	3’ 7” (1.1m)
1’ 11” (0.58m)	20%/11.3°	33’ 7” (10.2m)	4’ 4” (1.3m)
2’ 1” (0.64m)	22%/12.7°	36’ 4” (11.1m)	5’ 2” (1.6m)
2’ 4” (0.71m)	25%/14.0°	39’ 1” (11.9m)	6’ (1.8m)
2’ 7” (0.79m)	27%/15.3°	41’ 10” (12.8m)	6’ 11” (2.1m)
2’ 9” (0.84m)	30%/16.7°	44’ 6” (13.6m)	7’ 11” (2.4m)
3’ (0.91m)	32%/18.0°	47’ 3” (14.4m)	9’ (2.7m)

*Numbers in table based on 123’ (37.5m) minimum bend radius and beacon housing, EZ-Connect connector, transition sub, and one-third of first drill pipe (L, totaling 9’ 6” [2.9m]) in the ground before steering.

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.

Prepare Entry Point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For bore to be successful, first pipe must be straight as it enters the ground. See "Align the Joints" on page 131.

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. Steer down as required at start. Drill head will tend to move in easiest direction (toward surface) when rotated near the surface.

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

Prepare Operator

⚠ WARNING Jobsite hazards. Exposure can cause death or serious injury. Use correct equipment and work methods. Use and maintain appropriate safety equipment.

To help avoid injury:

- Wear personal protective equipment including hard hat, safety eye wear, foot protection, hearing protection, and gloves (except when near rotating equipment).
- Remove jewelry.
- Wear close-fitting, high visibility clothing.
- Have other personal protective equipment, such as insulated boots and gloves, breathing protection, and face shield, etc. available for use depending on jobsite hazards or requirements.

Follow these guidelines before operating any jobsite equipment:

- Complete proper training and read operator's manual before using equipment.
- 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.
- Review jobsite hazards, safety and emergency procedures, and individual responsibilities with all personnel before work begins. Safety videos are available from your Ditch Witch® dealer or at www.ditchwitch.com/safe. Safety Data Sheets (SDS) are available at www.ditchwitch.com/support.
- Use equipment carefully. Stop operation and investigate anything that does not look or feel right.

Any time jobsite is classified as electric, drill operator and tracker operator must wear protective boots, and the drill operator must have protective gloves within reach, all meeting the following standards:

- Boots must have high tops and meet the electric hazard protection requirements of ASTM F2413 or ASTM F1117 when tested at 18,000 volts. Tuck legs of pants completely inside boots.
- Gloves must have 17,000 AC maximum use voltage, according to ASTM specification D120.
- If working around higher voltage, use gloves and boots with appropriately higher ratings.

Prepare Equipment

Check Supplies

- fuel
- keys
- marking flags or paint
- notepad and pencil
- spare fuses
- lubricants
- receiver/transmitter or tracker
- extra batteries for accessories and equipment
- beacons
- two-way radios
- quick wrench
- transition sub
- anchoring equipment and accessories
- bits, screens, and nozzles
- adapters, pipe, and beacon housings
- marking flags or paint
- water and additional hoses
- drilling fluid and additives
- backreamers, swivels, and pulling devices
- wash down hose and spray gun
- duct tape
- spray lubricant
- tool joint compound

Check Equipment

Fluid Levels

- fuel
- engine oil
- diesel exhaust fluid (DEF), if needed
- hydraulic fluid
- engine coolant

Condition and Function

- all controls

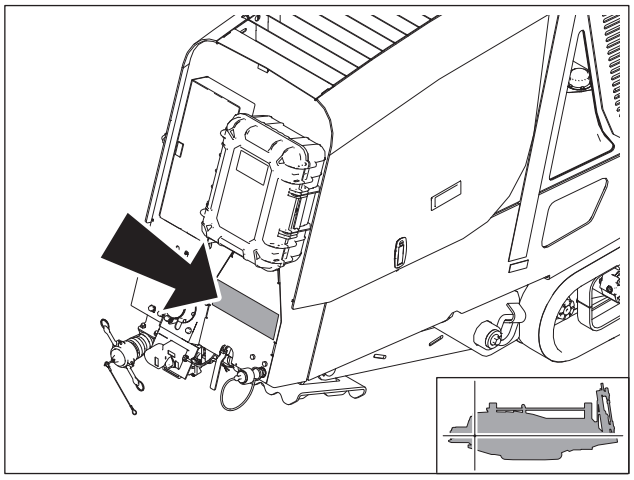
WARNING Improper control function. Use can cause death or serious injury. If control does not work as described in instructions, stop machine and have it serviced.

- battery
- hoses and valves
- pumps and motors
- tires or tracks
- signs, guards, and shields
- couplers and fittings
- water tank(s)
- fluid pump
- filters (air, oil, hydraulic)
- belts

Assemble Accessories

Fire Extinguisher

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



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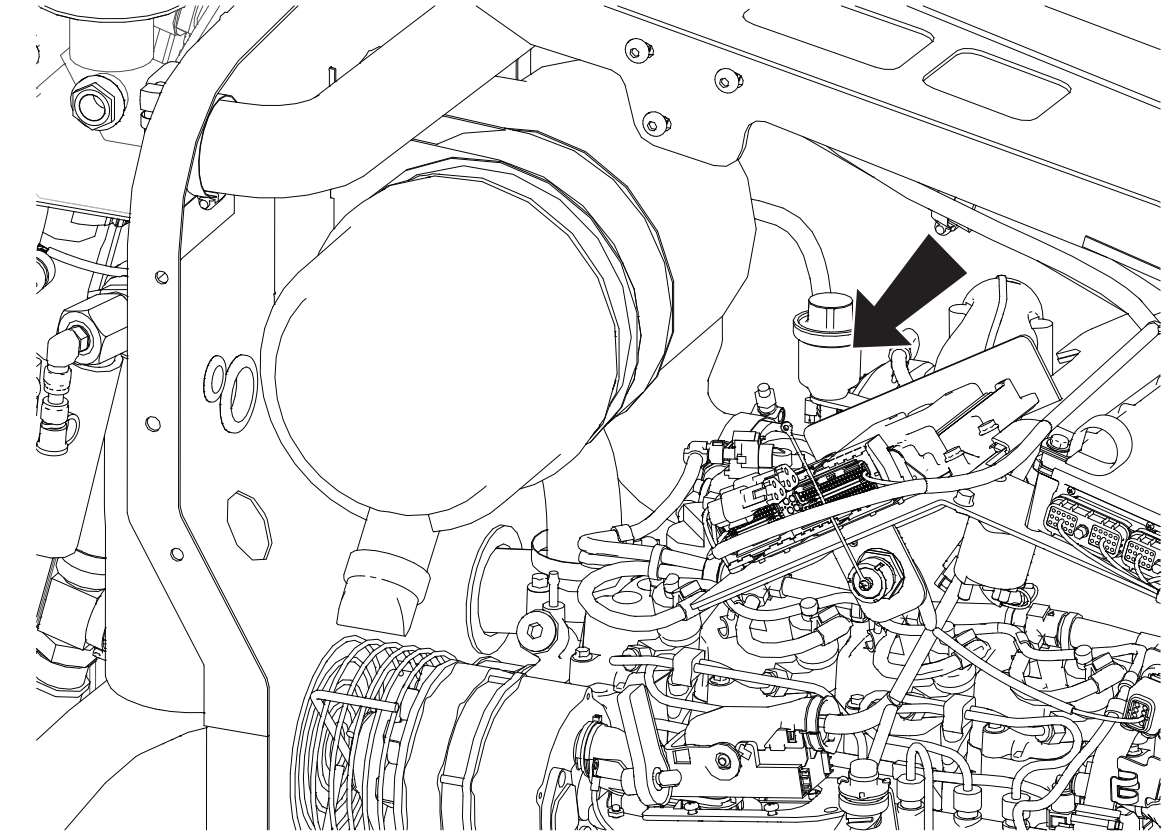
Controls

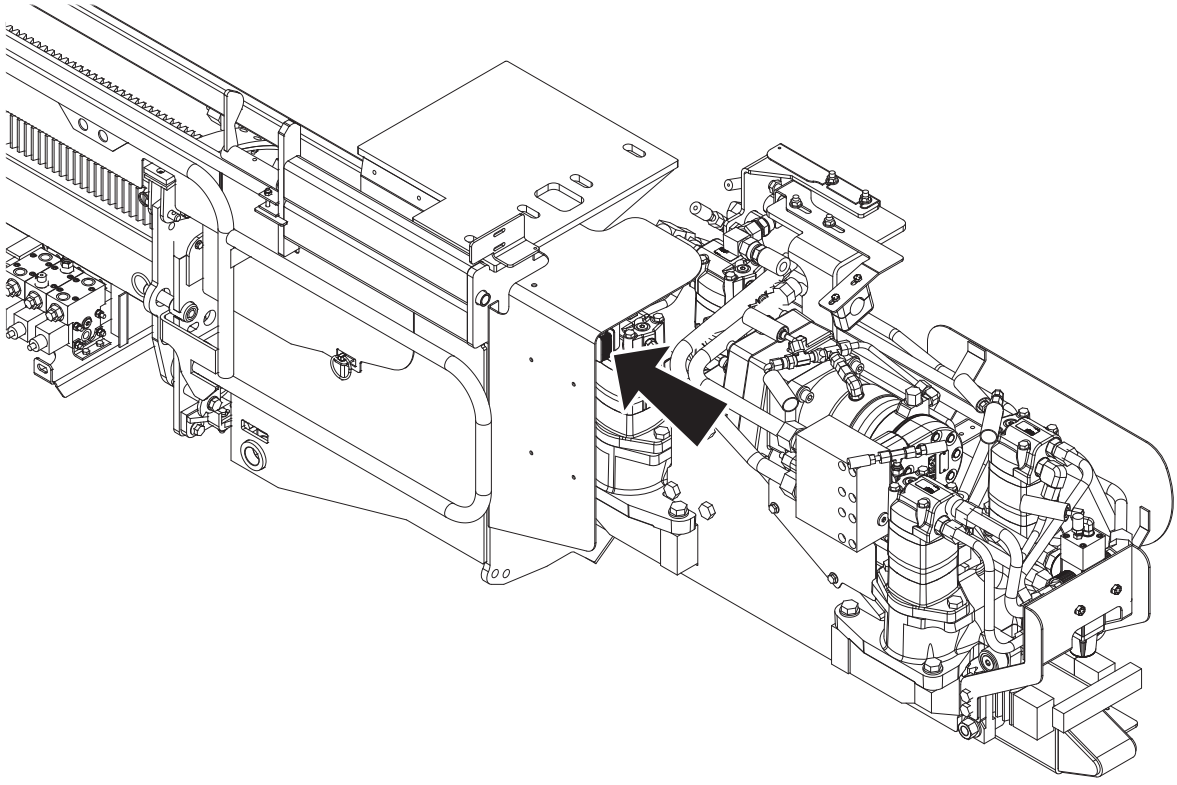
Chapter Contents

Air Filter



Item	Description	IMPORTANT
Air intake restriction indicator	Shows air intake restriction	Replace air filter elements when the indicator reaches the red zone. See "Filter, Air" on page 172.

Auxiliary Pipe Loading



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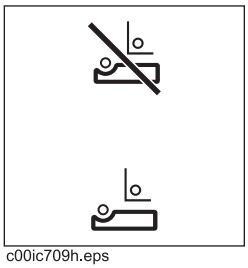
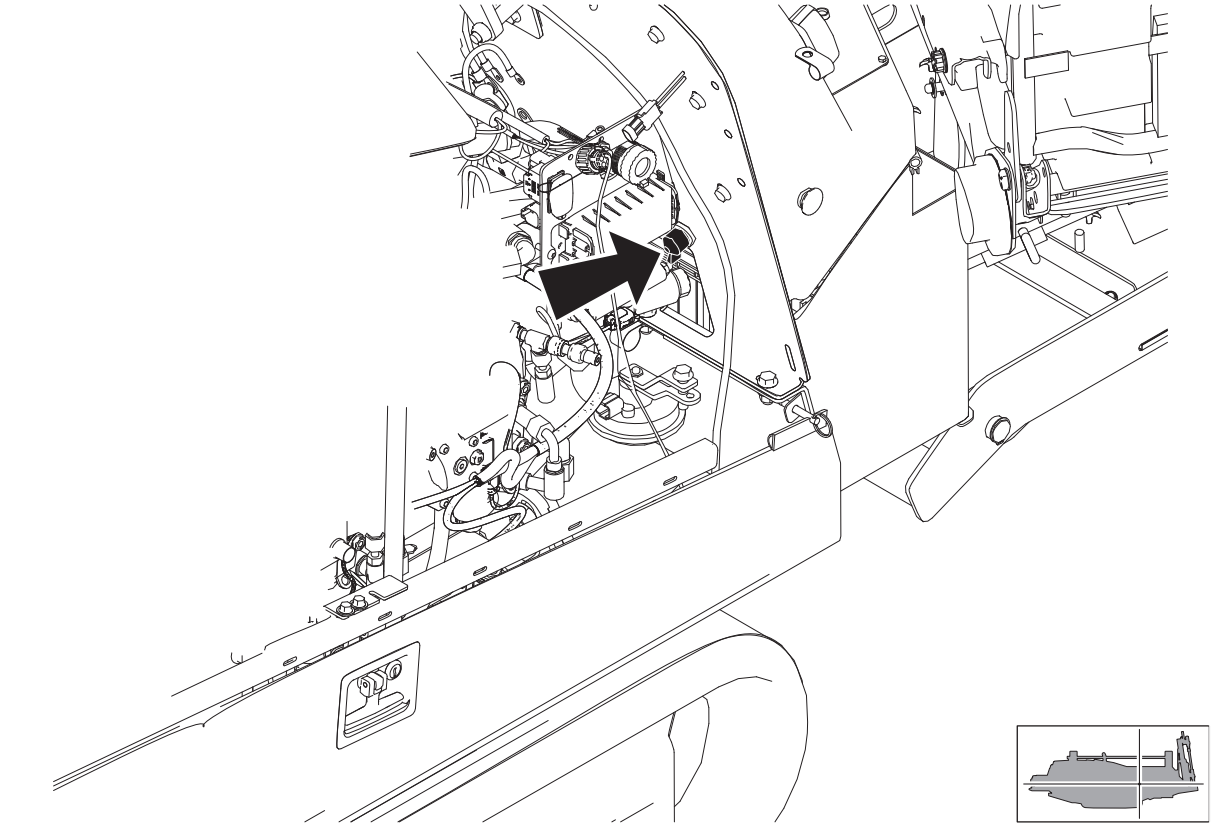
Item	Description	IMPORTANT
Auxiliary pipe load restricted operating mode switch  c00ic709h.eps	To override drill operator control of shuttles and lifters, press top.	

Battery Disconnect



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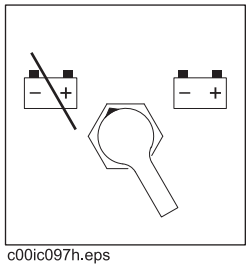
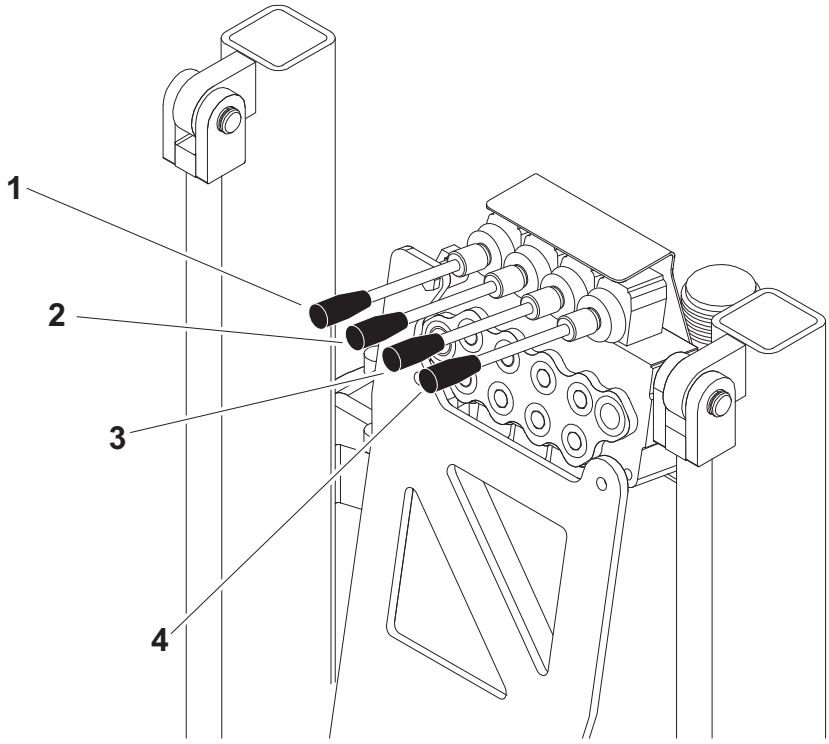
Item	Description	IMPORTANT
Battery disconnect  c00ic097h.eps	To connect, move right. To disconnect, move left.	***NOTICE:*** • Do not disconnect with engine running. • Wait two minutes after turning engine off before disconnecting battery.

Console, Anchor System



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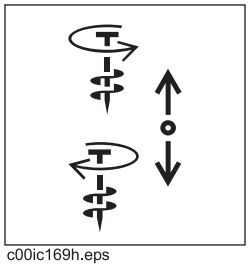
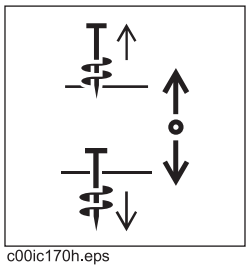
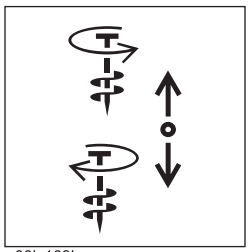
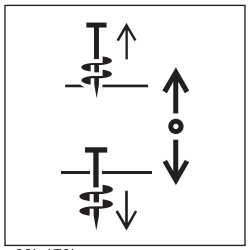
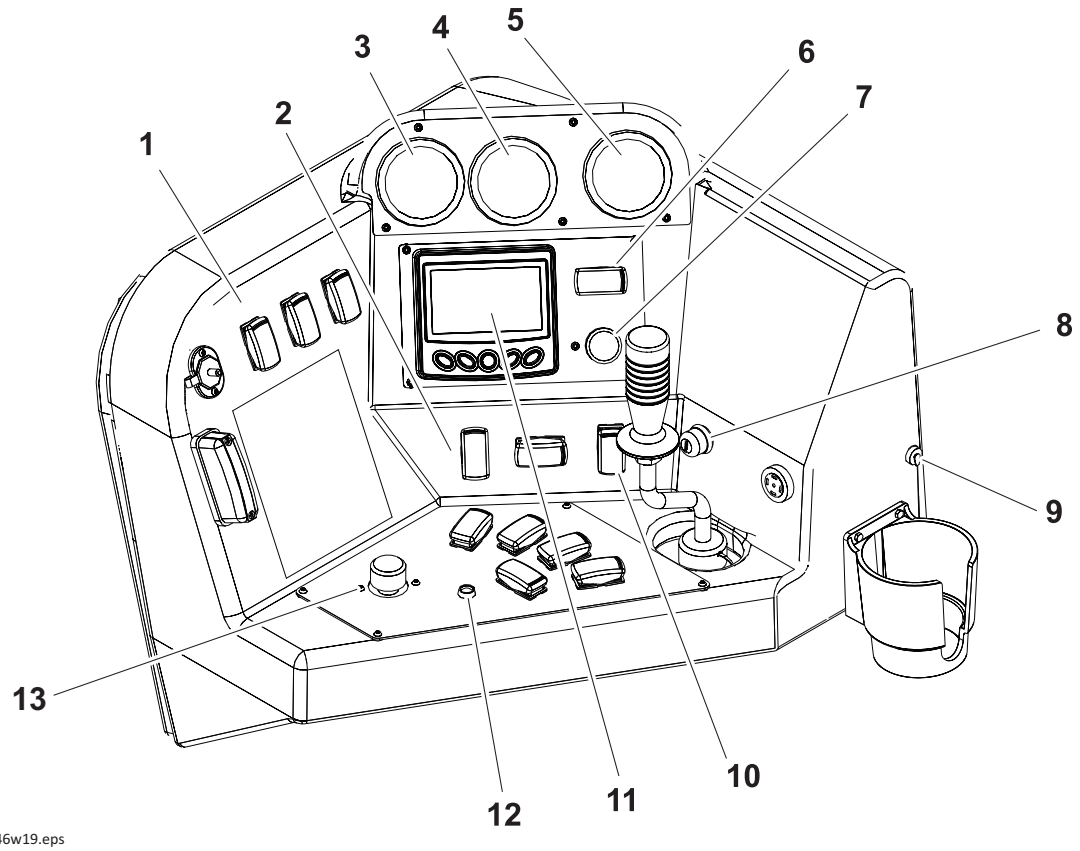
1. Left anchor rotation control
2. Left anchor lift control
3. Right anchor rotation control
4. Right anchor lift control

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

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

Console, Left

Drilling/Operation



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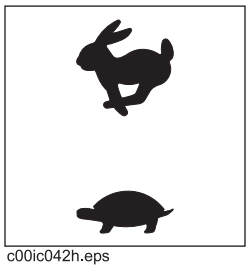
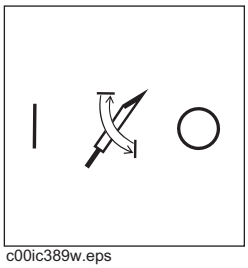
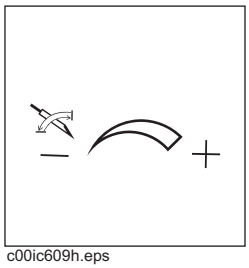
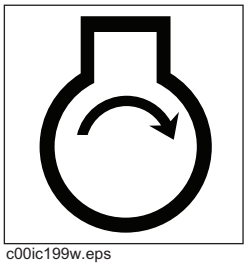
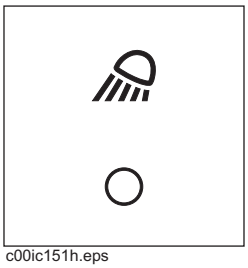
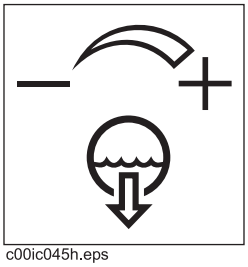
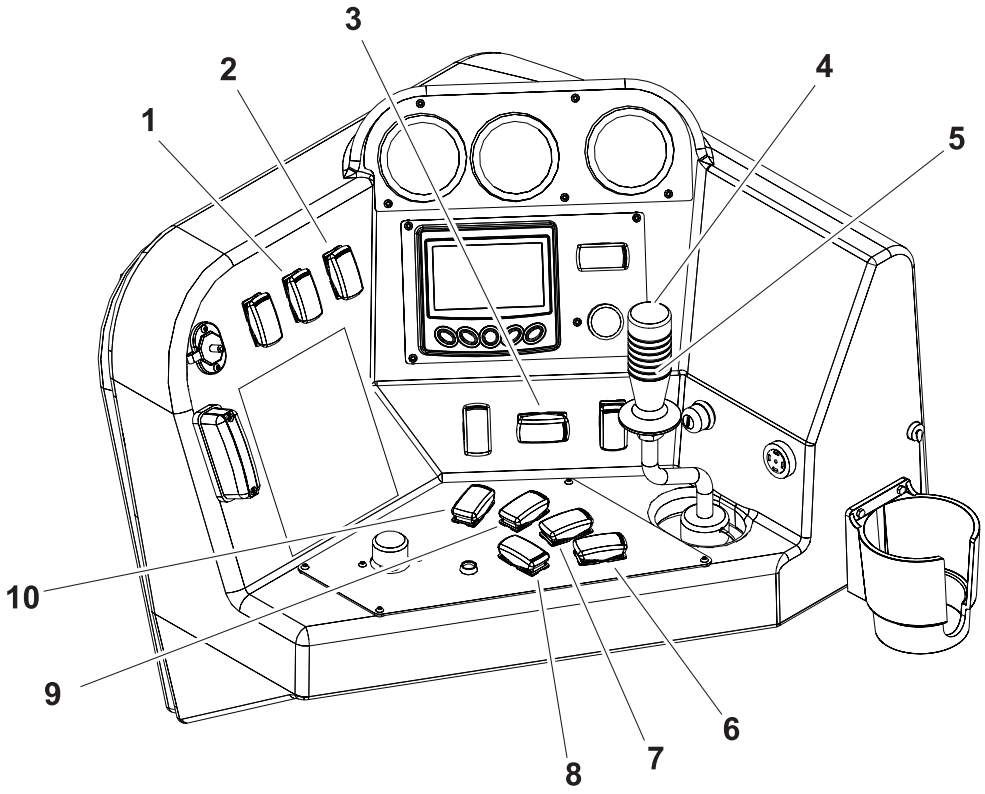
1. Throttle
2. ESID audible alarm interrupt/test switch
3. Drilling fluid pressure gauge
4. Thrust gauge
5. Rotation gauge
6. Autocarve switch
7. Carve window control
8. Remote engine start switch
9. EDT diagnostic port
10. Console/Work light switch
11. Display
12. Fluid pump indicator
13. Fluid flow control

Item	Description	IMPORTANT
1. Throttle  c00ic042h.eps	To increase engine speed, press top, then move switch to middle. To turn on autothrottle, press top. To turn off autothrottle, move to middle. To decrease engine speed, press bottom, then move switch to middle.	Autothrottle mode slows the engine to low throttle after 15 seconds of inactivity. To return to high speed, activate thrust, rotation, drilling fluid, or an add/remove pipe cycle.
2. ESID audible alarm interrupt/test switch  c00ic711h.eps	To turn off strike alarm at drill, press top. To start internal system test, press bottom. To reset system after a strike has been detected, press bottom.	Internal system test checks all systems and circuits except voltage limiter. See "Use Electric Strike Simulator" on page 140. See "If an Electric Line is Damaged" on page 14.
3. Drilling fluid pressure gauge	Displays drilling fluid pressure.	
4. Thrust gauge	Displays thrust pressure and force.	Thrust pressure is measured in psi (bar). Thrust force is measured in pounds.
5. Rotation gauge	Displays rotation pressure and force.	Rotation pressure is measured in psi (bar). Rotation force is measured in pounds.
6. Autocarve switch  c00ic389w.eps	To enable, press right. To disable, press left.	Use carve window selector to adjust carve window. Autocarve is disabled while front wrench is clamped. Two-speed carriage control is disabled while in autocarve mode.

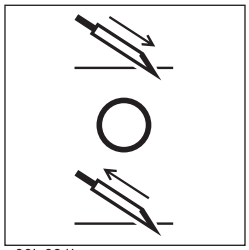
Item	Description	IMPORTANT
7. Carve window control  c00ic609h.eps	To increase, move right. To decrease, move right.	Autocarve control must be on. See "Autocarve switch" on page 48.
8. Remote engine start control  c00ic199w.eps	To start engine from operator station, press.	Works only when key in set-up console is on and operator is in seat. See "Drive" on page 79.
9. EDT diagnostic port	For use only by qualified Ditch Witch® technicians.	
10. Console/Work light switch  c00ic151h.eps	To turn on, press top. To turn off, press bottom.	
11. Display	Displays graphic symbols for indicators and conditions.	See "Display" on page 64.
12. Fluid pump indicator	Lights when fluid pump is on.	
13. Fluid flow control  c00ic045h.eps	To increase flow, turn right. To decrease flow, turn left.	Drilling fluid pump must be enabled. See "Drilling fluid pump switch" on page 53.

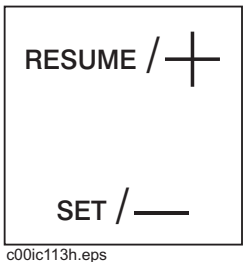
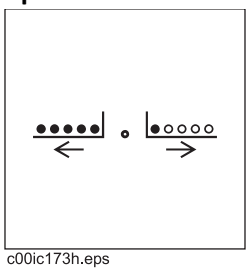
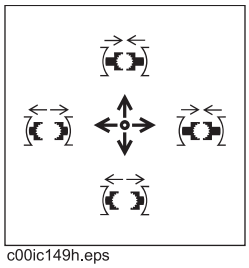
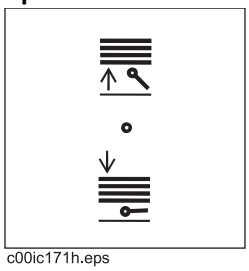
Pipe Loading

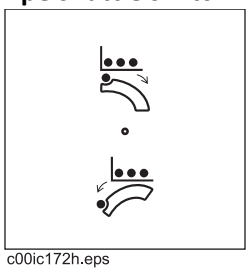
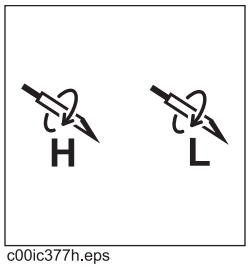
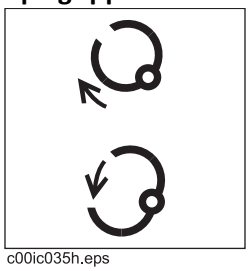
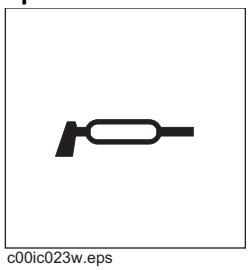


j80om047w19.eps

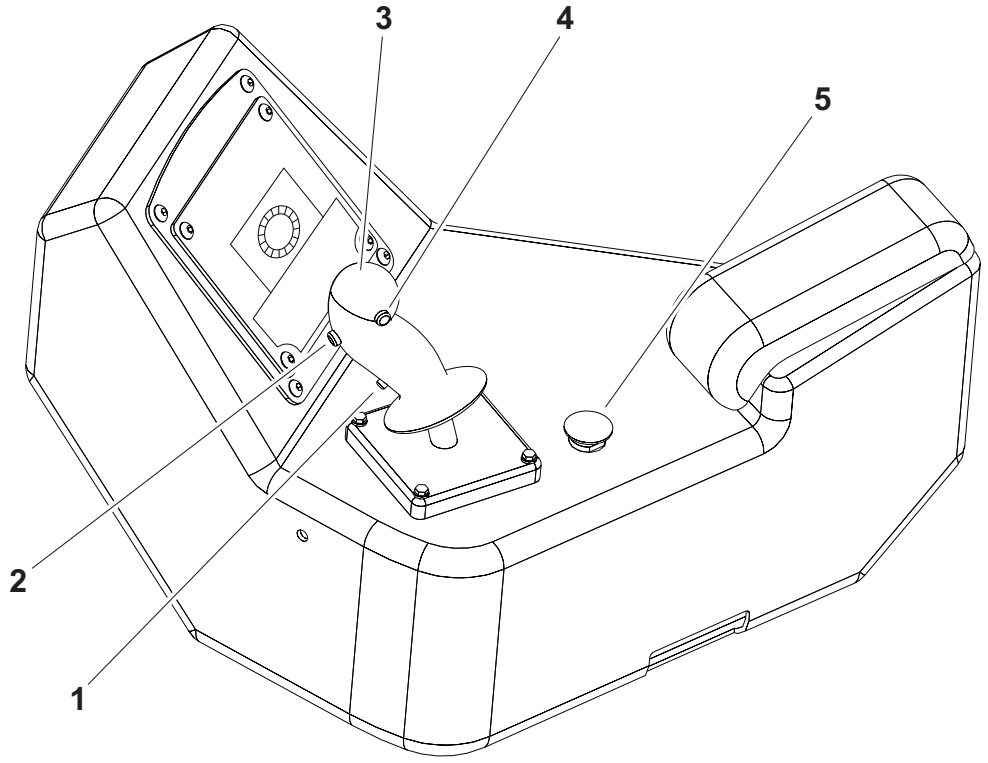
1. Add/Remove pipe switch
2. Set/Resume switch
3. Pipe box switch
4. Resume switch
5. Wrench control
6. Pipe lift switch
7. Pipe shuttle switch
8. Two-speed rotation switch
9. Pipe gripper switch
10. Pipe lubricator switch

Item	Description	IMPORTANT
1. Add/Remove pipe switch  c00ic031h.eps	To enable automated add pipe function, press top. To use manual pipeloader controls, move to middle. To enable automated remove pipe function, press bottom.	See "Use Automated Pipe Loader System" on page 104.

Item	Description	IMPORTANT
2. Set/Resume switch  c00ic113h.eps	To resume operation or increase operation levels, press top. To set operating conditions or reduce operation levels, press bottom.	See "Cruise Control" on page 121. See "Pipe Loader" on page 142. See "Use Autocarve Mode" on page 108.
3. Pipe box switch  c00ic173h.eps	To select previous row in pipe box, press left side. To select next row in pipe box, press right side. To stow pipe box, press left side.	See "Row Select" on page 145.
4. Resume switch	To resume operation, press.	See "Use Automated Pipe Loader System" on page 104.
5. Wrench control  c00ic149h.eps	To clamp and rotate rear wrench, push forward. To unclamp rear wrench, pull back. To clamp front wrench, move right. To unclamp front wrench, move left.	
6. Pipe lift switch  c00ic171h.eps	To raise, press top. To lower, press bottom.	

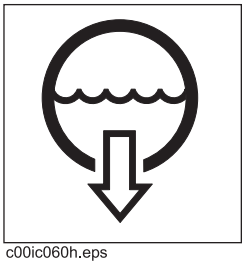
Item	Description	IMPORTANT
7. Pipe shuttle switch  c00ic172h.eps	To move toward pipe box (retract), press top. To move toward spindle (extend), press bottom.	
8. Two-speed rotation switch  c00ic377h.eps	To rotate at low speed, press right. To rotate at high speed, press left.	Two-speed rotation is disabled while in autocarve mode.
9. Pipe gripper switch  c00ic035h.eps	To close, press top. To open, press bottom.	
10. Pipe lubricator switch  c00ic023w.eps	To apply tool joint compound, press top.	

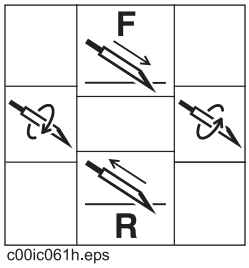
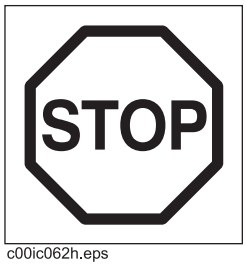
Console, Right



j38om004w.eps

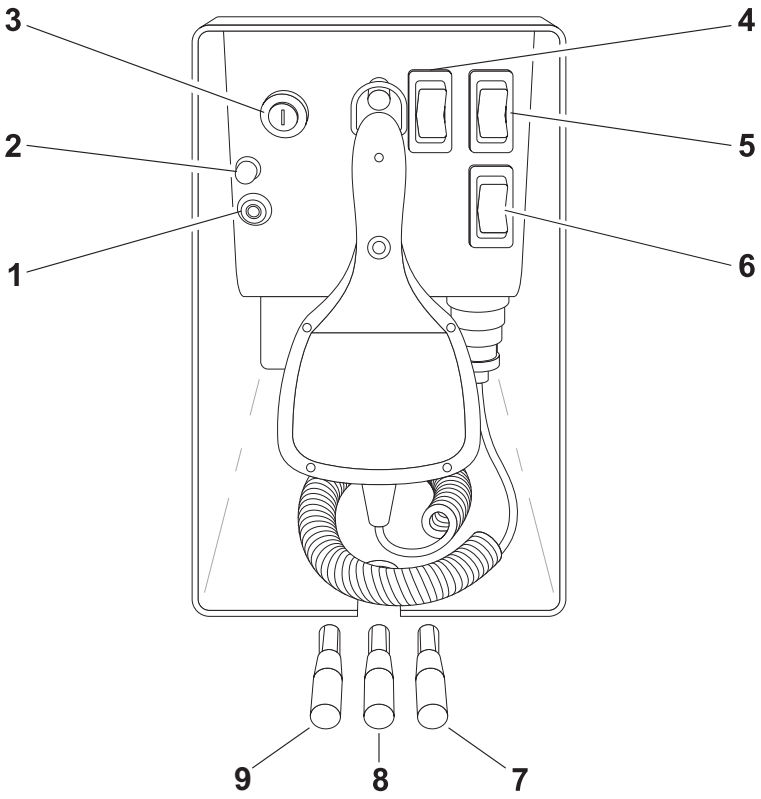
1. Drilling fluid pump switch
2. Multi-use button
3. Carriage control
4. Drilling fluid quick fill switch
5. Remote engine stop

Item	Description	IMPORTANT
1. Drilling fluid pump switch  c00ic060h.eps	To turn on, press once. To turn off, press again.	Drilling fluid pump switch and fluid flow selector must be enabled. See "Fluid flow control" on page 49.

Item	Description	IMPORTANT
2. Multi-use button	To engage a function, press and hold. To return to normal operation, release.	Operation options: • carriage control • autocarve reaming and positioning functions • interrupted makeup system override
3. Carriage control  c00ic061h.eps	To move carriage forward (thrust), push. To move carriage backward (pull back), pull. To rotate spindle counterclockwise (break out), move right. To rotate spindle clockwise (make up), move left.	See "Operate Carriage Control" on page 97.
4. Drilling fluid quick fill switch  c00ic059h.eps	To fill pipe with fluid, press and hold. To return fluid flow to flow control setting, release.	Overrides fluid control setting for full pump flow. Also overrides temporary fluid shutdown when front wrench is clamped.
5. Remote engine stop switch  c00ic062h.eps	To stop engine, press.	If used to stop machine, ensure ignition switch is in the off position. If wrenches are clamped when remote engine stop is pressed, wrenches could gradually unclamp.

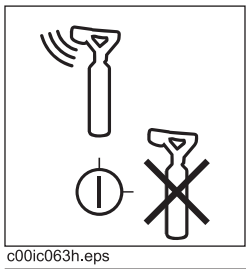
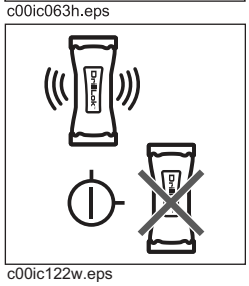
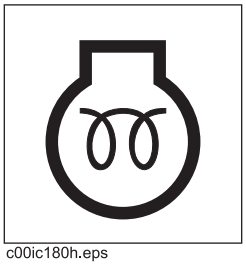
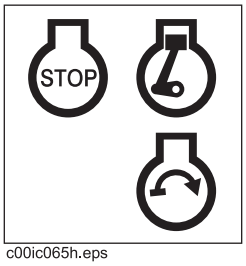
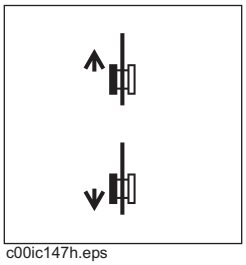
Console, Set-Up

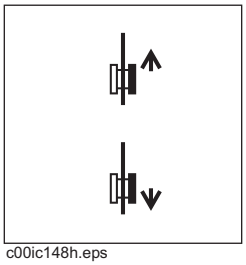
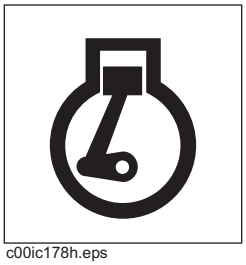
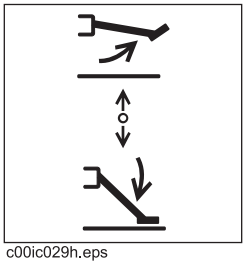
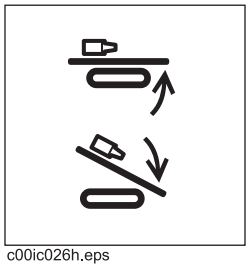
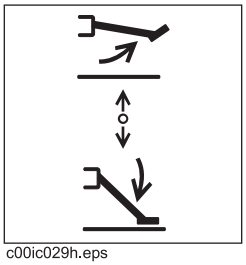
Controls



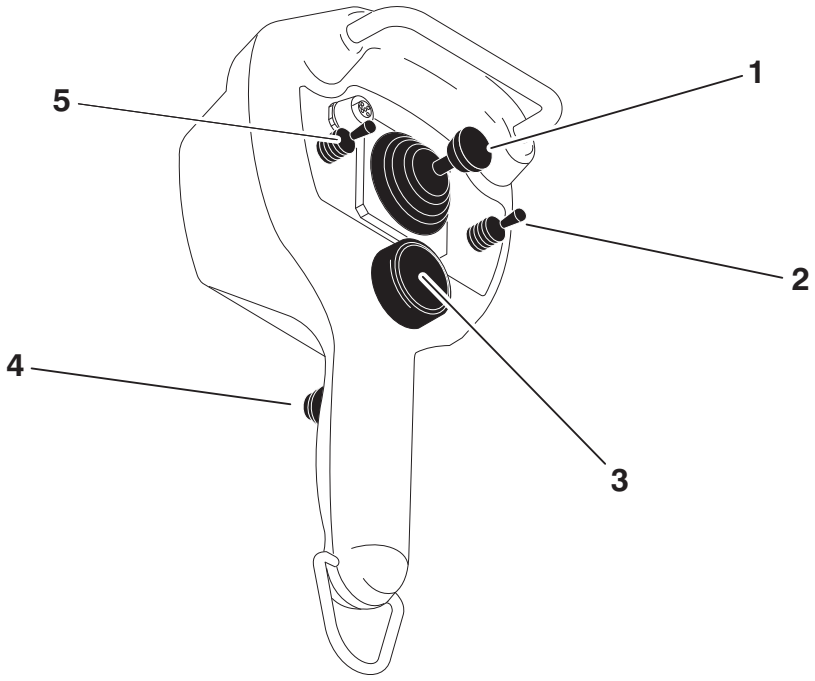
j38om039w.eps

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

Item	Description	IMPORTANT
1. DrillLok® key  c00ic063h.eps  c00ic122w.eps	To allow tracker operator to stop thrust and rotation, turn key left. To override DrillLok mode, turn key right.	Remove key and keep in tracker operator's possession.
2. Cold start wait indicator  c00ic180h.eps	Lights when intake air-preheater is operating.	See "Start" on page 80.
3. Ignition switch  c00ic065h.eps	To activate accessories, turn right. To start engine, turn right and hold. To shut off machine, turn left.	If accessories are activated for 25 seconds, alarm will sound. See "Accessory alarm key" on page 69. Wrenches can unclamp after machine is shut off. Wrenches will clamp when engine is started. See "Drive" on page 79.
4. Left track switch  c00ic147h.eps	To move left track forward, press top. To move in reverse, press bottom.	Use only if wireless control is inoperable.

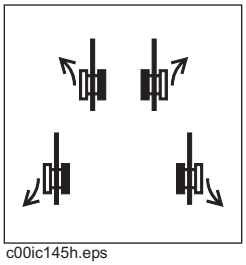
Item	Description	IMPORTANT
5. Right track switch  c00ic148h.eps	To move right track forward, press top. To move in reverse, press bottom.	Use only if wireless control is inoperable.
6. Engine shutdown override switch  c00ic178h.eps	If engine shutdown indicator lights, press to delay engine shutdown for 30 seconds.	***NOTICE:*** After 30 seconds, engine will shut down unless fault condition has been corrected. See "Electronic Controlled Engine Overview" on page 123.
7. Right stabilizer control  c00ic029h.eps	To raise, move up. To lower, move down.	Lower left and right stabilizers to the ground together, then adjust individually.
8. Frame tilt control  c00ic026h.eps	To raise, move up. To lower, move down.	
9. Left stabilizer control  c00ic029h.eps	To raise, move up. To lower, move down.	Lower left and right stabilizers to the ground together, then adjust individually.

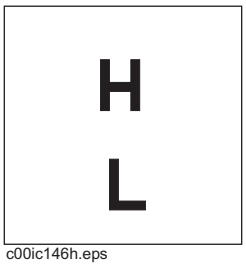
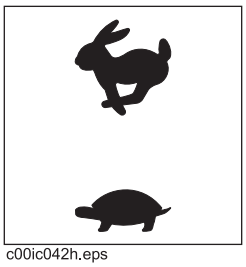
Tethered Ground Drive Controller



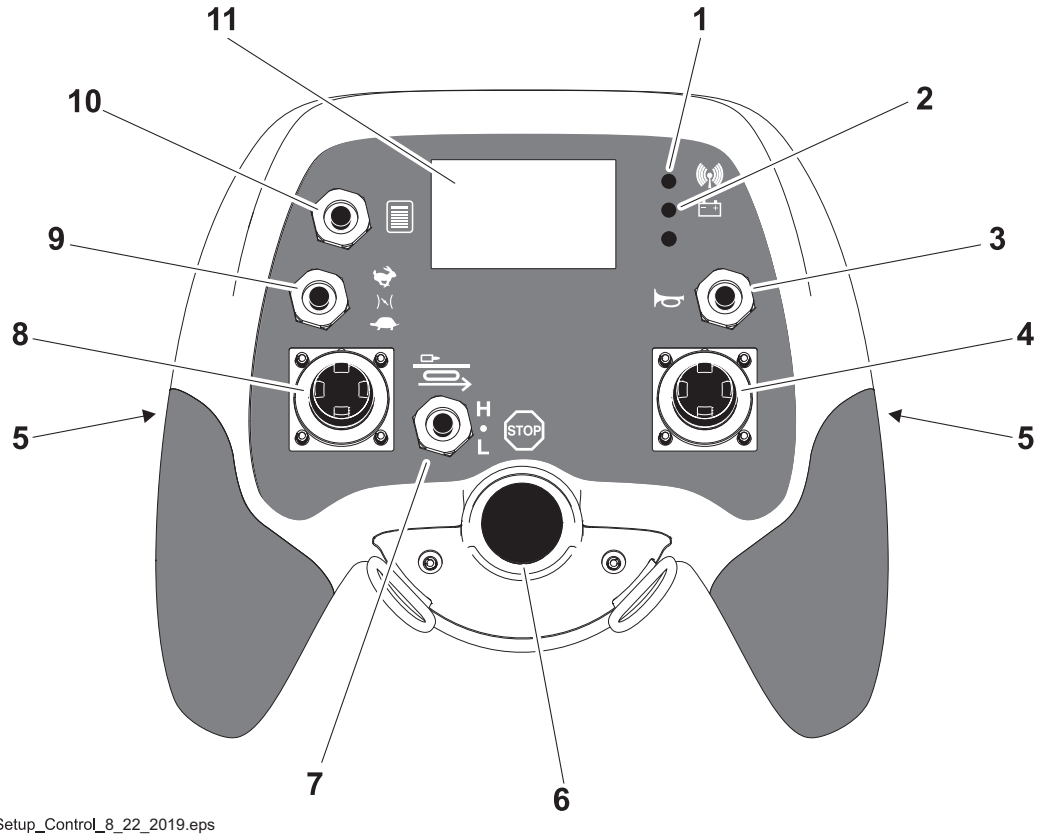
j10om016h.eps

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

Item	Description	IMPORTANT
1. Ground drive control  c00ic145h.eps	To move forward, move up. To move in reverse, move down. To steer, move left or right.	Operator presence switch(es) must be pressed and operator seat must be empty for control to work. See "Steer" on page 81.

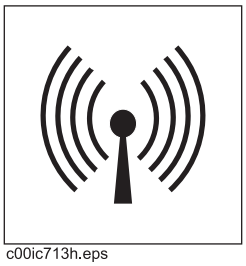
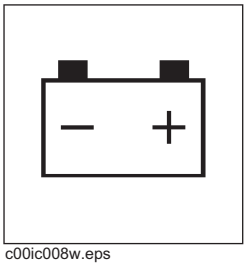
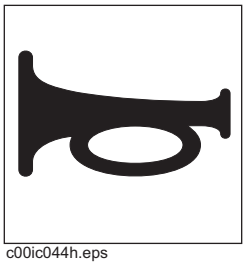
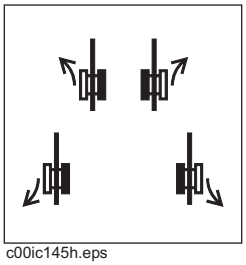
Item	Description	IMPORTANT
2. Drive mode switch  c00ic146h.eps	To select normal driving mode (high), move up. To select transport mode (low), move down. To disable ground drive, move to middle.	Use transport mode when loading and unloading machine.
3. Remote engine stop	To stop engine, press.	To restart engine, turn ignition switch off and then back on.
4. Operator presence switch	To enable tethered controller, press and hold.	
5. Throttle switch  c00ic042h.eps	To increase engine speed, move up. To decrease engine speed, move down.	Throttle switch at operator's station must be in neutral for switch to function.

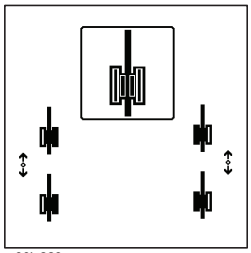
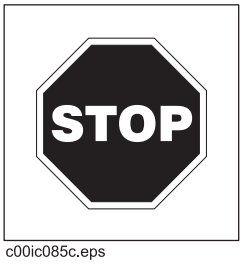
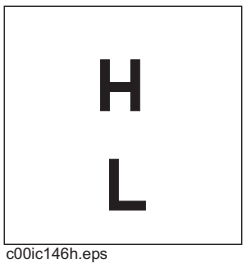
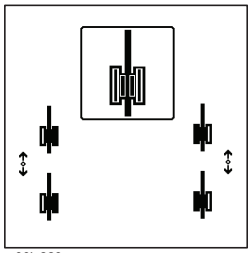
Wireless Remote Control

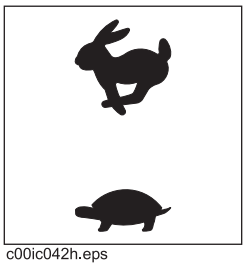


IMPORTANT: Operator station must be empty to operate wireless remote control.

1. Communication link indicator
2. Power status indicator
3. Power/Enable/Horn switch
4. Single joystick/left drive control
5. Operator presence switch
6. Engine stop
7. Drive mode switch
8. Right track drive control
9. Throttle switch
10. Ground drive mode select switch
11. LCD display

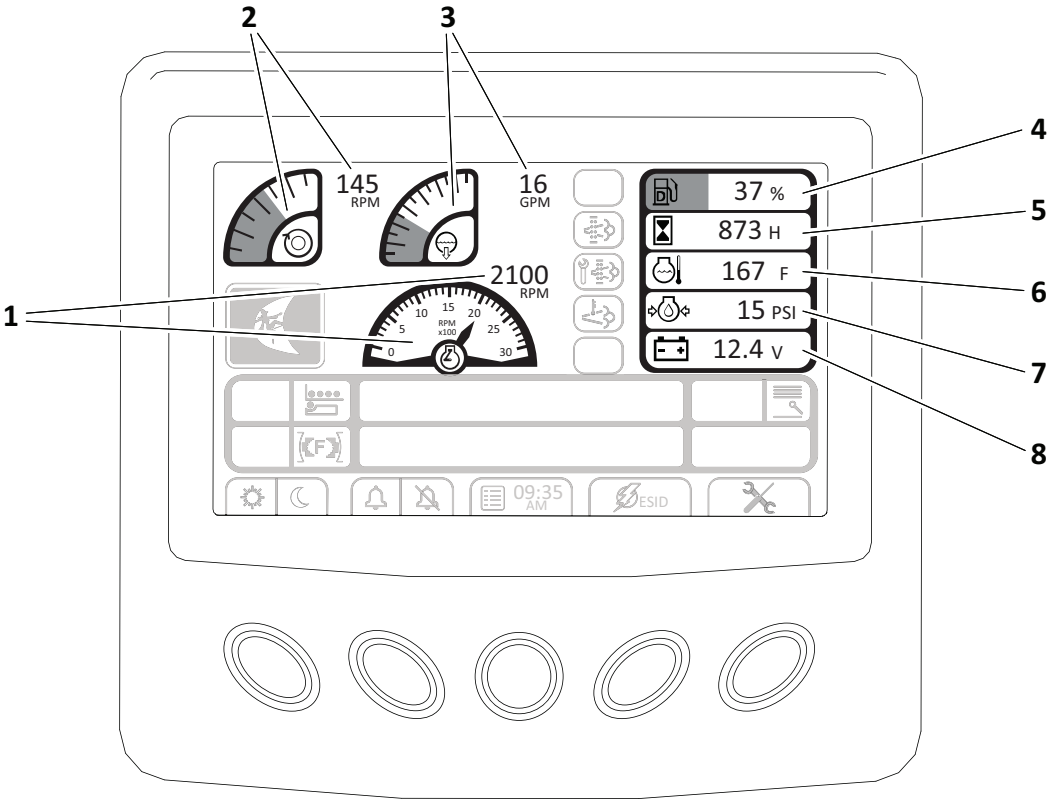
Item	Description	IMPORTANT
1. Communication link indicator  c00ic713h.eps	Indicates status of communication link between wireless remote control and machine.	An active communication link is required to operate wireless remote control. • Flashes yellow when no communication link. • Flashes green good communication link. • Lights red when an internal problem is detected. Contact your Ditch Witch® dealer.
2. Power status indicator  c00ic008w.eps	Indicates battery status and cable connection.	Flashes red when battery level is low. Lights green when transmitter is connected to and powered by machine.
3. Power/Enable/Horn switch  c00ic044h.eps	To turn power on, move up and hold until communication link indicator lights yellow and then flashes green. To start operation, move up and hold until horn sounds. To use horn, move up. To turn power off, move down until indicator turns off.	Wireless remote control indicator (page 4) will light. Ensure left and right joysticks are in neutral position. Wireless remote control turns off and communication link indicator flashes after one minute of inactivity. Move up twice to restart. See "Drive" on page 79.
4. Single joystick/Left drive control  c00ic145h.eps	To move forward, move up. To move in reverse, move down. To steer in single joystick mode, move left or right.	See "Steer" on page 81. See "Ground drive mode select switch" on page 63.

Item	Description	IMPORTANT
Left track drive control  c00ic229w.eps	To move forward, move up. To move in reverse, move down.	See "Steer" on page 81. See "Ground drive mode select switch" on page 63. Use when dual joystick mode is selected.
5. Operator presence switch  c00ic682w.eps	To operate wireless remote control, press one or both switches.	
6. Engine stop  c00ic085c.eps	To stop engine, press.	To restart engine, turn ignition switch off and then back on.
7. Drive mode switch  c00ic146h.eps	To select normal driving mode (high), move up. To select transport mode (low), move down.	Use transport mode when loading and unloading machine.
8. Right track drive control  c00ic229w.eps	To move right track forward, move up. To move in reverse, move down.	Use when dual joystick mode is selected. See "Ground drive mode select switch" on page 63.

Item	Description	IMPORTANT
9. Throttle switch  c00ic042h.eps	To increase engine speed, move up. To decrease, move down.	
10. Ground drive mode select switch	To select single or dual ground drive mode, move up or down.	Enable switch must be pressed after changing modes to enable new function.
11. LCD display	Displays selected mode of operation.	

Display

Gauges and Indicators



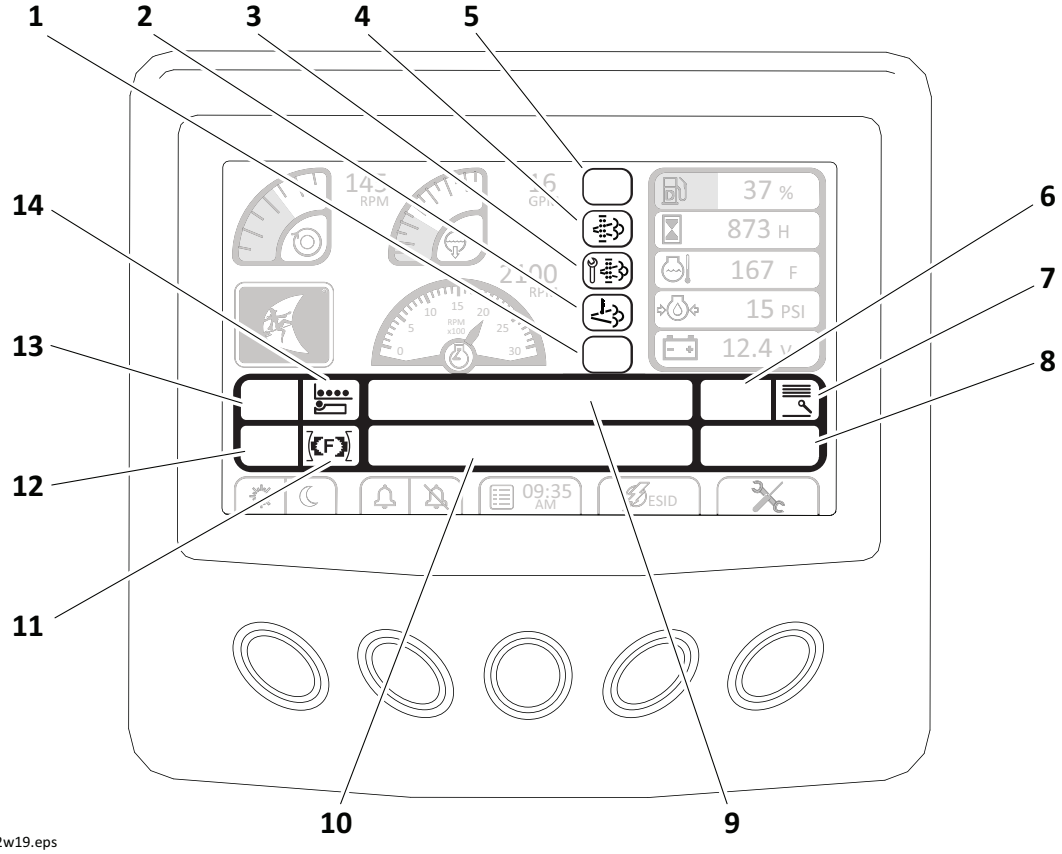
j80om002w20.eps

1. Tachometer
2. Rotation speed gauge
3. Drilling fluid flow gauge
4. Fuel gauge
5. Hourmeter
6. Engine coolant temperature gauge
7. Engine oil pressure gauge
8. Voltmeter

Item	Description	IMPORTANT
1. Tachometer	Displays engine speed.	
2. Rotation speed gauge	Displays rotation speed.	
3. Drilling fluid flow gauge	Displays drilling fluid speed.	

Item	Description	IMPORTANT
4. Fuel gauge	 Displays level of fuel.	Number flashes yellow when fuel level reaches 10%. See "Approved Fuel" on page 160.
5. Hourmeter	 Displays engine operating time.	Use these times to schedule service.
6. Engine coolant temperature gauge	 Displays engine coolant temperature.	Normal coolant temperature is below 230°F (110°C).
7. Engine oil pressure gauge	 Displays engine oil pressure.	
8. Voltmeter	 Displays system voltage.	

Gauges and Indicators



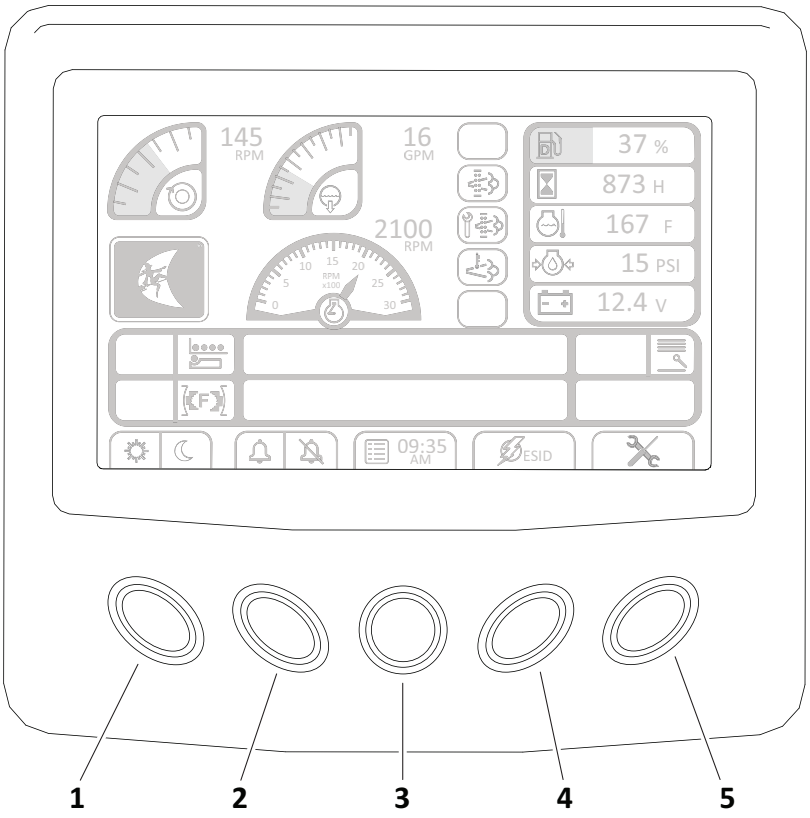
1. Hydraulic fluid temperature/filter restriction indicator
2. High exhaust temperature indicator
3. Exhaust cleaning service indicator
4. Exhaust cleaning indicator
5. Warning/Stop indicator
6. Pipe box status indicator
7. Pipe lift status indicator
8. ESID status indicator
9. Cruise/Carve status indicator
10. Automated pipe loader status indicator
11. Front wrench indicator
12. Carriage indicator
13. Dig/Drive mode indicator
14. Shuttle indicator

Item	Description	IMPORTANT
1. Hydraulic fluid temperature/ filter restriction indicator	Lights when hydraulic fluid temperature is too high. Lights when hydraulic filter is restricted.	

Item	Description	IMPORTANT
2. High exhaust temperature indicator	 Lights when exhaust temperature is high.	Lights during exhaust cleaning.
3. Exhaust cleaning service indicator	 Lights when exhaust cleaning service is needed.	If indicator lights, contact you Ditch Witch® dealer.
4. Exhaust cleaning indicator	 Lights when exhaust cleaning is needed.	See "Exhaust Cleaning" on page 161.
5. Warning/Stop indicator	 Lights when engine needs attention.  Lights when operator needs to stop engine.	
6. Pipe box status indicator	 Column is empty  Pipe is in column  Pipe not present in front of column  Pipe not present in rear of column	
7. Pipe lift status indicator	 Lights when lifters are fully raised.	
8. ESID status indicator	 ESID OK  ESID detected, not OK, current coil missing, voltage stake missing  ESID not detected	Green background Yellow background Red background See "ESID History Menu" on page 72.
9. Cruise/Carve status indicator	Displays cruise/carve status, thrust speed, and rotation.	
10. Automated pipe loader status indicator	Displays pipe loader status.	
11. Front wrench indicator	 Lights when wrenches are clamped.	

Item	Description	IMPORTANT
12. Carriage indicator	 Carriage in rear home  Carriage in front home	
13. Dig/Drive mode indicator	 Carve mode active  Drill mode active  Drive mode active	
14. Shuttle indicator	 Lights when shuttles are retracted.	

Soft Keys



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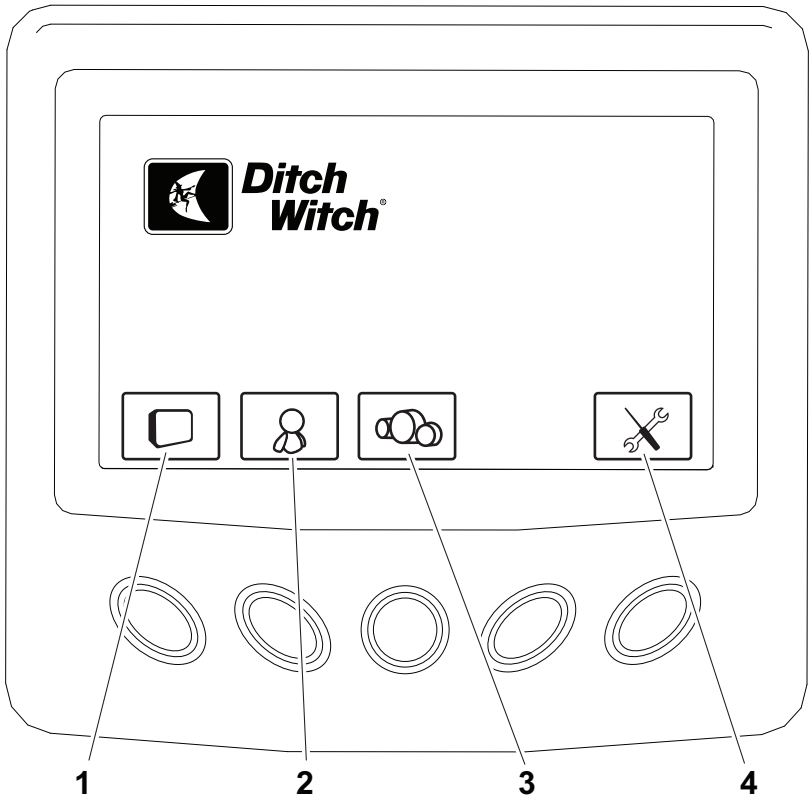
1. Day/Night mode key
2. Accessory alarm key
3. Menu key/Real-time clock
4. ESID status display key
5. Recall key

Item	Description	IMPORTANT
1. Day/Night mode key	To toggle between day and night modes, press.	
2. Accessory alarm key	Lights when accessories have been activated for 25 seconds. To disable alarm, press. To enable, press again.	

Item	Description	IMPORTANT
3. Menu key/Real-time clock	 To select main menu, press. Displays time.	See "Main Menu" on page 71.
4. ESID status display key	 To select ESID strike display, press.	
5. Recall key	 To hide/recall diagnostic messages, press.	

Main Menu



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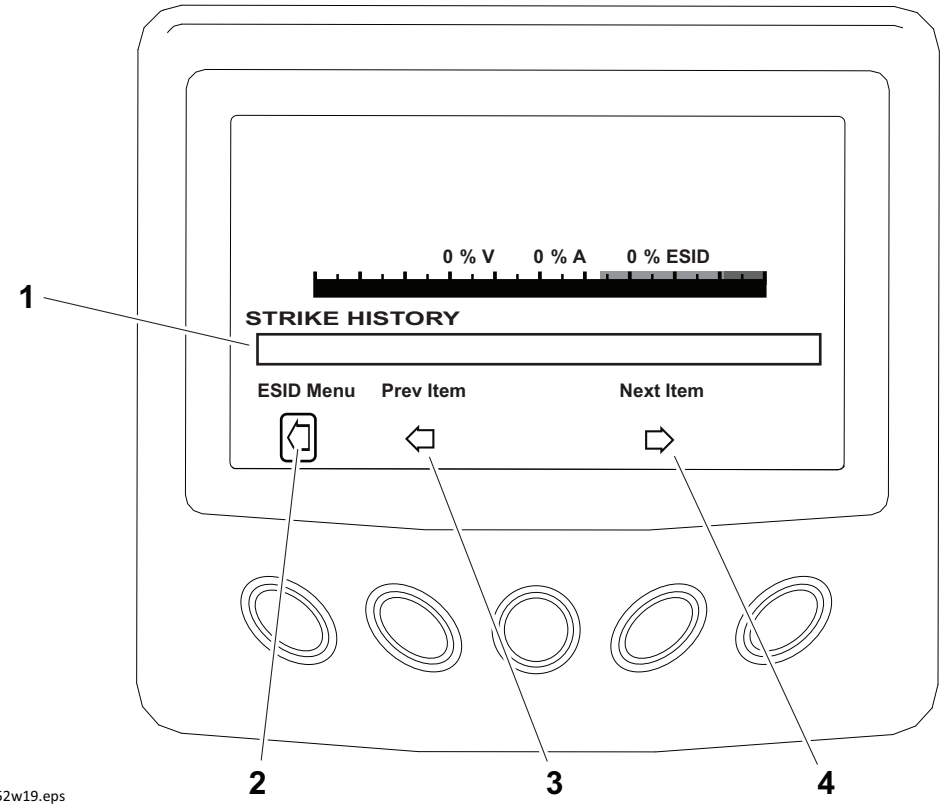
IMPORTANT: Key functions change with each menu screen and are displayed next to the key.

1. System settings key
2. User settings key
3. Return key
4. Diagnostic key

Item	Description	IMPORTANT
1. System settings key	To display software version information, press.	
2. User settings key	To access menu used to customize user settings, press.	Brightness, language, real time clock, and units of measurement can be adjusted.
3. Return key	To return to main screen, press.	
4. Diagnostics key	To display engine diagnostic codes, if any, press.	If diagnostic codes are displayed, contact your Ditch Witch® dealer.

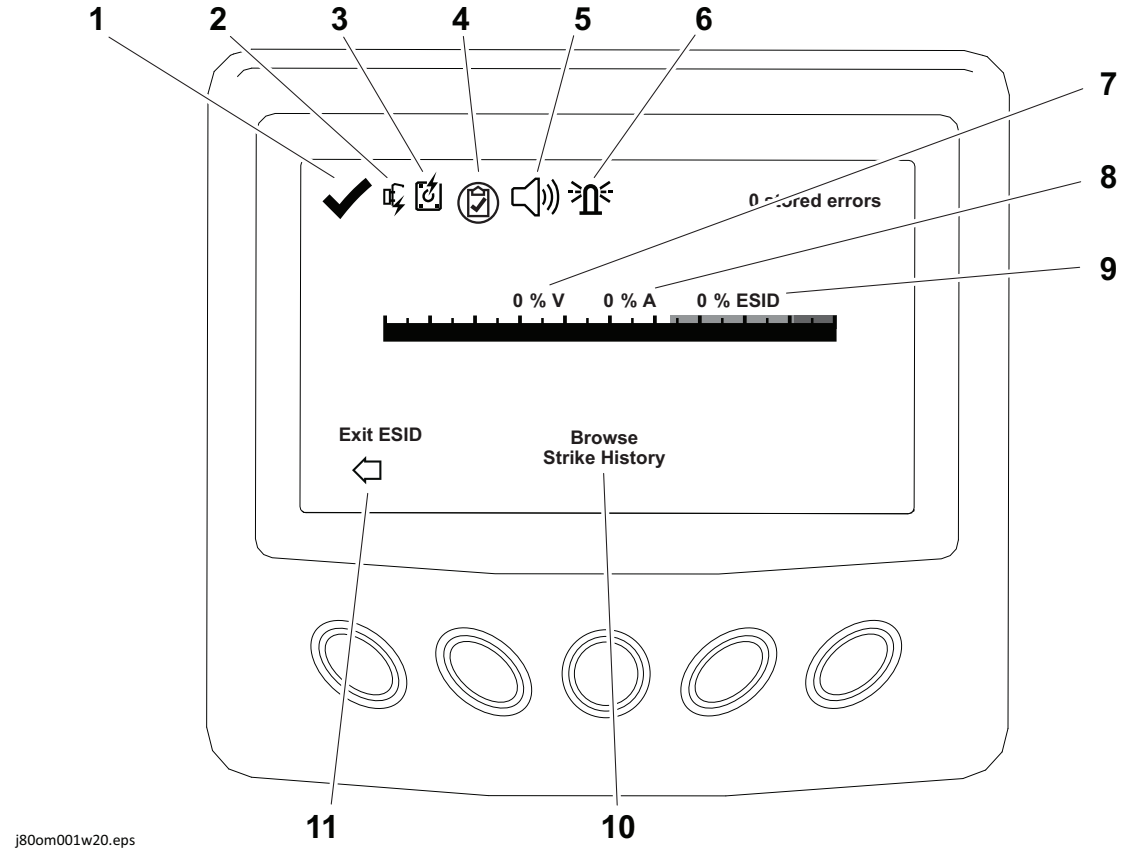
ESID History Menu



1. Strike history messages
2. Return key
3. Previous key
4. Next key

Item	Description	IMPORTANT
1. Strike history messages	Displays detailed information about ESID strike history.	
2. Return key	To return to ESID strike display, press.	
3. Previous key	To scroll to previous message, press.	
4. Next key	To scroll to next message, press.	

ESID Strike Display

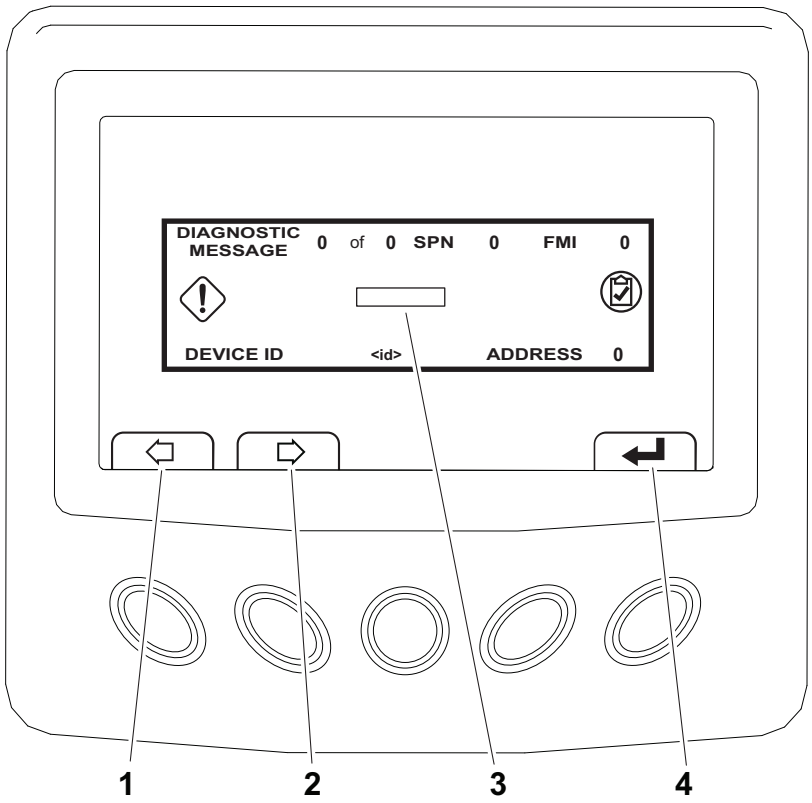


1. OK (check) indicator
2. Voltage detection system error indicator
3. Amperage detection system error indicator
4. Test indicator
5. Horn indicator
6. Strobe indicator
7. Volt strike percentage
8. Coil strike percentage
9. Strike condition indicator
10. Browse strike history key
11. Return key

Item	Description	IMPORTANT
1. OK (check) indicator	Lights when ESID test reports no problems.	
2. Voltage detection system error indicator	Lights when ESID has detected a non-specific problem with voltage limiter circuit.	

Item	Description	IMPORTANT
3. Amperage detection system error indicator	 Lights when ESID has detected a non-specific problem with current coil.	
4. Test indicator	 Lights when test is being conducted.	
5. Horn indicator	 Lights when ESID horn is active.	
6. Strobe indicator	 Lights when ESID strobe is active.	
7. Voltage indicator	Displays percentage of voltage difference detected between voltage limiter and unit.	30V will display as 100%. See "Electric Strike System" on page 137.
8. Current indicator	Displays percentage of current detected at current transformer.	300mA will display as 100%. See "Electric Strike System" on page 137.
9. Strike condition indicator	Displays the total combined percentage of detected voltage and current and displays it graphically.	An alarm condition occurs when total combined percentage is equal to or greater than 100%.
10. Browse strike history key	To display past ESID codes, if any, press.	
11. Return key	 To return to main screen, press.	

Diagnostic Messages



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Item	Description	IMPORTANT
1. Previous message key	To display previous active message in list, press.	
2. Next message key	To display next active message in list, press.	
3. Diagnostic messages	Displays detailed information about message.	
4. Hide/Acknowledge key	To hide/acknowledge active messages, press.	

Display Pop-Up Messages

Display will automatically show pop-up messages when needed. Display will return to normal once conditions are met.

Exhaust Cleaning

A pop-up message will appear when an exhaust cleaning is needed. See "Exhaust Cleaning" on page 161.

NOTICE: Failure to complete an exhaust cleaning when required can cause engine damage.

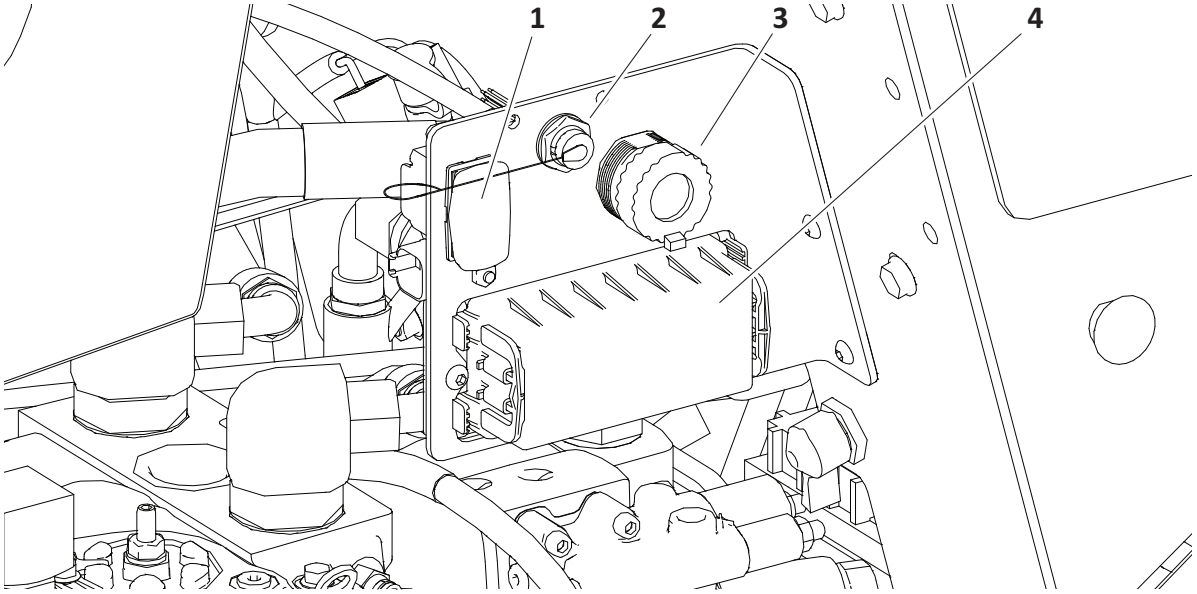
When pop-up message appears:

1. Ensure machine is away from combustible material.
2. Set to low throttle.
3. Follow on-screen prompts to initiate exhaust cleaning.

After exhaust cleaning is initiated, another pop-up message will be displayed with the estimated time remaining until process is complete. A typical exhaust cleaning cycle will take approximately 35 minutes.

IMPORTANT: If exhaust cleaning cannot be initiated when pop-up message occurs, follow on-screen prompts to return to main screen. Pop-up message will return to prompt exhaust cleaning at a later time.

Engine Compartment



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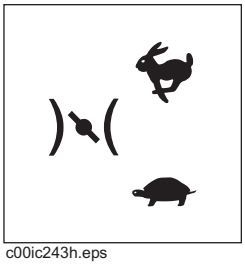
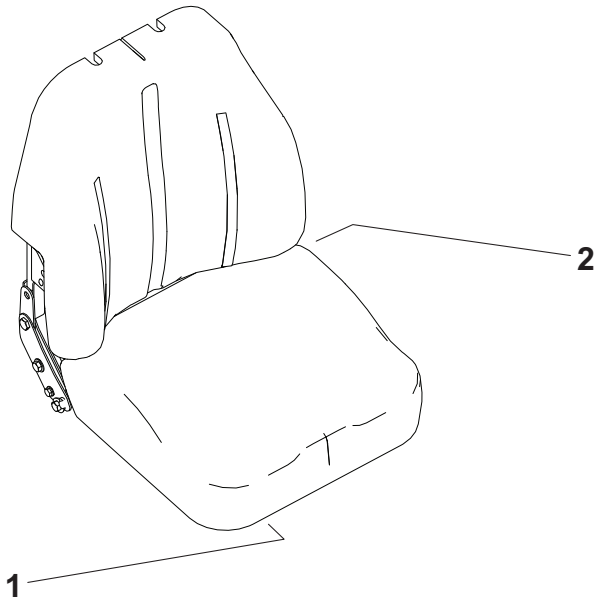
Item	Description	IMPORTANT
1. Throttle switch  c00ic243h.eps	To increase engine speed, press top. To decrease engine speed, press bottom.	Use this switch only if throttle switch on console does not work.
2. Ditch Witch® CAN diagnostic port	For use only by qualified Ditch Witch® technicians.	
3. J1939 Deutz® CAN diagnostic port	For use only by qualified Ditch Witch® technicians.	
4. Fuse box	For use only by qualified Ditch Witch® technicians.	

Seat



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Item	Description	IMPORTANT
1. Slide control	To slide forward or backward, pull then adjust seat. To lock seat in position, release.	
2. Recline control	To recline back of seat, move backward. To raise back of seat, move forward.	

Drive

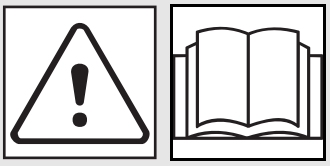
Chapter Contents

For additional precautions, see "Safety Awareness" and "Prepare" chapters.

IMPORTANT: For more information on how to operate controls, see "Controls" chapter.

Start

EMERGENCY SHUTDOWN: Turn ignition switch off.



WARNING Misuse of machine can cause death or serious injury. Read and understand operator's manual and all other safety instructions before use. Know how to use all controls.

To help avoid injury:

- Allow hydraulic fluid time to warm before operating in cold weather. Cold hydraulic fluid can lengthen ground drive stopping time.
- For starting in extreme temperatures, contact your Ditch Witch® dealer.

WARNING Pre-heater. Fire or explosion can cause death or serious injury. Never use starter fluid.

NOTICE: If engine turns but does not start within 30 seconds, engine ECU will prevent starting to allow starter to cool. Wait at least two minutes and try again.

1. Ensure all controls are in neutral.
2. Insert key and activate accessories using ignition switch.
3. **If starting machine in normal conditions,** start engine and run at low throttle under light load for at least three minutes before applying heavier load.

   If starting machine in cold weather:

   3.1 When cold start wait indicator turns off, start engine.

   3.2 Warm engine and hydraulic fluid by gradually increasing engine speed for up to 30 minutes.

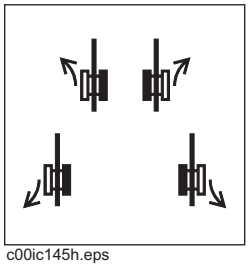
   3.3 After warmup, carefully operate all hydraulic controls at low throttle until controls operate as described in controls chapter.

Steer

NOTICE:

- Drive carefully in congested areas. Know machine's clearance and turning radius.
- Survey field of vision when operating machine.

Single Joystick Ground Drive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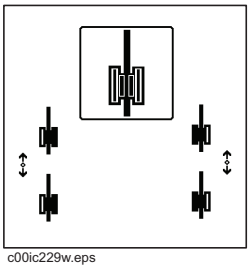
To steer while moving forward, push joystick and then move left or right. Machine will gradually turn.

To steer while moving in reverse, pull joystick and then move left or right. Machine will gradually turn.

For tight steering at low speed, return joystick to neutral position and then move joystick left or right and slightly forward. Tracks will counter-rotate and machine will turn in a tight circle.

Dual Joystick Ground Drive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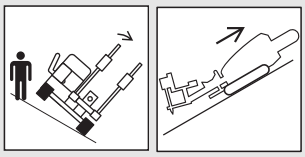
To steer while moving forward, move one joystick slightly more than the other to turn in desired direction. Machine will gradually turn.

To steer while moving in reverse, move one joystick slightly more than the other to turn in desired direction. Machine will gradually turn.

For tight steering at low speed, pull one joystick and push the other to turn in desired direction. Tracks will counter-rotate and machine will turn in a tight circle.

Slope Guidelines



⚠WARNING Tipover. Crushing can cause death or serious injury. Follow procedure in operator's manual. Drive cautiously.

To help avoid injury:

- Operate at slow speed when on rough terrain.
- Avoid driving across slopes.
- Never jerk control levers. Use a steady, even motion.
- Always operate from the uphill side of the machine.

Operating safely on a slope depends upon many factors including:

- distribution of machine weight (can change due to configuration)
- height of load
- even or rough ground conditions
- potential for ground giving way causing unplanned tilt forward, reverse or sideways
- nearness of ditches, ruts, stumps or other obstructions and sudden changes in slope
- speed
- turning
- braking performance
- operator skill

Reduce Track Wear

Rubber tracks are best suited at soil-based jobsites with minimal rocks and debris. To reduce track wear drive slowly and make wide turns. Avoid the following:

- spinning tracks under heavy load
- turning on sharp objects such as stones, broken concrete, or debris
- quick turns on asphalt or concrete
- driving over curbs or ledges
- driving with track edges pressed against hard walls or curbs
- operating on corrosive materials such as salt or fertilizer

Shut Down

1. When job is complete, move machine to level ground.
2. Stop machine movement.
3. Lower stabilizers to ground.
4. Lower drill frame to ground.
5. Return all controls to neutral.
6. Run engine at low throttle with no load for at least three minutes to cool.
7. Shut off machine.
8. If leaving machine unattended, remove key.
9. For maintenance or long-term storage, disconnect battery using battery disconnect switch.

> ***NOTICE:*** Wait two minutes after shutting off machine before disconnecting battery.

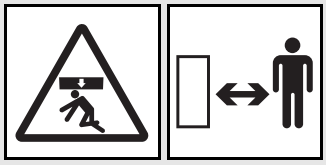
Transport

Chapter Contents

For additional precautions, see "Safety Awareness" and "Prepare" chapters.

IMPORTANT: For more information on how to operate controls, see "Controls" chapter.

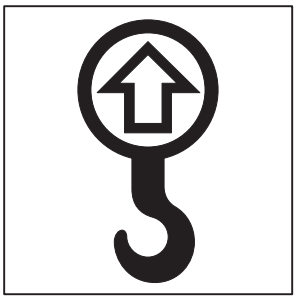
Lift



WARNING Lifted load. Crushing weight can cause death or serious injury. Stay away from lifted load and its range of movement.

Points

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



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Procedure

This machine is not configured for lifting. If the machine must be lifted, load machine into a container or onto a platform appropriate for lifting. See "Specifications" on page 195 for machine weight.

IMPORTANT: For pipe box lifting procedures, see See "Remove/Install Pipe Box" on page 149.

Haul

WARNING Misuse of machine can cause death or serious injury. Read and understand operator's manual and all other safety instructions before use. Know how to use all controls.

To help avoid injury:

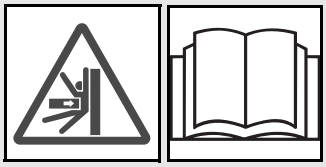
- Read trailer operator's manual before loading or transporting machine.
- Ensure tow vehicle has proper tow capacity rating.
- Incorrect loading can cause trailer swaying.
- Attach trailer to vehicle before loading or unloading.
- Load and unload trailer on level ground.
- To help prevent trailer sway, load trailer so that 10-15 percent of total vehicle weight (equipment plus trailer) is on tongue.

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

Inspect Trailer

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

Load



⚠ WARNING Horizontal movement. Crushing can cause death or serious injury. Read and understand operator's manual and all safety instructions before use.

1. Start engine.
2. Ensure transport mode is selected.
3. Move machine to rear of trailer and align with ramps.

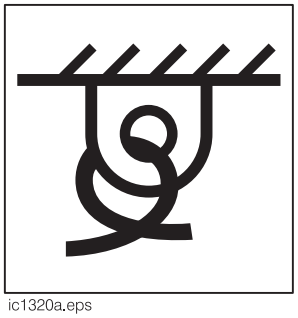
With Tiedown Kit	Without Tiedown Kit
3.1 Drive forward slowly to move machine onto trailer until track reaches chock. 3.2 Lower drill frame to rest. 3.3 Drive back slowly until front of drill frame is seated in rest. 3.4 Lower stabilizers to trailer floor.	3.1 Drive forward slowly to move machine onto trailer until tiedown position is reached. 3.2 Lower stabilizers to trailer floor. 3.3 Lower drill frame to trailer floor.

4. Shut off machine.
5. Tie down machine.
6. Ensure all covers are properly secured.

Tie Down

Points

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



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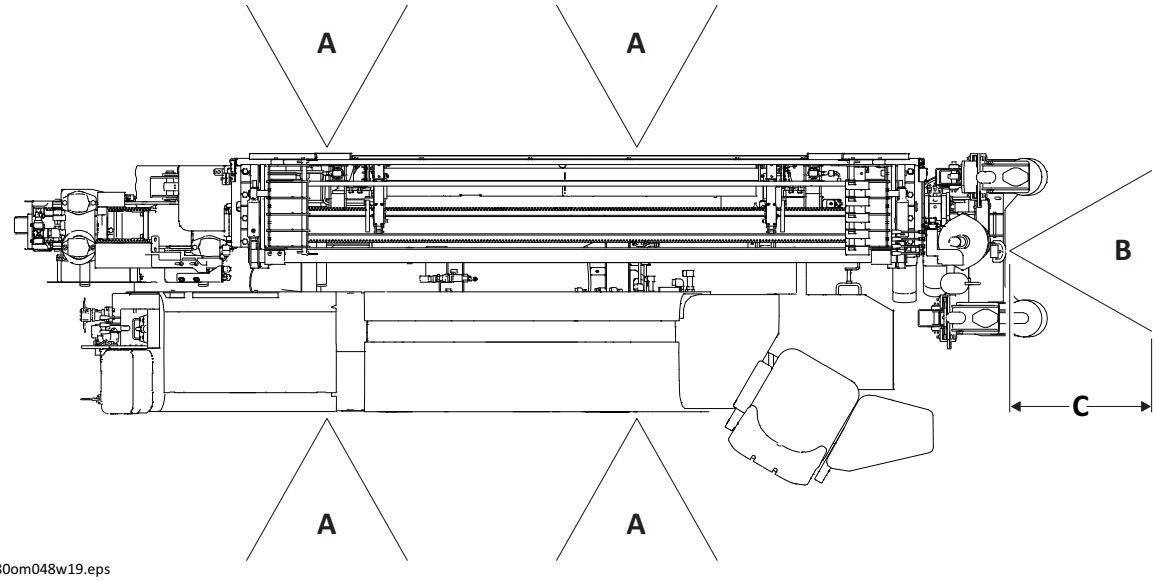
Procedure

NOTICE:

- Ensure that any downhole tool or pipe in wrenches is attached to spindle or removed before transport. Wrenches can unclamp after engine shutdown.
- Use minimum grade 7, 3/8" (18.7cm) transport chain to secure machine to trailer.

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



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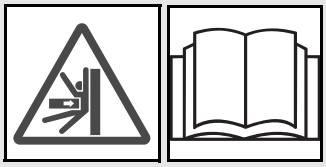
Distance	US	Metric
A	Greater than 22"	Greater than 55.9cm
B*	Less than 50"	Less than 127cm
C*	Greater than 10"	Greater than 25.4cm

*These tiedown distances are only used when not using tiedown kit.

Unload



⚠ WARNING Horizontal movement. Crushing can cause death or serious injury. Read and understand operator's manual and all safety instructions before use.

1. Prepare trailer and ramps for unloading.
2. Remove tiedowns.
3. Start engine.
4. Raise stabilizers.
5. If using tiedown kit, drive forward slowly until front of drill frame is clear of rest.
6. Raise drill frame.
7. Set throttle to low.
8. Slowly back machine down trailer or ramps.

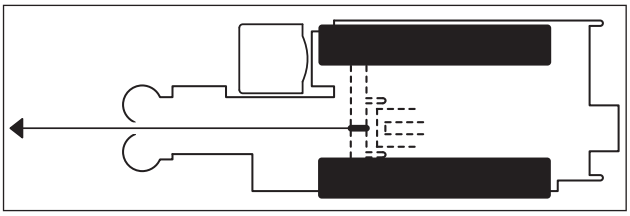
Retrieve

Under normal conditions, machine should not be towed. If machine becomes disabled and retrieval is necessary:

- Tow for no more than 100' (30m) at less than 1mph (1.6km/h).
- Use towing chains appropriately rated for maximum towing force.
- Use no more than 1.5 times machine weight.

Prepare Machine

1. Set parking brake.
2. Block tracks.
3. Attach chain to tow points (shown) facing towing vehicle.



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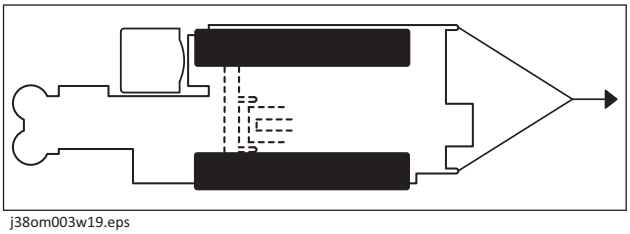

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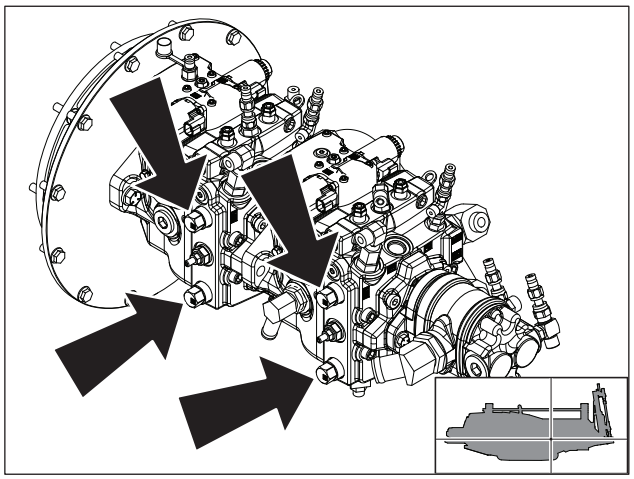
4. Back out hex plugs (shown) three full revolutions to open bypass valves.

   NOTICE: When bypass valves are open, machine has no brakes.



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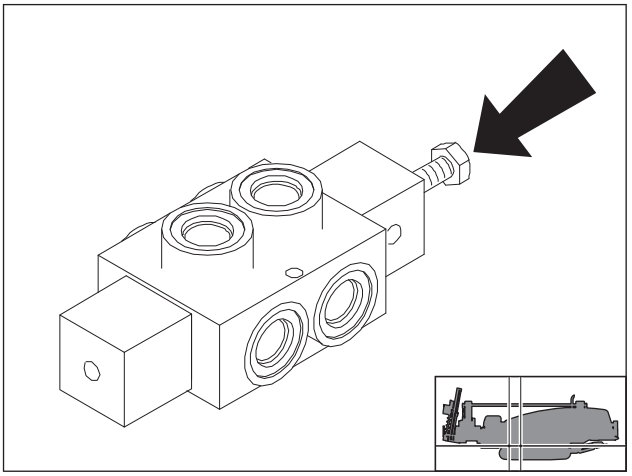
5. Loosen jam nut and tighten valve screw (shown) until it is fully threaded to open selector valves.
6. Release parking brake.
7. Remove blocks.



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Return Machine to Normal Operation

1. Set parking brake.
2. Block tracks.
3. Return valves to operating positions.
4. Release parking brake.
5. Remove blocks.

Conduct a Bore

Chapter Contents

For additional precautions, see "Safety Awareness" and "Prepare" chapters.

IMPORTANT: For more information on how to operate controls, see "Controls" chapter.

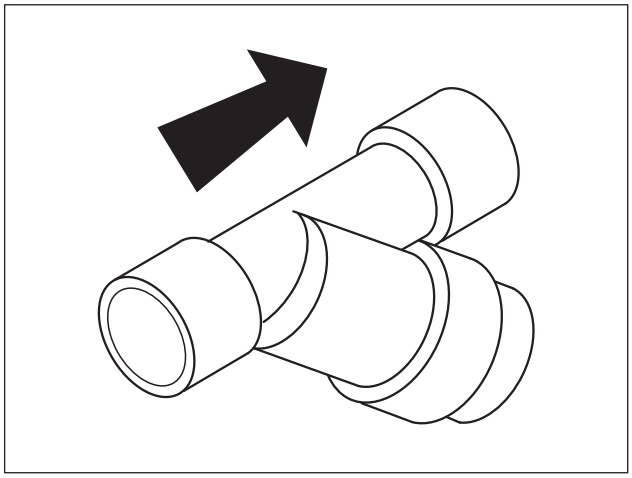
Position Equipment

1. Move equipment into selected positions. See "Select Start and End Points" on page 22.
2. Connect and test electric strike system. See "Electric Strike System" on page 137.
3. Drive anchors. See "Drive" on page 79.

Connect Fluid System

NOTICE: Do not connect machine to a public or private water supply.

1. Connect fluid hose from fluid mixer to fluid pump. A 1.5" (38mm) or larger, non-collapsible hose is required.
2. Install y-strainer between fluid mixer and fluid pump. Position y-strainer so that fluid flows in the direction of the arrow.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IMPORTANT:

- In most cases, positioning y-strainer at outlet of fluid mixer gives the best results.
- Clean y-strainer regularly. See "Drilling Fluid Y-Strainer" on page 170.

Start System

1. Start engine.
2. Start fluid mixer.

> **IMPORTANT:** Ensure mixture of drilling fluid matches drilling conditions. See "Drilling Fluid" on page 133.

3. Enable DrillLok® mode, if equipped. See "DrillLok® System" on page 136.
4. Set to high throttle.
5. Fill pipe with drilling fluid until pressure begins to rise.

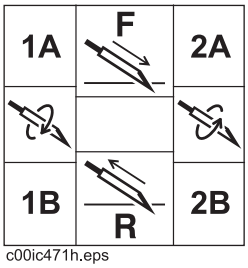
Prime Fluid Pump

> ***NOTICE:*** Failure to prime fluid pump will cause flow fluctuations, which will make it difficult to control the wash wand.

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

1. Fill drilling fluid hose.
2. Connect hose to machine.
3. Operate mixing/transfer pump on fluid mixer at full speed for 1-3 minutes to discharge air from system.
4. Return mixing/transfer pump on fluid mixer to normal operating speed and continue bore.
5. If drilling fluid pressure surges, repeat step 3.

Operate Carriage Control



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Drilling

IMPORTANT: Counterclockwise rotation can unthread pipe in the ground.

During normal operation, the carriage control joystick controls both thrust and rotation and allows any combination of the two based on position of the joystick.

Ref.	Function
1A	Forward thrust with clockwise rotation
2A	Forward thrust with counterclockwise rotation
1B	Reverse thrust with clockwise rotation
2B	Reverse thrust with counterclockwise rotation
F	Forward thrust with no rotation
R	Reverse thrust with no rotation

Coordinated Makeup

During pipe change operation when front wrench is clamped and carriage has reached front or rear home indicator, the carriage control joystick controls only speed and direction of rotation. Thrust speed and direction will be set automatically. Thrust speed can be increased or decreased slightly by moving control toward or against the direction of thrust travel. If joystick remains in neutral or rotation, thrust is controlled normally.

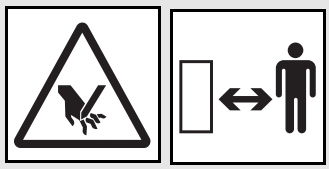
Ref.	Function
1A/1B	Clockwise rotation
2A/2B	Counterclockwise rotation
F	Forward thrust with no rotation
R	Reverse thrust with no rotation

To override coordinated makeup mode, use multi-use button.

NOTICE:

- Overriding coordinated makeup mode may damage pipe. If frequent overrides are necessary, contact your Ditch Witch® dealer for pipeloader adjustment.
- Only use dual speed carriage control during bore or pullback when no pipe is in spindle.

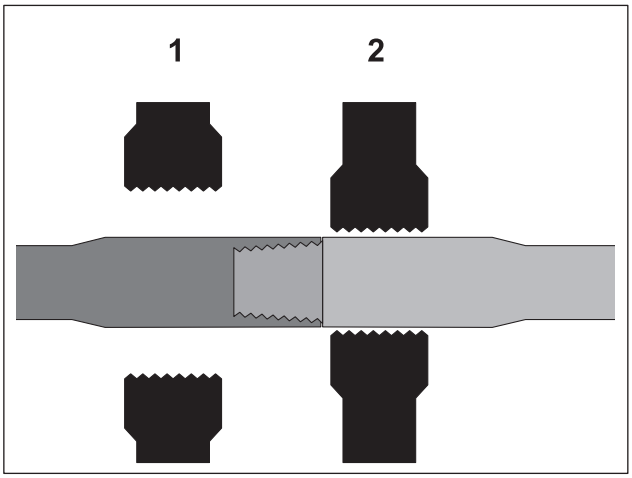
Clamp Pipe



WARNING Moving parts. Contact can cause serious injury. Stay away.

Clamp pipe when joint is between wrenches (1 and 2) as shown.

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



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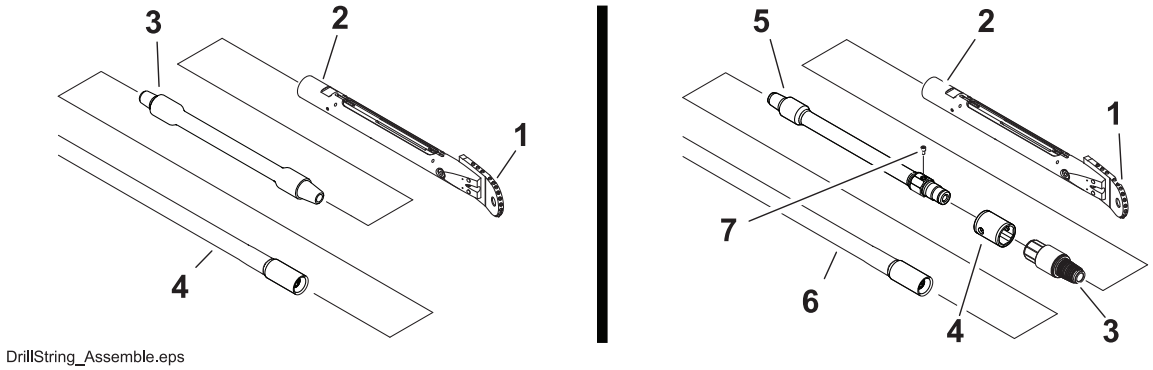
Assemble Drill String

DANGER Moving or thrown tools. Impact will cause death or serious injury. Never use pipe wrenches on drill string. Follow procedure in operator's manual.



Direct Connect Method	EZ Connect Method
1. bit	1. bit
2. beacon housing	2. beacon housing
3. transition sub	3. adapter
4. drill pipe	4. collar
	5. transition sub
	6. drill pipe
	7. bolt

Prepare Beacon Housing

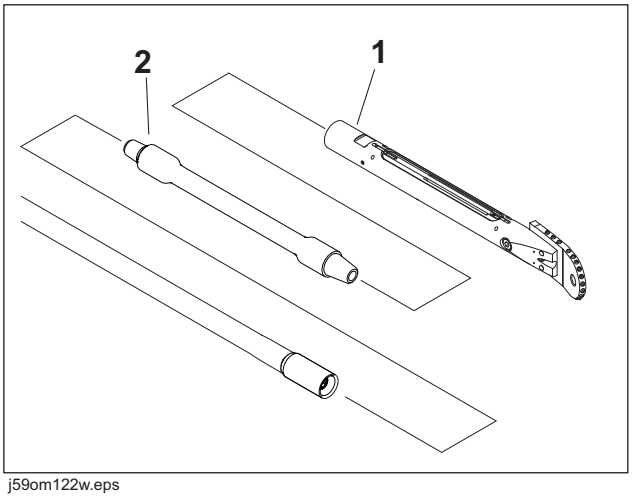
NOTICE: Beacon must be calibrated after installation in beacon housing. See beacon operator's manual.

IMPORTANT: Nozzle and bit selection depends on job conditions. See page 128 for more information or contact your Ditch Witch® dealer.

1. Select nozzle, if needed.
2. Select bit.
3. Attach bit to beacon housing.
4. Install beacon. See beacon operator's manual.
5. Install beacon housing lid.

Use Direct Connect Method

1. Start engine.
2. Position transition sub (2) in front wrench.
3. Apply tool joint compound.
4. Clamp front wrench.
5. Slowly move carriage forward until SaverLok® meets transition sub.
6. Rotate spindle clockwise until SaverLok threads onto transition sub.
7. Stop engine.
8. Connect beacon housing (1) to transition sub.
9. Start engine.
10. Position joint between wrenches.
11. Use machine torque to tighten joint fully.



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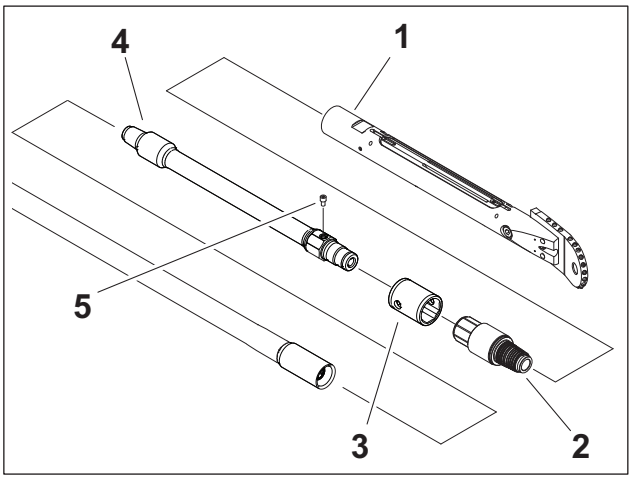
Use EZ Connect Method



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1. Apply tool joint compound to adapter threads.
2. Use quick wrench to connect adapter (2) to beacon housing (1).
3. Slide collar (3) onto transition sub (4).
4. Apply tool joint compound to threads.
5. Connect adapter to transition sub.
6. Unthread connection at least one full flat to align flats.

> **IMPORTANT:** Joint will not be tight. Assembly should have visible gap at shoulder.

7. Slide collar over flats on both transition sub and adapter, ensuring hole in collar is aligned with hole in transition sub.
8. Install bolt (5).

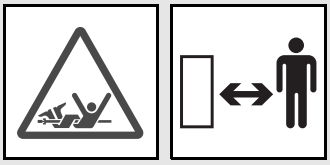
Connect Drill Pipe to Downhole Tool

1. Start engine.
2. Clamp tool in front wrench.
3. Load pipe.
   3.1 Ensure shuttle stop is positioned correctly.
   3.2 Apply tool joint compound to threads in front wrench.
   3.3 Lower pipe lifters.
   3.4 Close grippers.
   3.5 Extend shuttles.
4. Connect pipe to SaverLok® body.

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

   4.1 Move carriage forward until SaverLok meets pipe.
   4.2 Rotate spindle clockwise until SaverLok threads onto pipe.
   4.3 Relax grippers.
5. Connect pipe.
   5.1 Slowly move carriage forward to allow pipe to match up.
   5.2 Rotate spindle clockwise until pipe threads together.
   5.3 To fully tighten joint, slowly rotate pipe until spindle stops turning.
   5.4 Unclamp wrench.
   5.5 Open grippers fully.
   5.6 Raise pipe lifters.
   5.7 Retract shuttles.

Drill First Pipe



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

To help avoid injury:

- The tracker operator must have communication with the drill operator or DrillLok® system must be enabled with the DrillLok key in the operator's possession.
- Do not stand or walk over the bore path while drill string is moving during drilling and backreaming.

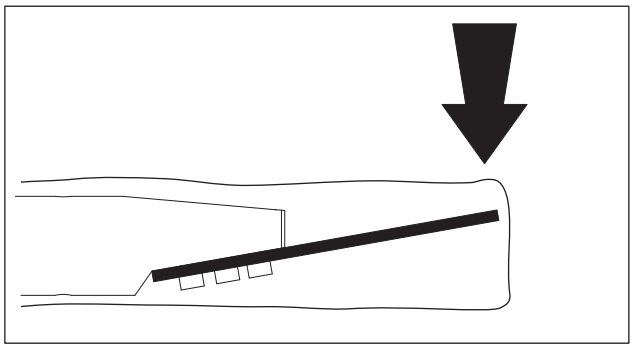
WARNING Underground utilities. Contact can cause death or serious injury. Locate and verify underground utilities before digging or drilling.

To help avoid injury:

- Use electric strike system.
- Expose line by careful hand digging or soft excavation. Use beacon to track bore path. If utility must be crossed, tracker operator must watch the drill head during drilling and backreaming. Consider type and stability of soil. Take precautions to ensure ground does not give way under tracker operator.

1. Turn on drilling fluid.
2. Visually check for drilling fluid flow.
3. Slowly move carriage forward. Drill first pipe as straight as possible.
4. Monitor gauges.

Swab the Hole


SwabHole_JT.eps

Swab the hole as needed after each pipe is drilled to remove cuttings and keep the bore clear.

IMPORTANT: Some conditions may require more frequent swabbing.

1. Move carriage forward until it reaches front of drill frame.
2. Move carriage to rear of drill frame with drilling fluid on.
3. Move carriage forward until pipe joint is properly located between wrenches for joint breakout.

Use Automated Pipe Loader System

IMPORTANT: If operator leaves the seat during an add or remove pipe cycle, while status indicator shows pipe loader system as active, automated add or remove will be disabled. Cycle must be completed using manual controls. If operator leaves the seat between add or remove pipe cycles, system will not need to be re-enabled.

Add Pipe	Remove Pipe
1. Ensure pipe box is properly positioned. If pipe box row is empty, select next full row. 2. Unclamp front wrench. 3. Retract shuttles. 4. Set to high throttle. 5. Position carriage in center of drill frame. 6. Select add pipe function. Grippers will open, pipe will be lowered into shuttles.	1. Ensure pipe box is properly positioned. 2. If pipe box row is full, select next empty row. 3. Unclamp front wrench. 4. Retract shuttles. 5. Set to high throttle. 6. Position carriage in center of drill frame. 7. Select remove pipe function. Grippers will open, pipe will be lifted out of shuttles.

Add Pipe

1. Turn autothrottle on.
2. Enable automated pipe loader system (optional).
3. Break joint at SaverLok®.
   - 3.1 Position pipe between wrenches. See "Align the Joints" on page 131.
   - 3.2 Locate drill head.
   - 3.3 Rotate pipe to 3 o'clock.
   - 3.4 Clamp front wrench.
   - 3.5 Rotate spindle counterclockwise. Carriage will slowly move back as threads separate.
   - 3.6 After threads are fully separated, stop rotation and move carriage back until rear stop indicator lights. If automated pipe loader mode is selected, grippers will close while carriage is moving.
4. Load pipe.

Manual Pipe Loader Controls	Automated Pipe Loader Controls
4.1 Ensure pipe lifters are completely lowered. 4.2 Close grippers. 4.3 Extend shuttles. 4.4 Apply tool joint compound at wrench. 4.5 Raise pipe lifters.	4.1 If pipe box row is empty, select next row. 4.2 With carriage at rear stop position, resume. Pipe will be shuttled into spindle, tool joint compound will be applied, and pipe will be lifted.

5. Connect pipe to SaverLok.

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

   - 5.1 Move carriage forward until SaverLok meets pipe.
   - 5.2 Rotate spindle clockwise until SaverLok threads onto pipe.
   - 5.3 Relax grippers, or resume if using automated pipe loader mode.

6. Connect new pipe.

Manual Pipe Loader Controls	Automated Pipe Loader Controls
6.1 Slowly move carriage forward to allow pipe to match up.	6.1 Slowly move carriage forward to allow pipe to match up.
6.2 Rotate spindle clockwise until pipe threads together.	6.2 Rotate spindle clockwise until pipe threads together.
6.3 To fully tighten joint, slowly rotate pipe until spindle stops turning.	6.3 To fully tighten joint, slowly rotate pipe until spindle stops turning.
6.4 Open grippers fully.	6.4 Resume. Grippers will open, shuttles will retract, and pipe lifters will lower.
6.5 Retract shuttles.	6.5 Unclamp wrench.
6.6 Lower pipe lifters.	
6.7 Unclamp wrench.	

7. Adjust fluid flow as needed.
8. Rotate spindle.
9. Slowly move carriage forward.
10. Adjust rotation speed according to bit size and soil conditions. See "Systems and Equipment" on page 115.
11. Set cruise control (optional). See "Cruise Control" on page 121.
12. Monitor gauges.
13. Locate drill head with tracker at least every half-length of pipe.

> ***NOTICE:*** All tracking equipment is subject to magnetic interference. The presence of interference can cause inaccuracies in both location and depth calculations. See tracker operator's manual for more information.

Correct Direction

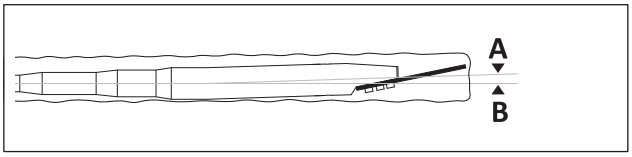
Correcting direction is a skill operators gain with experience and knowledge of equipment and soil conditions. These instructions cover only basic procedures. For information about specific equipment or jobsites, contact your Ditch Witch® dealer.

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 the 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 rotation.
- All corrections should be made as gradually as possible. See "Recommended Bend Limits" on page 28.
- Over correcting will cause "snaking." This can damage pipe and will make drilling and pullback more difficult. Begin to straighten out of each correction as early as possible.
- Do not push an entire piece of drill pipe into ground without rotation.This can exceed bend radius and cause pipe failure.

Procedure



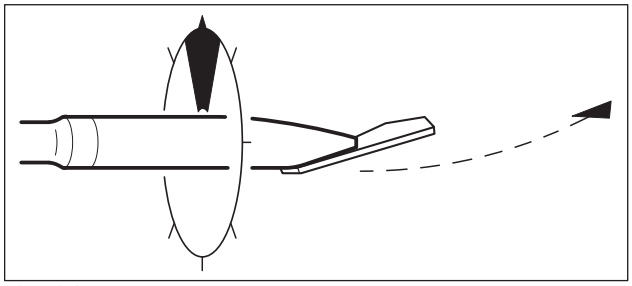
Correct_Direction_JT.eps

1. Locate drill head. Take reading available with beacon and tracking equipment such as:
   - depth

     IMPORTANT: Depth estimate improves if drill head is at 3 o'clock position (A) rather than horizontal (B).

   - pitch
   - left/right information
   - temperature
   - beacon roll
2. Compare position to bore plan to determine direction.
3. Position drill head.
4. Drill pipe.

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

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

To change direction:

1. Rotate pipe to intended clock position.
2. Push pipe into ground.

To move forward without changing direction:

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

Use Autocarve Mode

IMPORTANT:

- Two-speed carriage control is disabled while in autocarve mode.
- Two-speed rotation switch is disabled while in autocarve mode.
- Autocarve mode is disabled while front wrench is clamped.
- Adding or removing pipe does not affect autocarve mode.

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

Movement	Description
Alternating clockwise and counterclockwise rotation	Enables downhole tool to carve tough soil formations. Rotation speed can be adjusted during autocarving. ***NOTICE:*** To reduce the chance of unthreading pipe sections downhole, rotation pressure is limited during counterclockwise rotation. However, the operator should monitor carve operation and adjust thrust and rotation to prevent unthreading.
Carve window	The range of alternating rotation.

Movement	Description
Thrust	In autocarve mode, initial thrust speed is very slow or fully stopped. Adjust speed anytime during carving.
Pullback	Thrust and rotation operate normally when joystick is pulled. High-speed pullback is not available in autocarve mode.

1. Rotate drill head to desired position to position downhole tool for carving.
2. Enable autocarve.
3. Move carriage control joystick fully forward and return to neutral to begin carving.

   IMPORTANT: Pull carriage control joystick to pause carving.

4. Adjust thrust speed using set/resume switch. Adjust as needed while carving.
5. Set carve window. Adjust as needed while carving.
6. Move joystick fully left and hold. Use set/resume switch to adjust rotation speed. Adjust as needed while carving.
7. Press and hold multi-use button to pause autocarve and control rotation manually. To resume autocarve, reduce rotation speed and stop at desired carve position. Release multi-use button to resume carving.

   IMPORTANT: If rotation is restricted, move carriage back slightly until full rotation is possible, then move carriage forward while rotating.

8. Exit autocarve mode and continue normal drilling.

   IMPORTANT: Autocarve settings are retained until machine is turned off.

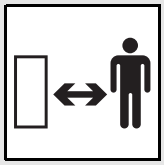
Record Bore Path

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

Subsite® Electronics bore tracking software is also available for plotting and tracking bore path. This software utilizes a Subsite Electronics tracking system, including tracker, display, 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. Contact your Ditch Witch® dealer for more information.

Surface Drill Head


DANGER Moving or thrown tools. Impact will cause death or serious injury. Never use pipe wrenches on drill string. Follow procedure in operator's manual.

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

To help avoid injury:

- Tracker operator and drill operator should maintain two-way communication.
- Drill operator should be instructed to discontinue drill string rotation as soon as drill bit exits the bore. Use only thrust to extend drill string beyond exit hole.
- Keep everyone clear of the exposed drill string.
- Only enter pit when clear communication is given by the drill operator that the machine is shut down. If using DrillLok® mode, only enter pit when DrillLok mode is turned off and DrillLok indicator is lit. See "DrillLok® System" on page 136.

1. Steer drill head to target pit or up through surface.

   NOTICE: See "Recommended Bend Limits" on page 28.

2. Turn drilling fluid off as soon as drill head emerges.
3. If using DrillLok® mode, allow tracker operator to remotely disable thrust/pullback and rotation. Tracker operator must ensure DrillLok indicator is lit before changing downhole tools.

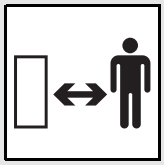
   If not using DrillLok mode, turn off machine and keep key in tracker operator's possession before changing downhole tools.
4. Clean drill head.

   IMPORTANT: Ensure threads remain clean.

5. Disconnect EZ Connect joint or use quick wrench to remove drill head. See "Quick Wrench" on page 128.

Backream


DANGER Moving or thrown tools. Impact will cause death or serious injury. Never use pipe wrenches on drill string. Follow procedure in operator's manual.

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

To help avoid injury:

- Ensure swivel turns freely with product attached.
- Tracker operator and drill operator should maintain two-way communication.
- Begin backream only when tracker operator has communicated that everyone is clear of the exposed backream string or has enabled thrust and rotation hydraulics using DrillLok® system.
- Never 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.


WARNING Underground utilities. Contact can cause death or serious injury. Locate and verify underground utilities before digging or drilling.

To help avoid injury:

- Continue to use electric strike system during backreaming.
- Watch utility crossings. Consider size of backreamer and ensure there is adequate space between existing utility and backreamer.

NOTICE: Number of passes needed depends on soil conditions. Do not attempt to increase hole size too much in one pass. Several passes using successively larger reamers will be more successful.

If needed, enlarge pilot hole to accommodate larger product. Final hole should be 1.5 times larger than the diameter of product being installed.

Assemble Backream String

NOTICE: Beacon must be calibrated after installation in beacon housing. See beacon operator's manual.

1. Select backreamers. See "Drilling Fluid" on page 133.
2. Determine drilling fluid flow requirements and install appropriate nozzles to provide sufficient fluid flow. See page 125 and page 124 for more information.
3. Attach backreamer to beacon housing if tracking backream.
4. Install beacon. See beacon operator's manual.
5. Install beacon housing lid.
6. Attach transition sub to drill pipe string.
7. Attach backreamer assembly to transition sub.
8. Attach additional pullback devices or product to end of backreamer assembly.

Begin Backream

1. After backream assembly is attached to pipe, allow tracker operator to leave pit and stand away from exposed drill string.
2. If using DrillLok® mode, allow tracker operator to turn on tracker to enable thrust/pullback and rotation.
   If not using DrillLok mode, wait for tracker operator to communicate that backream string is clear.
3. Turn on drilling fluid until pipe fills and fluid pressure begins to rise.
4. Without rotating, slowly pull back until reamer contacts bore opening.
5. Begin slow rotation and pullback.
6. Increase drilling fluid flow and rotation as backream string enters ground.
7. Monitor gauges.
8. Locate backreamer with tracker at least every half-length of pipe.

Remove Pipe

1. Turn autothrottle on.
2. If pipe box row is full, select next empty row.
3. Enable automated pipe loader system (optional). See "Use Automated Pipe Loader System" on page 104.

Break Front Joint

1. Position pipe joint between wrenches.

Manual Pipe Loader Controls	Automated Pipe Loader Controls
1.1 Open grippers. Ensure grippers are opened fully. 1.2 Extend shuttles.	Resume. Shuttles will extend, grippers will open fully, pipe lifters will lower.

2. Clamp front wrench. See "Clamp Pipe" on page 98.
3. Clamp rear wrench.
4. Break front joint.
   4.1 Rotate rear wrench counterclockwise.
   4.2 Unclamp rear wrench.
   4.3 Rotate rear wrench clockwise to original position.
5. Rotate spindle counterclockwise to separate pipe.

Break Rear Joint

1. Clamp rear wrench.
2. Rotate spindle counterclockwise until joint is loosened at SaverLok®.

> **IMPORTANT:** Do not fully unthread joint.

3. Unclamp rear wrench.
4. Move carriage back until pipe is aligned with pipe box.
5. Grip pipe.

Manual Pipe Loader Controls	Automated Pipe Loader Controls
Close grippers.	Resume. Grippers will close automatically.

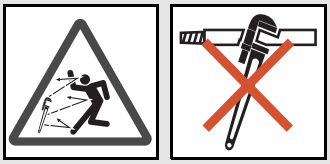
6. Rotate spindle counterclockwise until SaverLok® is separated from pipe.

7. Move carriage back to shuttle stop.
8. Return pipe to pipe box.

Manual Pipe Loader Controls	Automated Pipe Loader Controls
8.1 Retract shuttles. 8.2 Open grippers. 8.3 Raise pipe lifters.	Resume. Shuttles will retract, pipe lifters will raise.

9. Attach SaverLok® to next pipe.
   9.1 Move carriage forward until SaverLok touches pipe.
   9.2 Rotate spindle clockwise. Carriage will slowly move forward as pipe is connected.
   9.3 To fully tighten joint, slowly rotate pipe until spindle stops turning.
10. Unclamp front wrench to release pipe.

Remove Pullback Device



DANGER Moving or thrown tools. Impact will cause death or serious injury. Never use pipe wrenches on drill string. Follow procedure in operator's manual.

Pullback device can be removed when last pipe is on drill frame.

IMPORTANT: Pullback device can also be removed when target pit along bore path has been reached. Remaining pipe is then pulled back and removed.

1. Set to low throttle.
2. Turn off drilling fluid.
3. Shut off machine
4. Clean pullback device.
5. Disconnect pullback material.
6. Remove pullback device using quick wrench. See "Quick Wrench" on page 128.

Systems and Equipment

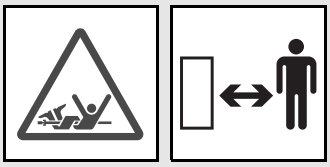
Chapter Contents

For additional precautions, see "Safety Awareness" and "Prepare" chapters.

IMPORTANT: For more information on how to operate controls, see page 41.

Anchor System

This machine can be anchored using standard anchoring.

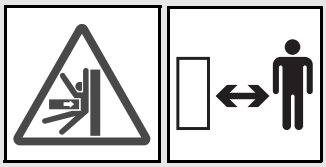


DANGER Rotating shaft. Crushing will cause death or serious injury. Stay away.

To help avoid injury: Never replace anchor collar bolt with one longer than original. Clothing could catch on turning shaft.

DANGER Underground utilities. Contact can cause death or serious injury. Locate and verify underground utilities before digging or drilling.

To help avoid injury: If you are not driving anchors to full depth, drive optional ground rod into soil away from machine and connect ground rod to machine.



WARNING Horizontal movement. Crushing can cause death of serious injury. Read and understand operator's manual and all safety instructions before use.

To help avoid injury:

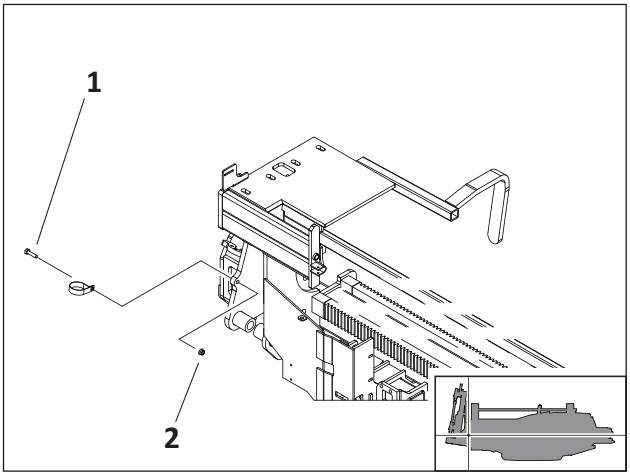
- Set stabilizers prior to driving anchors.
- Drive anchors and/or tie off machine before drilling.
- Remain safe distance away if driving anchors with wireless remote control.

Alternate Grounding

IMPORTANT: If not using anchors, additional grounding will need to be done for the machine using external kit 100-794. Contact your Ditch Witch® dealer for more information

Connect ground included in grounding kit to anchor.

1. Remove nut (3).
2. Remove paint from all surfaces prior to installing ground cable on screw (1).
3. Install nut.



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Select

There are two anchor options for this machine. Choose the correct anchor type based on job conditions as shown below.

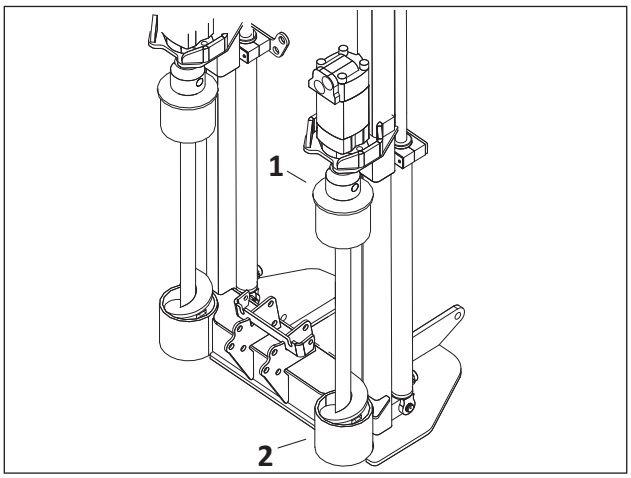
Anchor Type	Jobsite Conditions
Rock bit	Hard/soft rock, asphalt, concrete, cobble
Auger bit	Soft/hard soil, soft rock

Drive

IMPORTANT: Do not attempt to operate anchor controls while drilling fluid is on.

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

   NOTICE: Ensure centering cap (1) and centering tube (2) are properly positioned to prevent damage to anchor.



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5. Use high speed rotation and low thrust to drive anchor into the ground.

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

6. Anchor is set when centering cap rests firmly on centering tube.
7. Repeat process for other anchor.

Remove

1. Use anchor controls to slowly remove anchor from ground.
2. Repeat process for other anchor.

Cruise Control

During the bore, thrust/pullback and rotation can be set to match ground conditions. Cruise control enables the machine to maintain these settings hands-free. These settings can be engaged, disengaged, overridden, and resumed at any time.

Engage

IMPORTANT: In order for cruise control to function, carve mode must be disabled, front wrench must be unclamped, and shuttles must be fully retracted.

1. Position joystick to desired thrust or pullback settings.
2. Position joystick to desired rotation setting (optional).
3. Press set. Cruise mode indicator will appear on display.
4. If using cruise control for thrust/pullback and rotation, release joystick. If not using cruise control for rotation, use joystick to control rotation.

Adjust Settings

Thrust or Pullback

To increase thrust or pullback speed, set joystick in neutral position and press resume.

To decrease thrust or pullback speed, set joystick in neutral position and press set.

Rotation

To increase rotation speed, move joystick slightly left and press resume.

To decrease rotation speed, move joystick slightly left and press set.

Override

To override thrust/pullback settings, move joystick out of neutral and beyond current setting. Machine will increase to joystick setting.

To return to previous setting, release joystick.

Disengage

To disengage cruise control, move joystick out of neutral in opposite direction of carriage travel. Cruise mode indicator on display will turn off and carriage will stop moving.

Resume

Move joystick out of neutral in direction to be resumed (forward or backward) and press resume. Thrust and rotation will resume at the previous settings and cruise mode indicator will appear on display.

Diagnostic Codes

This machine is equipped with two diagnostic systems: engine and machine. The engine diagnostic system detects errors within the engine operating system and communicates fault codes on the display. The machine diagnostic system detects errors within the automated machine control system. These error codes are also displayed on the display.

Use the display to hide/recall active codes. Note the SPN, FMI, and description of the diagnostic code for future reference.

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

Electronic Controlled Engine Overview

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

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

Machine Diagnostic System Overview

Use the display to view condition of the machine automation diagnostic system. Under normal operating conditions, any diagnostic code that is recorded will be shown as a pop-up message on the display.

Reading Engine Diagnostic Codes

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

Downhole Tools

The chart below should be used when selecting downhole tools.

Soil	Description
Sandy	Sugar sand, blow sand, or other soils where sand is the predominant component
Soft	Sandy loam
Medium	Loams, loamy clays
Hard	Packed clays, gumbo, all compacted soils
Soft rock	Sandstone, shale, coral, caliche, chaulk
Medium rock	Limestone, caliche, sandstone, shale
Hard rock	Granite, schist, marble, hard limestone

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. Contact your 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
Compact Fluted	1	1	2	2	2	3	4
Compaction Cone	1	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
HC Hard Condition	4	3	2	1	1	4	4
Kodiak	4	3	3	2	1	2	4
MX Mixer	2	2	3	4	4	4	4

Backreamer	Sandy Soil	Soft Soil	Medium Soil	Hard Soil	Rocky Soil	Soft Rock	Hard Rock
Rhino Rock	4	4	4	4	3	2	1
Rockmaster™	4	4	4	4	3	1	1
ST Saw Tooth	2	2	1	2	2	3	4
Three Wing	4	3	3	2	1	1	4
Water Wing	4	3	2	1	2	2	4

Backreaming 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: Using less than the recommended amount of fluid can cause bore to be dry and unsuccessful.

Instructions	Example
1. Find amount of fluid needed for your size of backreamer. See the following table.	6" (152mm) backreamer requires at least 1.47gal/ft (18.24L/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.	1.5gal (18L) x 2'/min (0.5m/min) = 3gal (9L) for each minute of backreaming

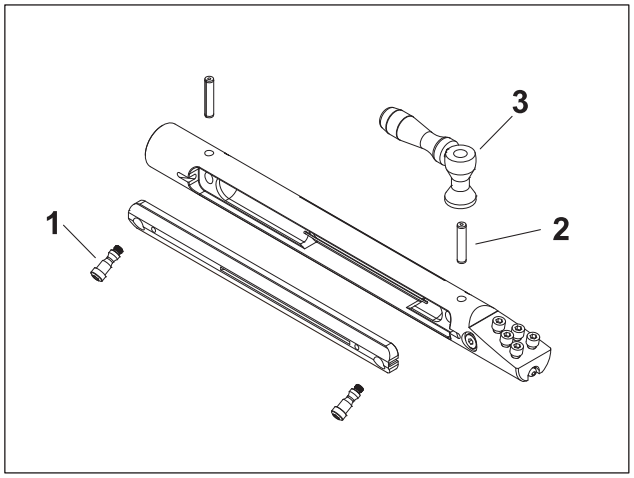
Backreamer/Product Diameter	Gal/ft	L/m	Backreamer/Product Diameter	Gal/ft	L/m
0.5" (13mm)	0.01	0.13	13.5" (343mm)	7.44	92.35
1" (25mm)	0.04	0.51	14" (356mm)	8.00	99.31
1.5" (38mm)	0.09	1.14	14.5" (368mm)	8.58	106.54
2" (51mm)	0.16	2.03	15" (381mm)	9.18	114.01
2.5" (64mm)	0.25	3.17	15.5" (394mm)	9.80	121.74
3" (76mm)	0.37	4.56	16" (406mm)	10.44	129.72
3.5" (89mm)	0.50	6.21	16.5" (419mm)	11.11	137.95
4" (102mm)	0.65	8.11	17" (432mm)	11.79	146.44
4.5" (114mm)	0.83	10.26	17.5" (445mm)	12.49	155.18

Backreamer/Product Diameter	Gal/ft	L/m	Backreamer/Product Diameter	Gal/ft	L/m
5" (127mm)	1.02	12.67	18" (457mm)	13.22	164.17
5.5" (140mm)	1.23	15.33	18.5" (470mm)	13.96	173.42
6" (152mm)	1.47	18.24	19" (483mm)	14.73	182.92
6.5" (165mm)	1.72	21.41	19.5" (495mm)	15.51	192.68
7" (178mm)	2.00	24.83	20" (508mm)	16.32	202.68
7.5" (191mm)	2.29	28.50	20.5" (521mm)	17.15	212.94
8" (203mm)	2.61	32.43	21" (533mm)	17.99	223.46
8.5" (216mm)	2.95	36.61	21.5" (546mm)	18.86	234.23
9" (229mm)	3.30	41.04	22" (559mm)	19.75	245.25
9.5" (241mm)	3.68	54.73	22.5" (572mm)	20.65	256.52
10" (254mm)	4.08	50.67	23" (584mm)	21.58	268.05
1.5" (267mm)	4.50	55.86	23.5" (597mm)	22.53	279.83
11" (279mm)	4.94	61.31	24" (610mm)	23.50	291.86
11.5" (292mm)	5.40	67.01	24.5" (622mm)	24.49	304.15
12" (305mm)	5.88	72.97	25" (635mm)	25.50	316.69
12.5" (318mm)	6.37	79.17	25.5" (648mm)	26.53	219.49
13" (330mm)	6.90	85.63	26" (660mm)	27.58	342.53

Beacon Housings

Dirt Housing Lid Installation

1. Clean all threads, bolt holes, and mating surfaces.
2. Use removable thread locker (Loctite® 242 or equivalent).
3. Place lid on trough and install bolts (1).
4. Use punch holder (3) to drive roll pins (2) from direction shown.



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Bits

Selection

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

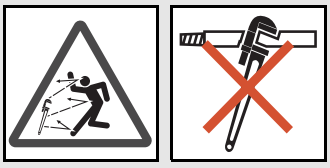
- 1 = best
- 2 = good
- 3 = fair
- 4 = not recommended

Bit	Sandy Soil	Soft Soil	Medium Soil	Hard Soil	Rocky Soil	Soft Rock	Hard Rock
Barracuda	2	1	1	2	3	4	4
Glacier	4	4	4	3	1	2	4
Hard Surface	3	1	2	3	4	4	4
Omni™	1	1	1	1	2	2	4
Rhino	4	4	3	3	1	1	3
Rockmaster®	4	4	3	2	1	1	1
Sand™	1	2	3	4	4	4	4
Steep Taper	2	2	1	2	2	3	4
Steep Taper Tuff	2	2	1	1	2	1	4
Talon	3	3	2	1	1	2	4
Tornado	2	2	2	1	1	3	4
Tuff	3	2	1	1	3	1	4

Installation

Remove all paint and primer from mating surfaces before attaching any bit to housing. Install screws and tighten bolts to 120ft•lb (163N•m).

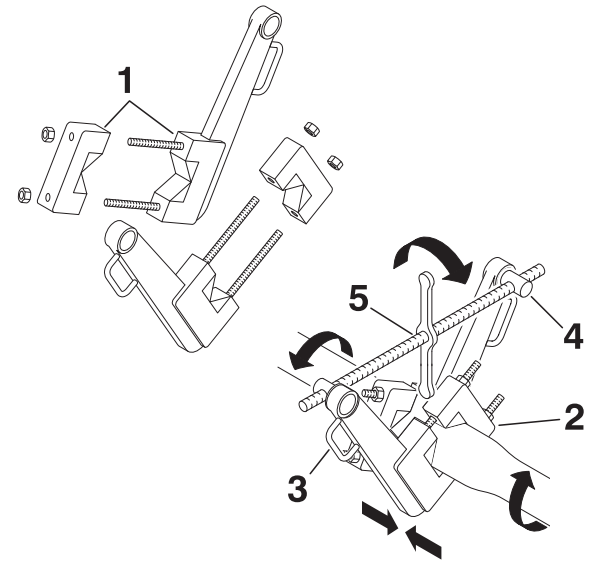
Quick Wrench



DANGER Moving or thrown tools. Impact will cause death or serious injury. Never use pipe wrenches on drill string. Follow procedure in operator's manual.

NOTICE: Apply tool joint compound to threads and hand-tighten joint before attaching quick wrench components to tighten joint.

Attach quick wrench in either the join or break position.



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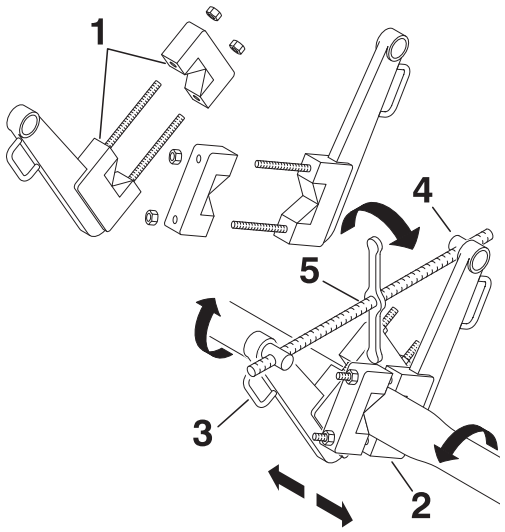
Join



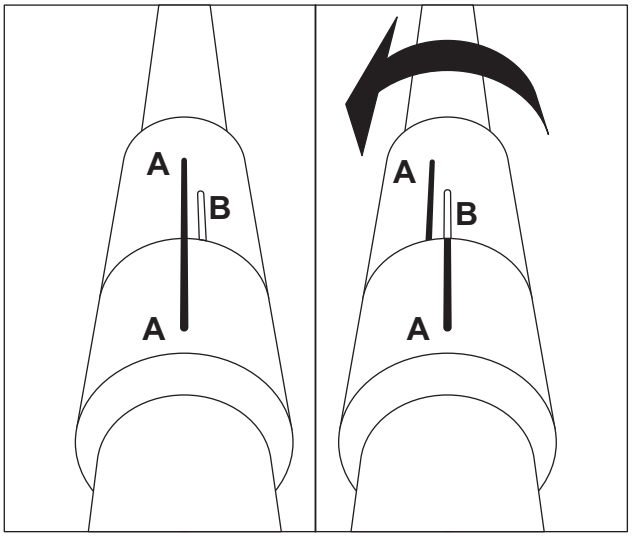
Break

1. Shut off machine.
2. Unbolt vise (1) and place jaws around pipe.
3. Bolt jaws of vise together.
4. Place jaw (2) around pipe, transition sub, or downhole tool.
5. Pin handles (3) to wrench jaws. Ensure handles are both up.
6. Attach pivot nuts (4) to wrench handles so that screw drive handle (5) is over joint.

To Join

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

Connection	Dimension
Transition sub to JT20 Power Pipe® HD	1/4" (6.35mm)
Transition sub to beacon housing	5/8" (15.88mm)
Transition sub to #600 HDX pipe	1/4" (6.4mm)



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To Break

NOTICE: Ensure machine is shut off or tracker operator has disabled thrust and rotation.

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

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. Contact your Ditch Witch® dealer for nozzle recommendations.

Drill Pipe

Perform Regular Drill Pipe Care

Precondition New Pipe

NOTICE: Failure to follow this procedure could result in damaged or destroyed pipe.

IMPORTANT: Precondition new SaverLok® body using this procedure.

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 tool joint compound. See "Recommended Lubricants" on page 158.
2. Join pipe and tighten joint.
3. Break joint.
4. Move pipe back to box.

Lubricate Joints before Each Use

Lubricate threads and shoulders of male joints with tool joint compound. This prevents rust and reduces wear on shoulders and threads. See "Recommended Lubricants" on page 158.

Clean the Threads

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

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

Replace Work SaverLok® Body

NOTICE: Failure to replace SaverLok body will result in damaged drill pipe.

Because each pipe comes in contact with the SaverLok body, check SaverLok body regularly for wear. Compare condition of SaverLok body threads to condition of drill pipe threads. Replace SaverLok body any time when its thread condition is not better than thread condition of drill pipe. See "SaverLok® System" on page 181.

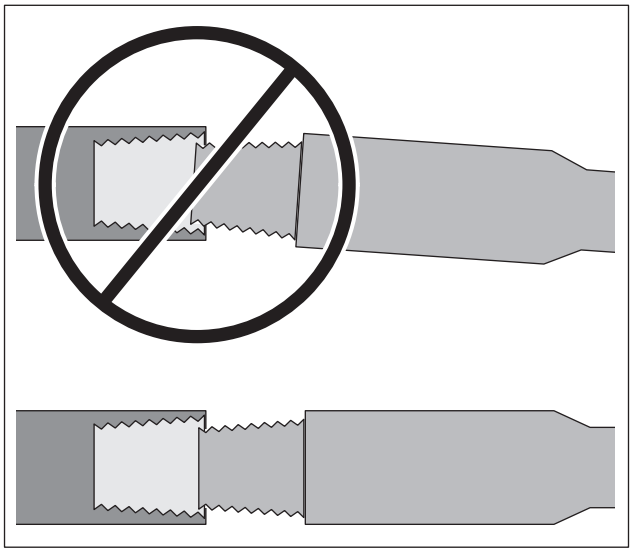
Use Drill Pipe Correctly

Align the Joints

Always carefully align the male and female ends of pipe before threading them together.

NOTICE:

- Poor alignment can damage the threads and destroy the usefulness of the joint.
- If joints get out of alignment during a bore, use frame tilt or rear stabilizers to adjust the machine.



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Clamp Pipe Correctly

See "Clamp Pipe" on page 98.

Make Up and Break Out Joints Correctly

Assisted Makeup

NOTICE: To prevent thread crossing, galling, and shoulder swelling:

- 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 to rotation speed, and always connect and disconnect joints slowly and deliberately.

IMPORTANT: If assisted makeup is not functioning, machine will not thrust or rotate while carriage is on front or rear home with front wrench clamped.

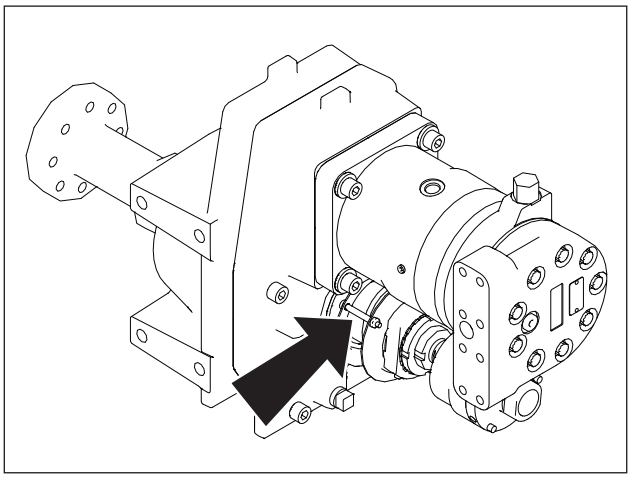
Assisted makeup protects threads by automatically matching carriage movement speed to rotation during makeup and breakout.

- To connect pipes together and fully tighten joint, slowly rotate pipe 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 as threads fully separate.

Makeup

NOTICE: Tighten joints fully. Improperly tightened joints will damage the shoulder faces and threads, and will cause joints to leak or break while drilling or backreaming.

1. Carefully move carriage forward (thrust) until spindle or pipe contacts threads of pipe in the wrench and begins to collapse spring on the back of the gearbox (shown).
2. Stop thrust and rotate clockwise until spring is fully relaxed.
3. Carefully move carriage forward as you spin the threads together, keeping the spring as relaxed as possible.
4. Once the joint is connected and the shoulder faces are touching, tighten to full machine torque.



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Breakout

1. Carefully move the carriage backward (pull back) until spring on the side of the carriage is almost fully collapsed. Do not fully collapse spring.
2. Stop pull back and rotate counterclockwise until spring is fully relaxed.
3. Carefully move carriage backward and spin the threads apart, keeping the spring as relaxed as possible until the pipe joint is fully separated.

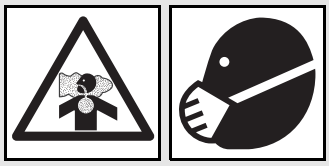
Do Not Overwork Pipe

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

Do not exceed the bend radius for pipe. See "Recommended Bend Limits" on page 28. Do not oversteer.

Drilling Fluid

⚠ WARNING Chemicals. Improper handling or use can result in illness, injury, or equipment damage. Follow instructions on labels and in Safety Data Sheets (SDS).



⚠ CAUTION Silica dust. Exposure can cause lung disease. Use breathing protection.

To help avoid injury:

- Use water spray or other means to control dust.
- Follow US Occupational Safety and Health Administration (OSHA) or other applicable regulating guidelines for appropriate breathing protection or dust control methods.

Recommended Products

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

Product	Description
Bentonite	Forms a thin cake on bore walls, lubricating the bore and keeping it open and holding fluid
Premixed bentonite	Contains premixed bentonite, polymer, and soda ash
Polymer	Provides lubrication, increases viscosity in average soils and heavy clay, and reduces swelling that traps pipe in the bore in swelling clay
Wetting agent	Water soluble cleaning solution
Soda ash	Used to adjust pH of water and water hardness

Match drilling fluid to soil type. This chart is meant as a guideline only. Contact your Ditch Witch® dealer or drilling fluid representative for drilling fluid recommendations and soil conditions in your area, or use the Fluid Formulator on www.ditchwitch.com.

Soil Type	Drilling Fluid Recommendation
Smooth, flowing sand	Bentonite or premixed bentonite + medium chain polymer
Coarse sand or light soil	Bentonite or premixed bentonite
Heavy or swelling clay	Long chain polymer + wetting agent
Rock	Premixed bentonite

Mixtures

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

IMPORTANT:

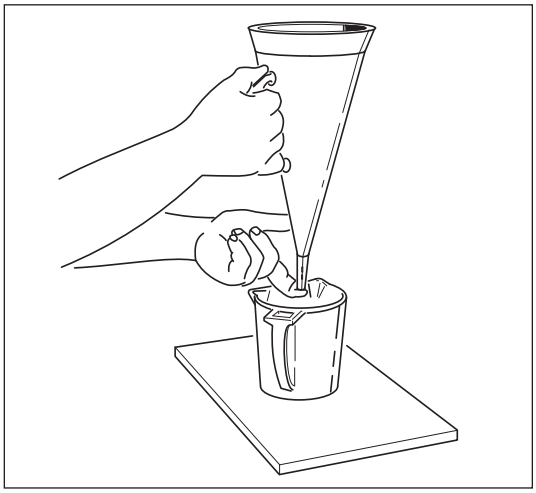
- If chemicals are added in the wrong order, they will not mix properly and will form clumps.
- If tank contains bentonite/polymer mix and more drilling fluid is needed, completely empty tank and start with fresh water before mixing another batch.

1. Soda ash
2. Bentonite
3. Polymer
4. Wetting agent

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 120ppm.
- 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. See "Funnel Viscosity" on page 135.

Funnel Viscosity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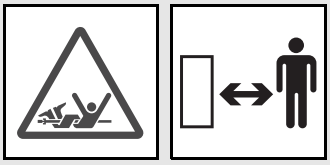
Viscosity is the measure of internal resistance of a fluid to flow; the greater the resistance, the higher the viscosity. Viscosity of drilling fluids must be controlled. Contact your Ditch Witch® dealer or drilling fluid representative for more information.

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 1.5qt (1.4L).
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 1qt (0.95L) container.
4. Remove finger from bottom of funnel and use the stopwatch to count the number of seconds it takes for 1qt (0.95L) of fluid to pass through the funnel. The number of seconds is the viscosity.
5. Thoroughly rinse measuring cup and Marsh funnel.

DrillLok® System



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

To help avoid injury:

- Use DrillLok system every time downhole tools are changed or during other times when the drill string is exposed.
- If you are not using a DrillLok system, turn off machine and keep key in tracker operator's possession before changing downhole tools.

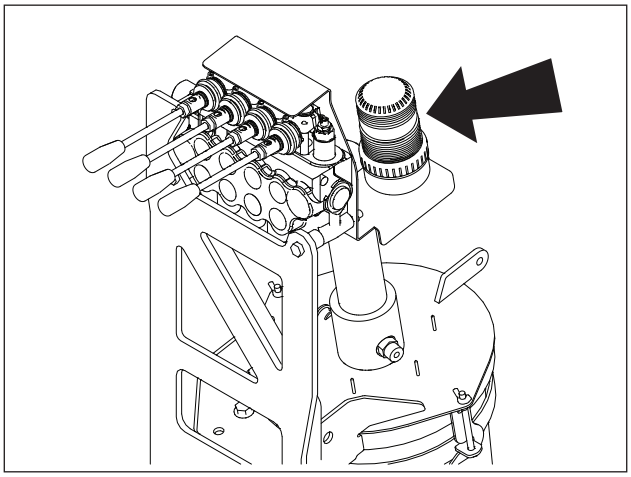
IMPORTANT:

- See "DrillLok® key" on page 56.
- This mode does not disable thrust and rotation immediately. Functions are disabled within 16 seconds.
- Tracker operator cannot disable thrust and rotation from tracker if DrillLok key is installed in machine and turned to the deactivated position.

This mode allows the tracker operator to disable hydraulic power to machine thrust and rotation. DrillLok indicator (shown), located on front of machine, will light when thrust and rotation have been disabled by DrillLok system.

If operating with Subsite® Electronics tracking equipment, DrillLok system will be incorporated into tracker. See tracker operator's manual.

If operating without Subsite Electronics tracking equipment, DrillLok system will be a separate handheld device. See DrillLok operation sheet.



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Electric Strike System

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

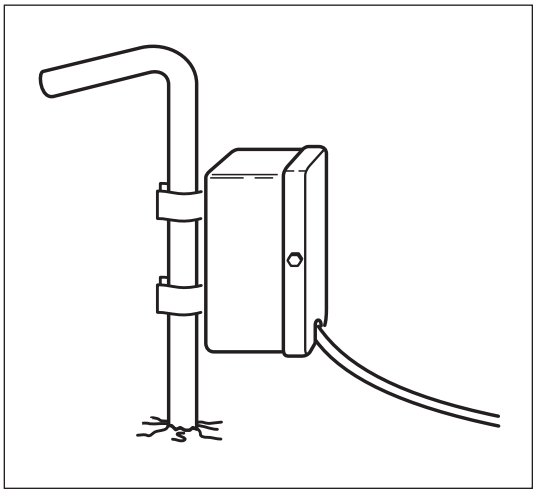
Electric strike system must be properly set up, tested, and used any time jobsite is classified as electric.

See "Apply Precautions" on page 25. Review safety procedures before each job.

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

Assemble Voltage Detector

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



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Test Strike System

If system fails any part of this test, see "Troubleshoot Strike System" on page 138. Do not drill until test is completed successfully.

1. Start engine.
2. Test alarms and strobe. See page 47.
3. View test results and historical data stored in the display. This data includes:
   - ESID bar graph
   - alphanumeric readout showing volts and amps
   - current diagnostic codes, or diagnostic codes detected during previous tests
4. Use Electric Strike Simulator to test voltage and current sensors. See page 140.

Troubleshoot Strike System

When strike system detects a problem, a diagnostic code will be displayed. If this happens, press test switch to retest. If an 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 communication with ESID. Red icon shown in display. 	Problems in startup	Select test function from ESID menu. If problem goes away, retest strike system.
	No power to strike system control module	Check machine electrical system. Ensure harness from machine to control module is connected.
	Defective control module	Have control module checked or replaced.
	Defective CAN bus connection	Ensure CAN cable from machine to ESID control module is connected.
ESID wiring issue shows on display	Test wire not connected	Ensure test wire is connected to ESID control module. Ensure test wire is connected to display. Have ESID control module checked or replaced.

Problem	Possible Cause	Possible Solution
Strobe light on machine does not work during total test	Improper connections with control module	Check connections and wiring harness.
	Defective strobe light	Disconnect strobe and connect to external 12V power source. If strobe still does not work, replace.
	Defective control module	Have control module checked or replaced.
Alarm on machine does not work during total test	Improper connections with control module	Check connections and wiring harness.
	Defective alarm	Disconnect alarm and connect to external 12C power source. If alarm still does not work, replace.
	Defective control module	Have control module checked or replaced.
Red ESID current indicator shows on display 	Improper connections with control module	Check cable connections on control module and current transformer.
	Defective current transformer	Disconnect current transformer. Check for 20-40ohms from pin 1 to pin 4 and from pin 1 to pin 2, and less than 1ohm from pin 2 to pin 4.
	Defective current transformer cable	Check cable function. Replace if cable is damaged.
	Defective control module	Have control module checked or replaced.
Red ESID voltage indicator shows on display 	Improper connection of voltage limiter to ground stake	Check voltage limiter connection to ground stake and verify that ground stake is driven properly.
	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 220-1275) to test voltage and current sensors on ESID. If readings are less than indicated here, replace battery in simulator and retest. If readings are still less than indicated, contact your Ditch Witch® dealer to have ESID repaired before drilling.

Current Test

To test for current at normal levels:

1. Thread one lead wire through current transformer.
2. Clip ends of lead wires together to make one loop.
3. Select ESID menu on display.
4. Move simulator switch to "current" and press test button.
5. Watch display on display.
   - ESID bar graph should show 1/2 scale on display.
   - ESID % and current "AMPS" should show 30% or higher in display.

To test for current at strike levels:

1. Thread two or three loops through current transformer.
2. Follow steps above to test.
3. Display should show the following:

   With two loops:

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

   With three loops:

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

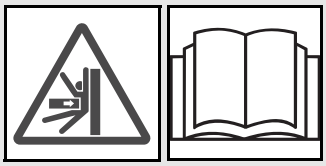
Voltage Test

1. Place voltage limiter on something insulated from ground and machine (such as dry board or tire), but near frame of machine.
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. Display should show the following:
    - ESID % and voltage "VOLTS" should show 90% or higher.
    - Alarm and strobe should turn on.

It is normal for ESID total to drift. After a strike is detected, total strike percentage may drift below strike level. To clear active strike, perform self-test. If self-test reports normal levels, alarm and strobe will stop. If self-test reports strike or detects system errors, alarm and strobe should turn on again.

Pipe Loader

Add/Remove Single Pipe



WARNING Horizontal movement. Crushing can cause death or serious injury. Read and understand operator's manual and all safety instructions before use.

To help avoid injury:

- Never attempt to move shuttles until everyone is at least 10' (3m) away from machine.
- Ensure switch operator is standing clear of all moving parts while adding pipe.

WARNING Misuse of machine can cause death or serious injury. Read and understand operator's manual and all other safety instructions before use. Know how to use all controls.

To help avoid injury:

- Use auxiliary pipe loading controls to add/remove single pipe. See "Auxiliary Pipe Loading" on page 43.
- Open or close both auxiliary pipe loaders.
- Carriage must be in full back position to load and unload pipe.
- Always use provided pipe guide.
- Drill pipe is heavy. Have enough people on hand to manually add or remove single pipe to pipe box.

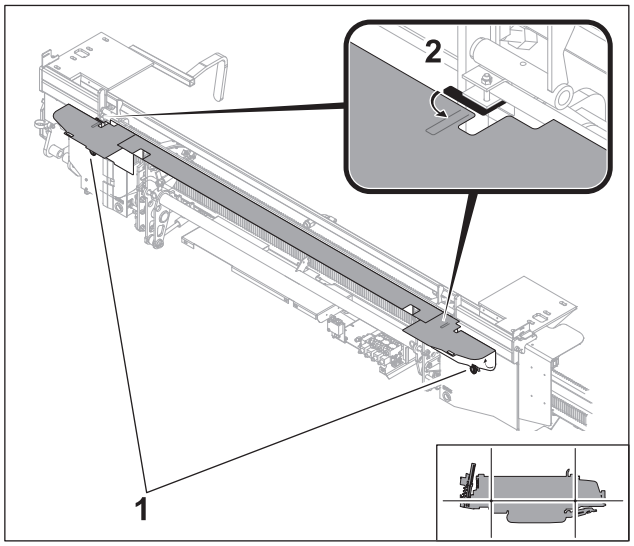
WARNING Underground utilities. Contact can cause death or serious injury. Locate and verify underground utilities before digging or drilling.

To help avoid injury:

- Never attempt to load and unload pipe while drilling or backreaming.
- On electrical jobsite, load and unload pipe only if loader is wearing electrically insulating boots and gloves.

Load a single pipe or up to a whole row of pipe into last row of pipe box to finish bore. Pipe can be added as soon as last row of pipe has been started and other rows are empty. Unload added drill pipe with auxiliary pipe loaders once bore is finished. Pipe in last row of pipe box can be unloaded only when other rows are empty.

1. Move pipe box to last row.
2. Override drill operator control of shuttles and pipe lifters.
3. Lower shuttle guard.
4. Remove two pins (1) and raise shuttle cover.
5. Slide tabs (2) out to support shuttle cover.



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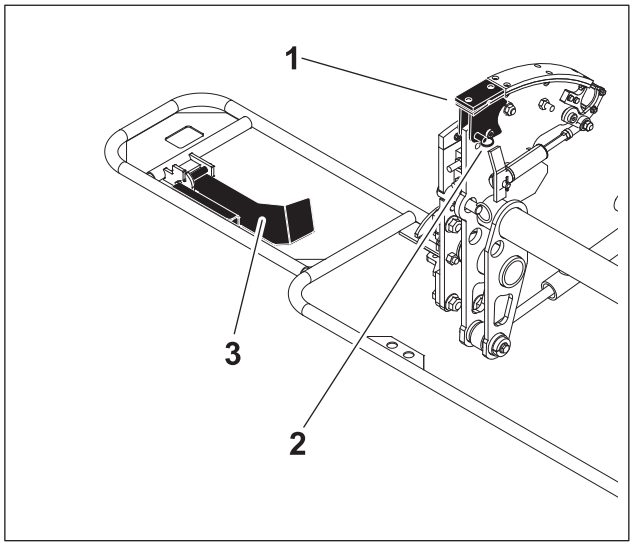
6. Remove pins (2).
7. Lower auxiliary pipe loader (1).
8. Install pin.
9. Repeat steps 6-8 on other shuttle.
10. Lift pipe guide (3).
11. Rotate pipe guide.
12. Lock pipe guide in place.



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Add Pipe	Remove Pipe
12.1Load single pipe in auxiliary pipe loader and rest against pipe guide. 12.2Enable drill operator control of shuttles and pipe lifters. 12.3Lower pipe lifters. 12.4Extend shuttles fully. 12.5Repeat if more than one pipe is needed.	12.1Raise pipe in last row. 12.2Extend shuttles. 12.3Lower pipe lifters. 12.4Retract shuttles. 12.5Override drill operator control of shuttles and pipe lifters. 12.6Remove pipe from auxiliary pipe loaders and store properly. 12.7Repeat if more than one pipe needs removed.

13. Close both auxiliary pipe loaders.
14. Remove pipe guide and store on shuttle drive cover.
15. Replace covers.
16. Enable drill operator controls of shuttles and pipe lifters.
17. Step away from machine.

Correct Dropped Pipe

To return a dropped pipe to the drill string, shut off machine and manually retrieve pipe. Return it to pipe box by loading as a single piece of pipe. See "Add/Remove Single Pipe" on page 142.

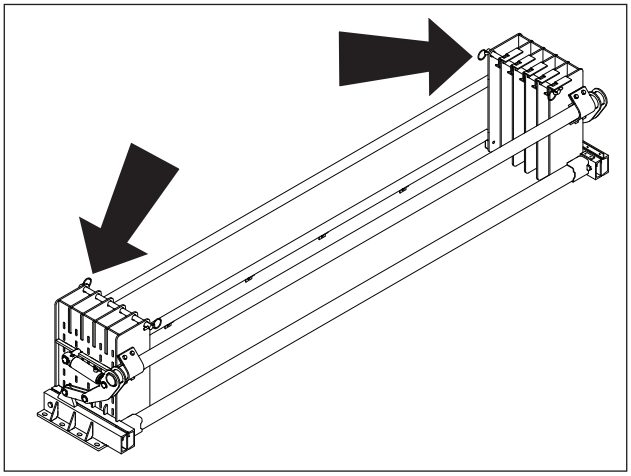
Correct Misaligned or Jammed Pipe

Display will indicate a misaligned or jammed pipe. Turn engine off and inspect pipe in active row.

- If one end of drill pipe is jammed and will not load correctly, inspect position of pipe in box.
- If pipe box appears to be improperly aligned, return to operator's station and move pipe box slightly until mechanical pointer is in center of cutout for active column.
- If drill pipe is bent, remove from pipe box and discard.

NOTICE: If misaligned or jammed pipe cannot be corrected by removing bent pipe, contact your Ditch Witch® dealer for assistance.

Rotate Drill Pipe Order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Rotating the drill pipe is a manual process. Rotate drill pipes in the drill string weekly. Rotate only as many rows as used on the longest bore of the week. For example, if the longest bore was 200' (61m), then only rotate two rows used.

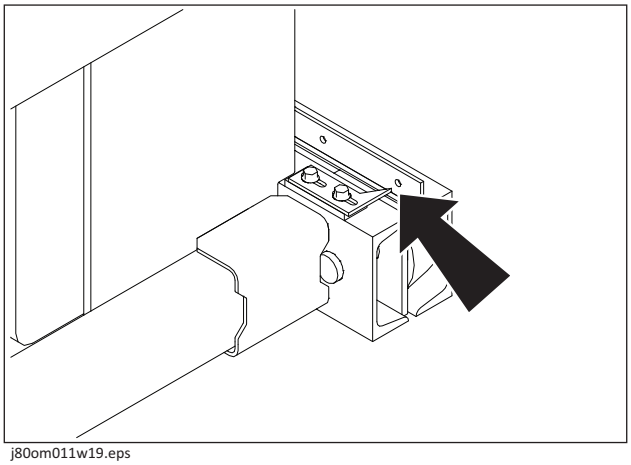
Procedure

1. Before the drilling, remove desired number of pipe starting in first row and set aside. See "Add/Remove Single Pipe" on page 142.
2. Surface drill head.
3. Shut off machine.
4. Before beginning pullback, remove pins from top of pipe box.
5. Manually load pipe into top of pipebox in last row used.

   IMPORTANT: Only load 8 pipes into a row.

6. Install pins in top of pipe box.
7. Follow pullback procedures.

Row Select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NOTICE: Do not raise pipe lifters with too many pipes in a row.

IMPORTANT:

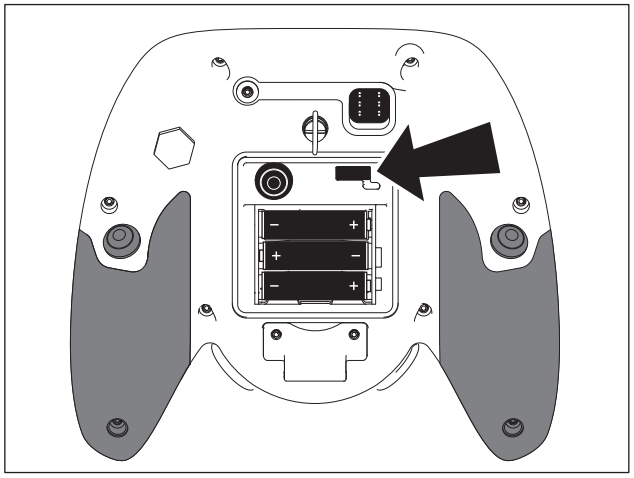
- Pipe lifters must be fully raised for pipe box to move.
- Ensure guide is aligned in center of cutout as shown.

Shift pipe box when active column is empty (drilling) or full (backreaming).

Wireless Remote Control

Set-Up

1. Check wireless remote control battery status. Replace batteries if needed. See "Battery, Wireless Remote Control" on page 170.
2. Ensure USB key (shown) is installed. This key is a lock-out feature to prevent unauthorized use.



Operation

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


⚠ CAUTION Remote-controlled equipment. Impact can cause death or serious injury. Stay away.

To help avoid injury:

- Never drive while on machine.
- Keep machine in sight at all times when using wireless remote control.
- Keep a safe distance away from machine when operating wireless remote control.
- Ensure bystanders are not near the area where machine will be driven.
- Remove strap from around neck when using wireless remote control near moving parts.

NOTICE: Place wireless remote control in storage box after use. Take care not to store with neck strap on top of switches.

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

1. Turn on wireless remote control. Wireless remote control indicator will light.

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

2. Select mode.
3. Operate.
4. Turn wireless remote control off when job is complete.

Troubleshooting

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

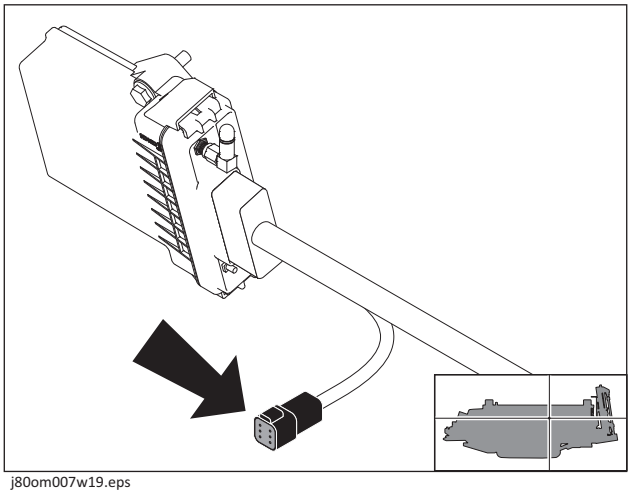
If communication link indicator is flashing yellow, communication between wireless remote control and machine has stopped. Move wireless remote control closer to machine while maintaining a safe distance. If in an area with interference, try changing the channel (see below).

If communication link indicator is red, communication has been lost. Shut down wireless remote control and restart enable communication. If remote still will not work, contact your Ditch Witch® dealer.

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

To change channel:

1. Activate accessories.
2. Connect harness (shown) to transmitter (2).
3. Ensure battery indicator is solid green.



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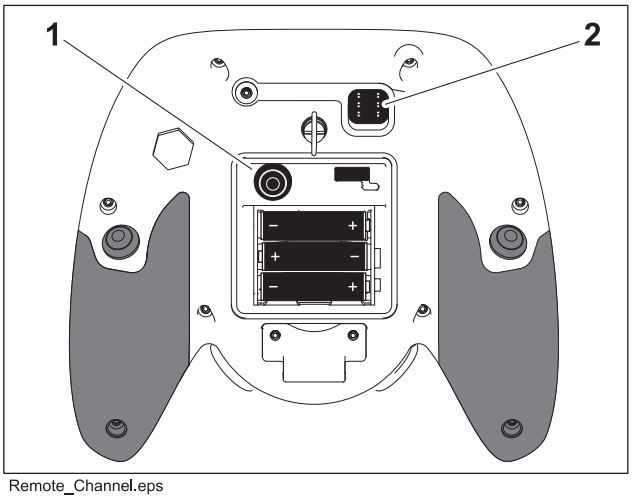
4. Press channel switch (1) until communication link indicator begins to flash green/yellow and then release the channel switch.
   - Rapid flashing green indicator signals successful channel connection.
   - Flashing yellow indicator signals unsuccessful channel connection.



Remote_Channel.eps

Complete the Job

Chapter Contents

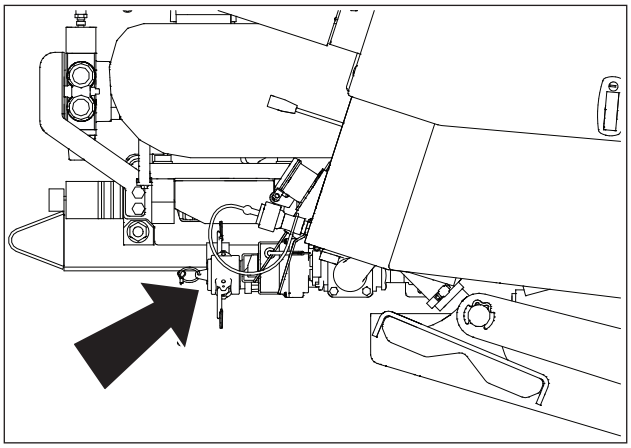
For additional precautions, see "Safety Awareness" and "Prepare" chapters.

Antifreeze Machine

This machine can be left overnight in freezing conditions by filling fluid lines with a polypropylene glycol-based, RV antifreeze with optional antifreeze system before shutdown.

Add Antifreeze

1. Add antifreeze to antifreeze tank. See "Specifications" on page 187.
2. Install plug at quick coupler for drilling fluid pump (shown).
3. Open valve below antifreeze tank.
4. Install optional antifreeze reclaimer adapter in spindle.
5. Ensure drilling fluid flow is off.



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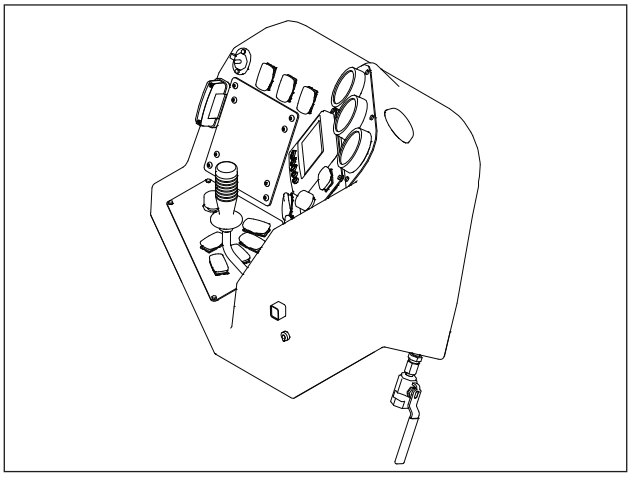
6. Ensure valve is open as shown.
7. Start machine and set to low throttle.
8. Enable drilling fluid control.
9. Slowly increase drilling fluid flow until antifreeze comes out of spindle.
10. Disable drilling fluid control.



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Reclaim Antifreeze

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

1. Hold hose on optional antifreeze reclaimer over top of antifreeze tank.
2. Open valve on reclaimer.
3. Connect drilling fluid transfer hose from tank to drilling fluid pump inlet.
4. Close valve below antifreeze tank.
5. Start engine.
6. Set throttle to low.
7. Enable drilling fluid control.
8. Set drilling fluid control to low.
9. Turn drilling fluid off when drilling fluid comes out of reclaimer hose.
10. Remove antifreeze reclaimer.

Rinse Equipment

WARNING Pressurized fluid or air. Contact can cause death or serious injury. Refer to operator's manual for correct use.

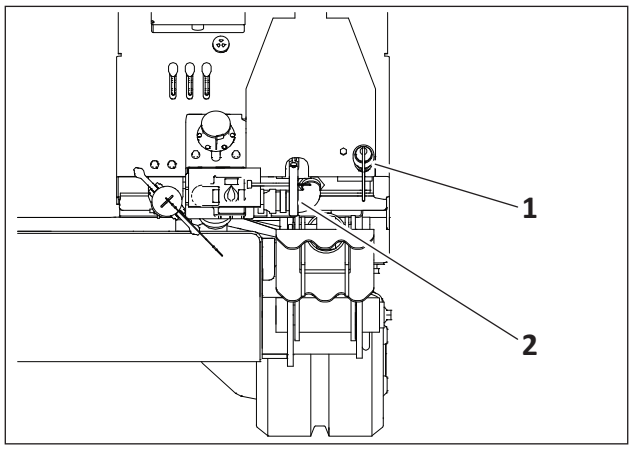
To help avoid injury:

- Never use high flow when using wash wand.
- Never point or aim wand at yourself or anyone else. Keep nozzle low to the ground.
- Prime drilling fluid pump before operating wash wand. Failure to prime drilling fluid pump will cause flow fluctuations, which will make it difficult to control the wash wand.

NOTICE:

- Do not spray water onto operator console or electrical center in engine compartment. Water can damage electrical components. Wipe down instead.
- Ensure all mud and debris is rinsed from tracks before parking machine overnight.

1. Turn fluid flow to low.
2. Connect wash wand at quick connect (1) at rear of machine.
3. Press wash wand switch (2) to close discharge valve.
4. Check surroundings before pressing handle to start pressurized fluid flow.
5. Spray water onto equipment to remove dirt and mud. Some pressure might be needed to remove dried mud from wrench area. Thoroughly rinse operator station and step.



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IMPORTANT: If front wrench is clamped, fluid will not flow to the wash wand.

6. Release handle to stop flow.

Disconnect

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

- electric strike system voltage stake
- fluid hose

Stow Tools

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

Service

Chapter Contents

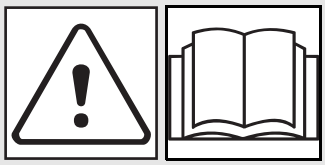
For additional precautions, see "Safety Awareness" and "Prepare" chapters.

Service Precautions

WARNING Jobsite hazards. Exposure can cause death or serious injury. Use correct equipment and work methods. Use and maintain appropriate safety equipment.

To help avoid injury:

- Wear personal protective equipment including hard hat, safety eye wear, foot protection, hearing protection, and gloves (except when near rotating equipment).
- Remove jewelry.
- Wear close-fitting, high visibility clothing.
- Have other personal protective equipment, such as insulated boots and gloves, breathing protection, and face shield, etc. available for use depending on jobsite hazards or requirements.



WARNING Misuse of machine can cause death or serious injury. Read and understand operator's manual and all other safety instructions before use. Know how to use all controls.

To help avoid injury:

- Unless otherwise instructed, all service should be performed with the engine off and cool.
- Lower unsecured, raised components before servicing equipment.
- Unless otherwise instructed, all service should be performed with machine parked on level surface.
- Refer to US Occupational Safety and Health Administration (OSHA) guidelines for appropriate lockout-tagout procedures.

Washing Precaution

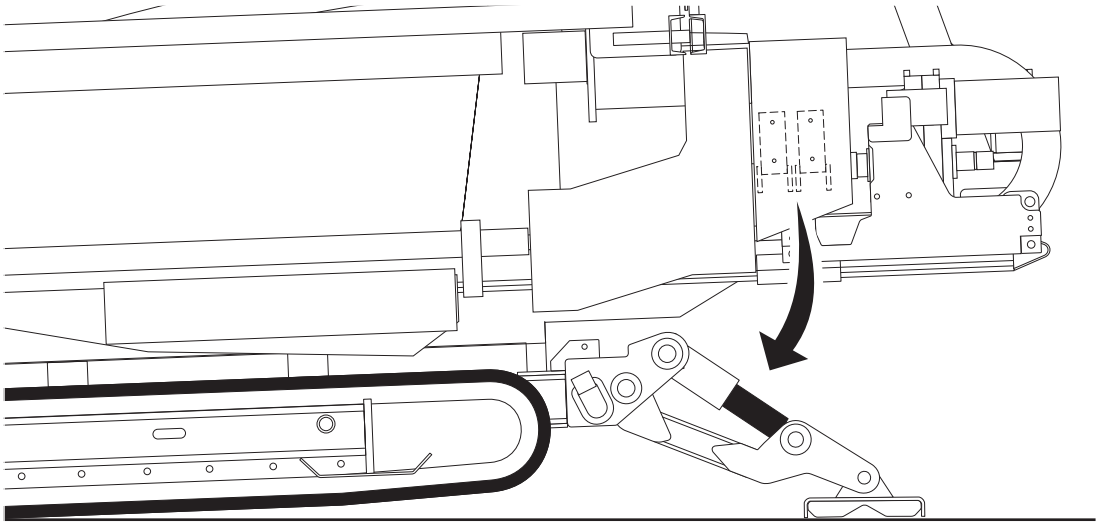
NOTICE: Water can damage electronics. When cleaning equipment, do not spray electrical components with water.

Welding Precaution

NOTICE: Welding can damage electronics.

- Welding currents can damage electronic components. Always disconnect the ECU ground connection from the frame, harness connections to the ECU, and other electronic components prior to welding on machine or attachments.
- Connect welder ground close to welding point and make sure no electronic components are in the ground path.
- Failure to disconnect battery will cause damage to battery.

Working under Machine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WARNING Raised component. Crushing can cause death or serious injury. Stay away or secure raised component with locking device. Use correct equipment and procedures.

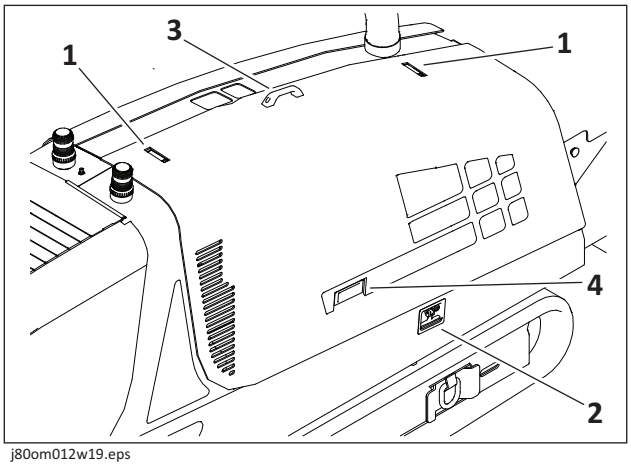
Before working under area of machine supported by stabilizer or frame tilt cylinder, ensure machine is parked on hard surface.

1. Lower stabilizers fully.
2. Remove stabilizer locks from storage at rear of pipe box.
3. Place over extended cylinder rods (shown) with curved ends toward stabilizer shoes.
4. Lower machine until load is supported by cylinder locks.

Opening/Closing Front Hood

To open:

1. Unlock hood at handles (1, 2) if needed.
2. Unlatch handles (1).
3. Turn handle (2) left.
4. Grasp upper (3) and lower (4) handles.
5. Lift hood upward and outward.
6. Continue lifting hood and push inward until up latch (5) engages.



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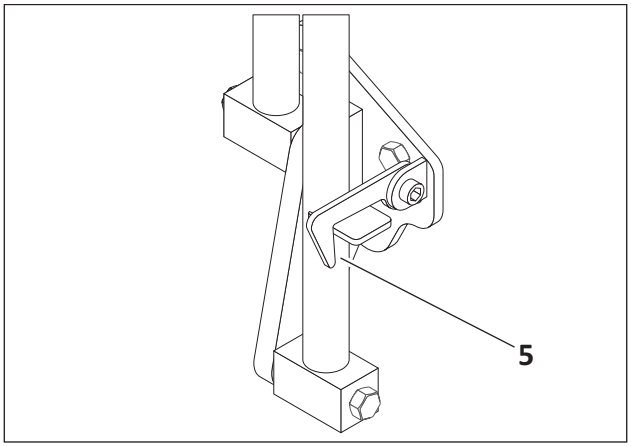
To close:

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



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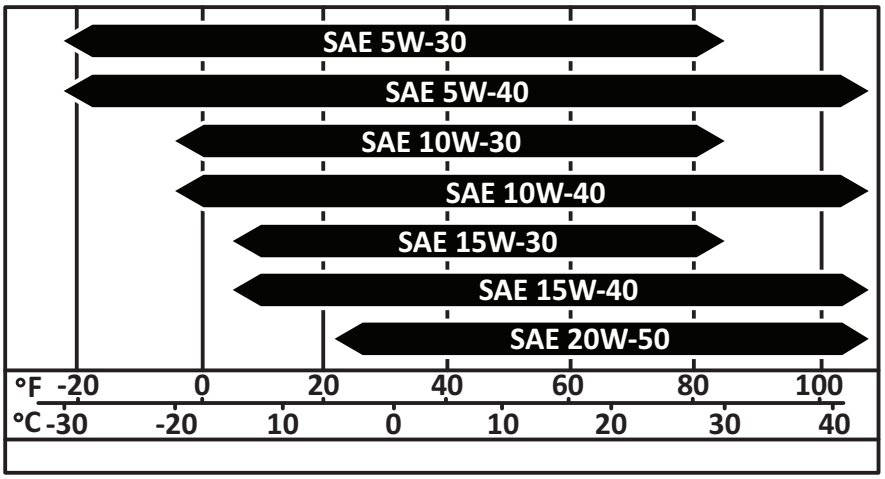
Recommended Lubricants

Item	Description
DEAC	Diesel engine antifreeze/coolant meeting DQC CB-14 See "Approved Coolant" on page 159.
DEO	Diesel engine oil meeting or exceeding Deutz® DQC III-LA or DQC IV LA or API CK-4. See "Engine Oil Temperature Chart" on page 159. API American Petroleum Institute, ACEA European Automobile Manufacturer's Association
EPG	Extreme pressure grease meeting ASTM D217 and NLGI 5
EPS	Extreme pressure spray lubricant, Lubriplate LO152-063 or equivalent
MPG	Multipurpose grease, polyurea based NLGI GC-LB Grade 1.5 or lithium based NLGI GC-LB Grade 2
MPL	Multipurpose gear oil meeting API GL-5 (SAE80W90)
PF	Phillips 66® PowerDrive® Fluid 30
THF	Tractor hydraulic fluid, Phillips 66® PowerTran XP Fluid or equivalent
TJC	Tool joint compound, Ditch Witch® standard or environmental

Proper lubrication and maintenance protects Ditch Witch® equipment from damage and failure. Service intervals listed are for minimum requirements. In extreme conditions, service machine more frequently. Use only genuine Ditch Witch parts, filters, approved lubricants, TJC, and approved coolants to maintain warranty. Fill to capacities listed in "Specifications" on page 187.

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

Engine Oil Temperature Chart



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Temperature range anticipated before next oil change

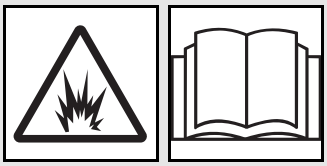
Approved Coolant

NOTICE:

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

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

Approved Fuel



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

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

NOTICE: Use only Ultra Low Sulfur Diesel (less than 15ppm sulfur content in the US and Canada or 10mg/kg in EU and Japan) in this machine. Operating with higher sulfur content will damage the engine and aftertreatment device.

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

Exhaust Cleaning

This engine has a Diesel Particulate Filter (DPF) that separates soot caused by the combustion of diesel fuel from the exhaust gases exiting the engine. The DPF must be cleaned as the soot level increases.

Sensors in the engine monitor the exhaust status. When a cleaning cycle is needed, the system will create a pop-up message indicating cleaning is needed and power loss may occur. The exhaust cleaning icon will flash. Follow on-screen prompts to initiate exhaust cleaning. An operator may choose to hide and ignore this message. If so, the icon will continue to flash and the message will reappear after fifteen minutes.

If the operator continues to ignore the cleaning request, the system will create a pop-up message indicating cleaning is needed and power loss will occur. Engine power reduced by 25%. The exhaust cleaning icon will flash and the engine caution icon will appear. Follow on-screen prompts to initiate exhaust cleaning. An operator may choose to hide and ignore this message. If so, the icons will continue to display and the message will reappear after five minutes.

If the operator continues to ignore the cleaning request, the system will create a pop-up message indicating exhaust service is required. Engine derating has been activated. Contact Deutz® service. The exhaust cleaning and the engine stop icons will flash. An operator may choose to hide and ignore this message. If so, the icons will continue to display and the message will reappear after one minute.

Once the operator starts the exhaust cleaning cycle, adjusting the throttle or releasing the parking brake will terminate the cycle. A typical cycle will take approximately 35 minutes. A pop-up message will display the remaining time in the cycle. The high exhaust temperature icon may also light.

The frequency of exhaust cleaning is dependent upon working conditions. In general, operating in hotter conditions and higher loads will lengthen the time between cleaning cycles.

Service Interval Chart*

▽	Adjust, service, or test	□	Change, initial	○	Lube, initial
▲	Check	■	Change	●	Lube

Service	Startup	10 Hours	50 Hours	250 Hours	500 Hours	750 Hours	1000 Hours	2000 Hours	As Needed
Air intake system	▲	▲							
Battery		▲							▽
Battery, wireless remote control									■
Belt, engine drive			▲						■
Control switches	▽	▽							
Coolant	▲	▲						■	
Drilling fluid y-strainer	▲	▲							
Dust ejector valve	▲	▲							
Engine compartment			▲						
Belt, engine drive			▲						▽
Filter, air	▲	▲							■
Filter, engine oil (see Oil, engine)									
Filter, fuel					■				
Filter, hydraulic			□		■				
Fluid, hydraulic	▲	▲			■				
Fluid pump	▲								
Hydraulic hoses	▲	▲							
Hydraulic tank	▲								
Oil, engine	▲	▲		■					

Service	Startup	10 Hours	50 Hours	250 Hours	500 Hours	750 Hours	1000 Hours	2000 Hours	As Needed
Oil, fluid pump	▲	▲	□			■			
Oil, ground drive gearbox			▲				■		
Oil, rotation gearbox			▲	■					
Pipe auto-lubricator	▲	▲							
Pipe guide inserts	▲								■
Pipe loader inserts	▲								
Radiator			▲						▽
Radiator cap					▲				
Rotation gearbox							●		
Rotation gearbox output shaft			●						
Saver sub			▲						■
SaverLok®			▲						■
Slide blocks			▲						
Tool joint compound	▲	▲							■
Track tension	▲	▲							▽
Water separator	▲	▲							
Wrench jaw inserts	▲								■

*The chart above indicates the first instance of repeated service procedures. See detailed information below.

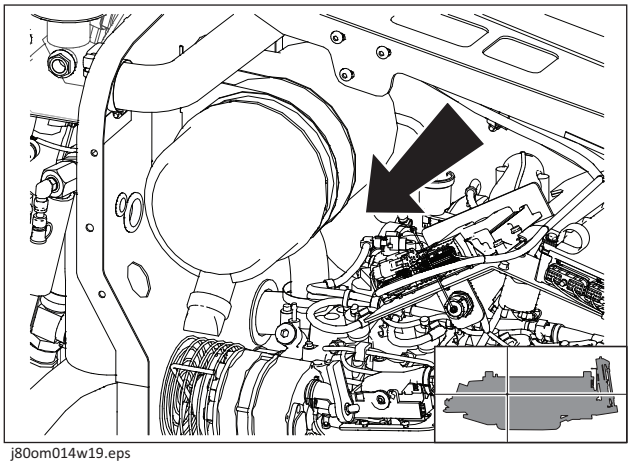
Procedures

Air Intake System

Check air intake system (shown) for dirt and debris before start up and every 10 hours.

If clamp is loose, apply oil to threads and retighten.

If hose is cracked or worn, replace.



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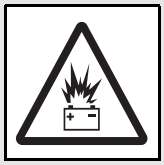
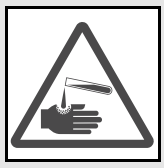
Battery




⚠ CAUTION Explosive hydrogen gas. Fire or explosion can cause death or serious injury. Keep heat flames, sparks, and other sources of ignition away.

To help avoid injury:

- Use a single 12V maximum source for charging. Never connect to rapid chargers or dual batteries.
- Never lean over battery when making connections.
- Never allow vehicles to touch when charging.
- Never short-circuit battery terminals for any reason or strike battery posts or cable terminals.
- Refer to Safety Data Sheet (SDS) for additional information regarding battery.




⚠ CAUTION Corrosive fluid. Contact can cause death or serious injury. Avoid contact. Wear appropriate gloves. See Safety Data Sheet (SDS) for more information.

To help avoid injury:

- Never attempt to charge a battery that is leaking, bulging, heavily corroded, frozen, or otherwise damaged.
- Refer to Safety Data Sheet (SDS) for additional information regarding battery.

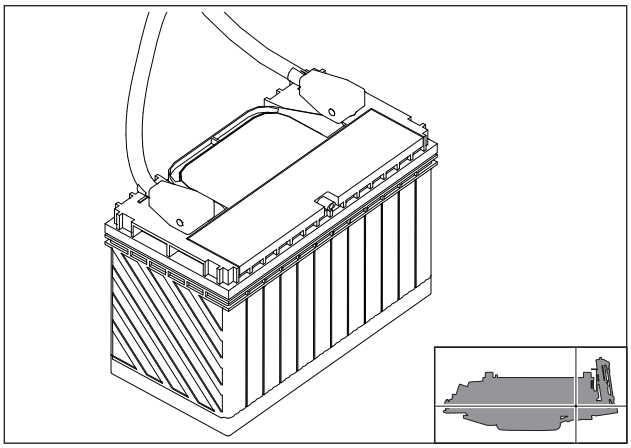
NOTICE:

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

Check every 10 hours. Charge as needed.

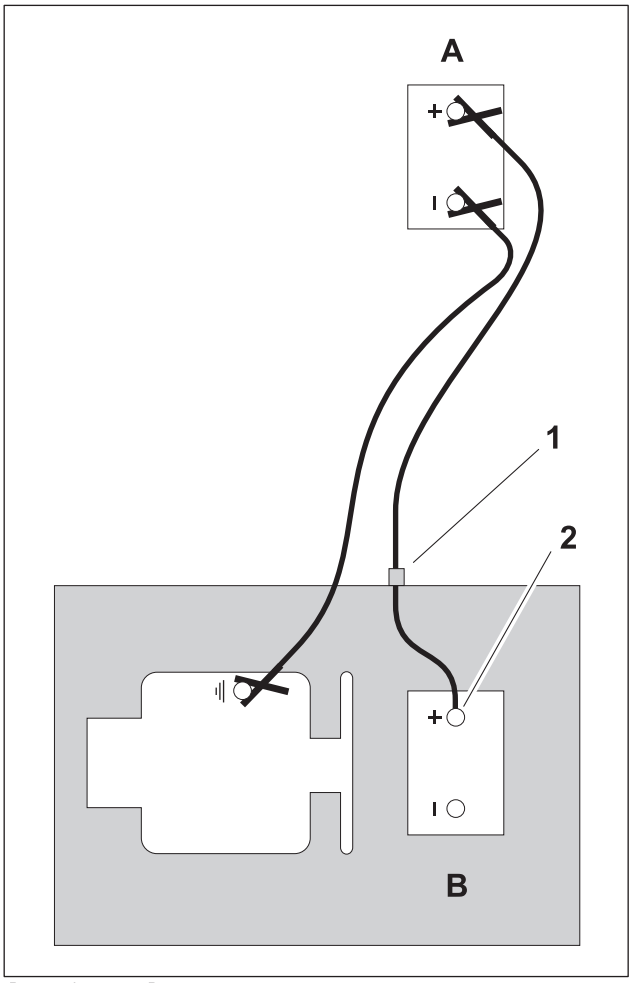
Check

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



j80om015w19.eps

Charge



Battery_Jumpstart_B.eps

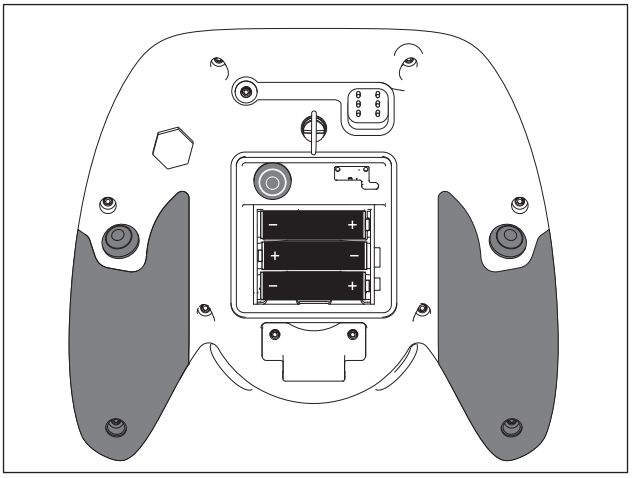
1. Park service vehicle close to disabled machine but do not allow vehicles to touch.
2. Set parking brake in both, if equipped.
3. Turn both off.
4. Disconnect machine controller.
5. Inspect battery in disabled machine (B) for signs of cracking, bulging, leaking, or other damage.
6. Connect red positive (+) jumper cable clamp to positive (+) post of battery (2) in disabled machine.

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

7. Connect the other red positive (+) jumper cable clamp to positive (+) post of battery (A) in service vehicle.
8. Connect black negative (-) cable clamp to negative (-) post of battery in service vehicle.
9. Connect the other black negative (-) cable clamp to engine or frame ground on disabled vehicle (1), at least 12" (305 mm) from failed battery, as shown.
10. Operate service vehicle engine at 1500-2000 rpm for a few minutes to build an electrical charge in failed battery.
11. Stop engine in service vehicle.
12. Remove jumper cables from service vehicle, black negative (-) clamp first. Do not allow clamps to touch.
13. Remove black negative (-) cable clamp from disabled engine or frame ground.
14. Remove red positive (+) cable clamp from disabled machine.
15. Reconnect machine controller.
16. Start disabled machines.

Battery, Wireless Remote Control

Change batteries when low battery indicator is displayed. Install six AA batteries as shown.



Remote_Battery.eps

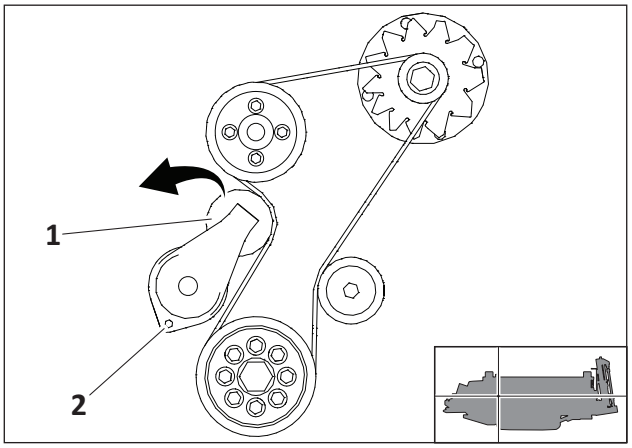
Belt, Engine Drive

Check every 50 hours. Change as needed.

Check

Check for excessive slack, damage, or wear.

Change



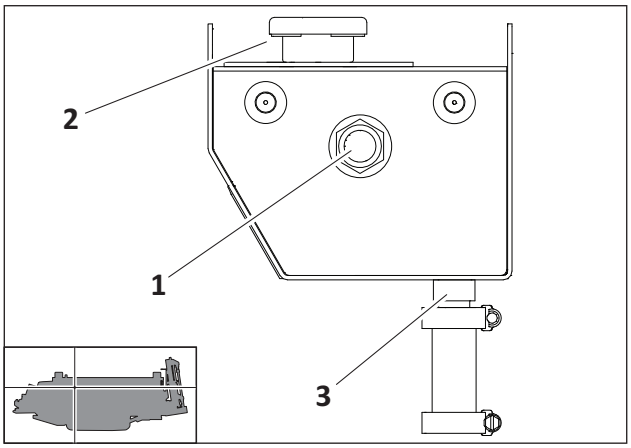
j80om016w19.eps

1. Move tensioner pulley (1) in the direction shown.
2. Insert retaining pin into assembly bore (2).
3. Replace belt.
4. Holding tensioner pulley in place, remove retaining pin.

Coolant

IMPORTANT: See "Approved Coolant" on page 159.

Check before startup and every 10 hours. Change every 2000 hours.



j80om017w19.eps

Check

1. Check level at sight glass (1).
2. Add DEAC at fill cap (2) as needed to keep level at halfway point on sight glass.

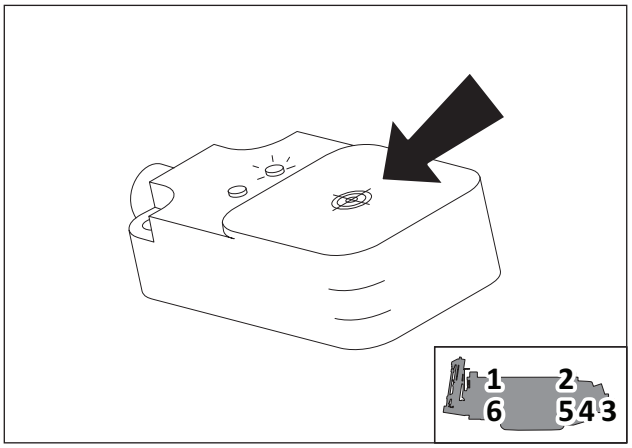
Change

1. Remove fill cap.
2. Open drain valve (3) to drain.
3. Close valve.
4. Add DEAC at fill at a rate of 3gpm (11.4L/min) to keep level at halfway point on sight glass.
5. Start engine.
6. Run engine at 195°F (90°C) for several minutes.
7. Stop engine and let cool.
8. Check coolant level.
9. Add DEAC at fill as needed to keep level at halfway point on sight glass.

Control Switches

Test before startup and every 10 hours. Clean or replace as needed.

1. Insert key and activate accessories using ignition switch.
2. Place metal object above target (shown) on each switch.



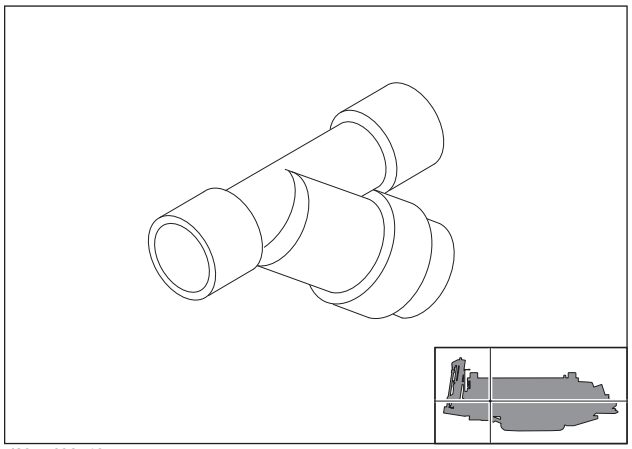
j80om025w19.eps

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

3. If yellow LED on switch lights, switch sensor is working.

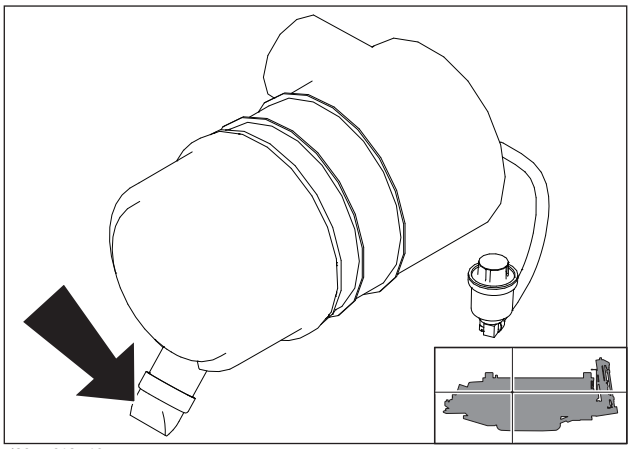
Drilling Fluid Y-Strainer

Check y-strainer before startup and every 10 hours. Ensure y-strainer is free of obstructions and operates properly. Clean as needed.


j80om026w19.eps

Dust Ejector Valve

Check valve (shown) before startup and every 10 hours. Ensure valve is not inverted, damaged, plugged, or cracked.



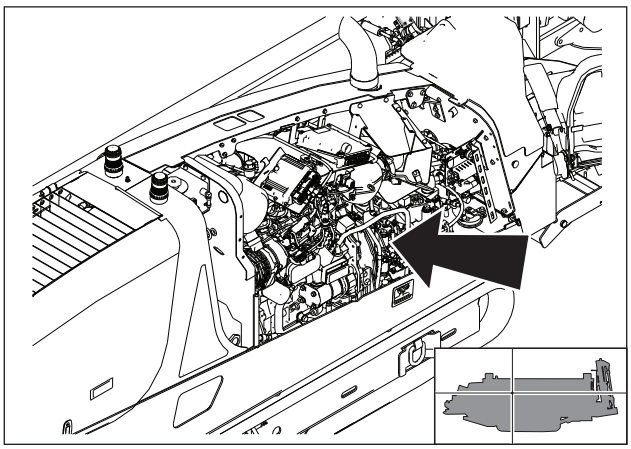
j80om018w19.eps

Engine Compartment

NOTICE:

- Check more often if operating in large brush or grassy conditions.
- Do not use water or compressed air to remove debris.

Check engine compartment (shown) for debris every 50 hours and after long-term storage. Manually clean out debris as needed.



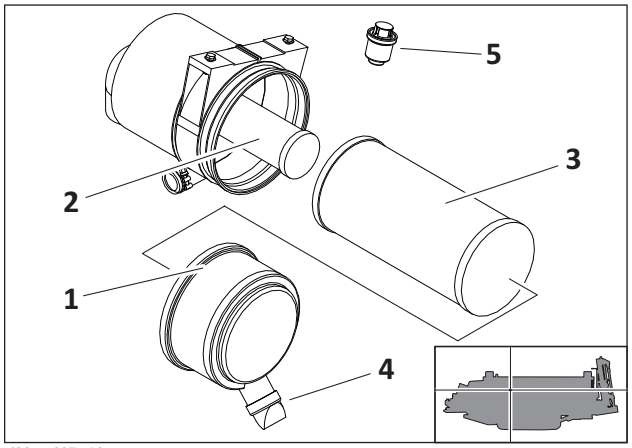
j80om019w19.eps

Filter, Air

NOTICE:

- Only open air filter canister when air restriction is indicated.
- Change elements. Do not attempt to clean them.
- Compressed air or water may damage elements.
- Tapping to loosen dirt may damage elements.

Check at startup and every 10 hours. Change as needed.



j80om027w19.eps

Check

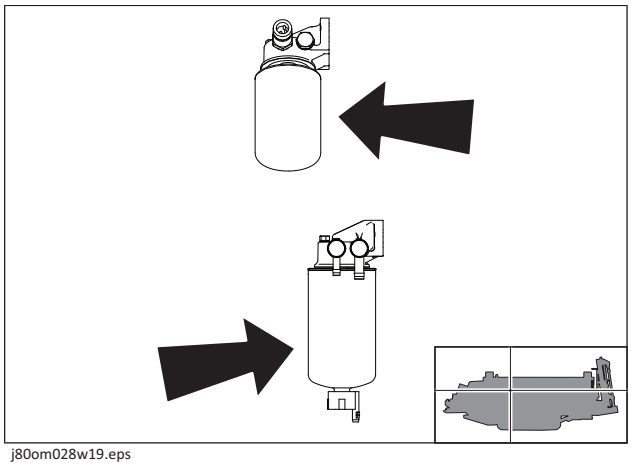
Check air filter restriction indicator (5). Change filter when red band on indicator is visible.

Change

1. Remove cover (1).
2. Remove primary element (3) and secondary element (2).
3. Wipe inside of housing and wash cover.
4. Insert new secondary element and ensure it is seated correctly.
5. Insert new primary element.
6. Install cover with dust ejector (4) facing down.
7. Reset air filter restriction indicator.

Filter, Fuel

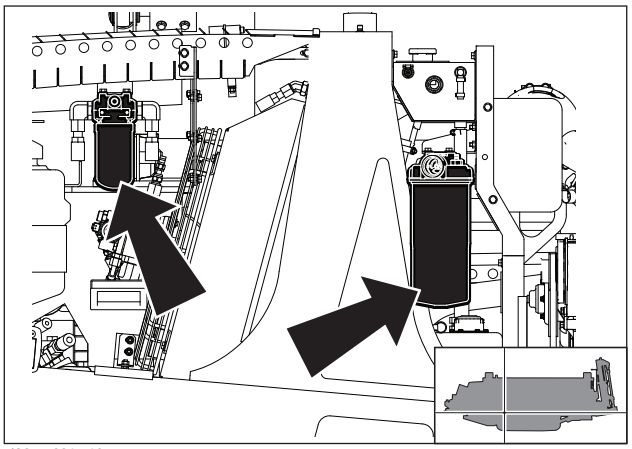
Change filters (shown) every 500 hours.


j80om028w19.eps

Filter, Hydraulic

NOTICE:

- Change filter more often as indicated by filter indicator.
- If hydraulic system must be opened for repair, install new hydraulic filter. If new filter becomes plugged in fewer than 20 hours, replace.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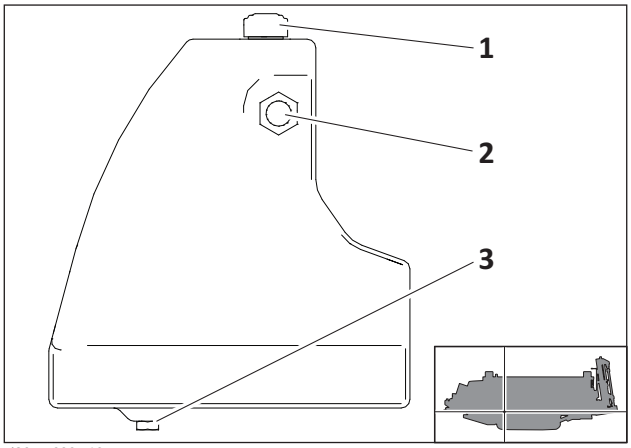
Change filters at 50 hours and every 500 hours thereafter.

Fluid, Hydraulic

IMPORTANT: Replace hydraulic filter each time hydraulic system is opened.



j80om020w19.eps

Check before startup and every 10 hours. Change every 500 hours.

Check

1. Check level at sight glass (2).
2. Add THF at fill (1) as needed to keep level at halfway point on sight glass.

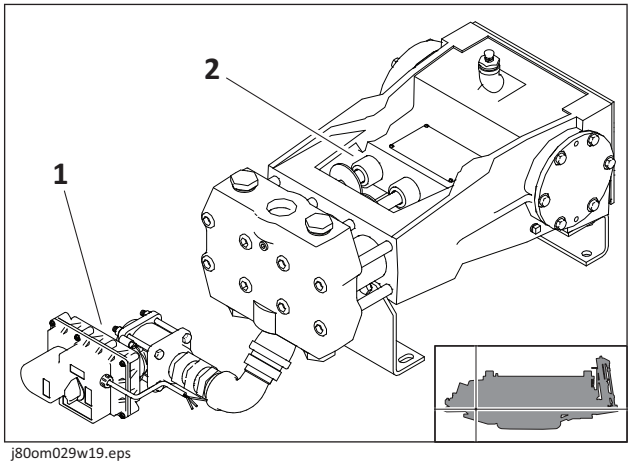
Change

1. Remove plug (3) to drain.
2. Install plug.
3. Add THF at fill as needed to keep level at halfway point on sight glass.

Fluid Pump

Check ball valve (1) for leaks every 10 hours. Tighten stem packing as needed.

Check piston seals (2) for signs of excessive leaking before startup and every 10 hours. Replace if needed.



j80om029w19.eps

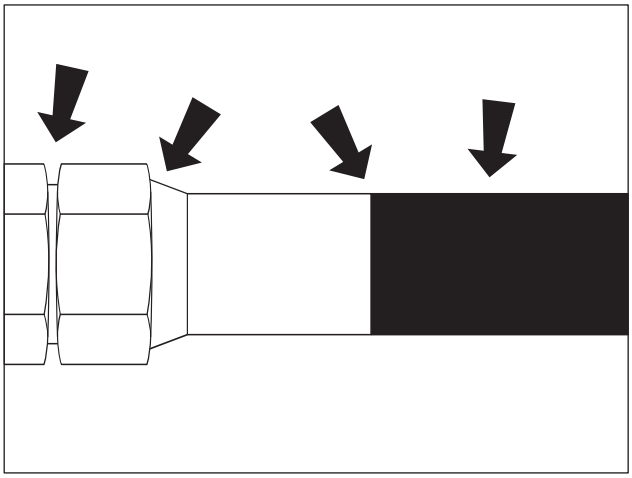
Hydraulic Hoses

WARNING Pressurized fluid or air. Injection can cause death or serious injury. Refer to operator's manual for correct use.

To help avoid injury:

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

Check for leaks where shown before startup and every 10 hours.

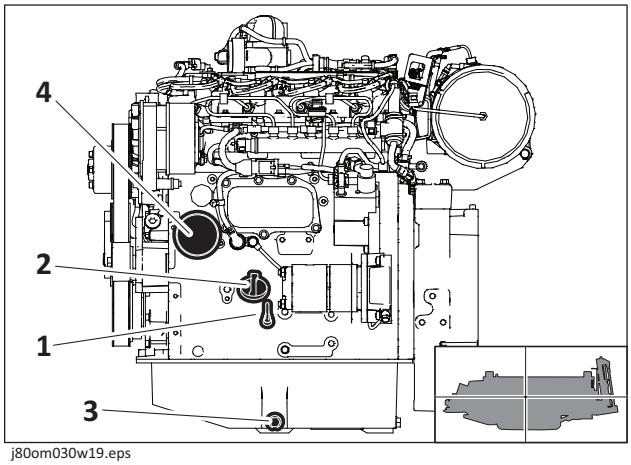


CheckHoses.eps

Oil, Engine

Check before startup and every 10 hours. Change every 250 hours.

IMPORTANT: Change at 500 hours if using Deutz® engine oil meeting or exceeding DQC III-LA or DQC IV LA.



j80om030w19.eps

Check

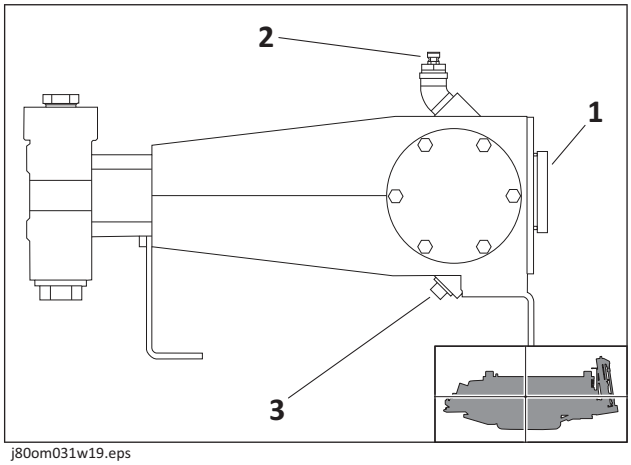
1. Check level at dipstick (1).
2. Add DEO at fill (2) as needed to keep level at highest line on dipstick.

Change

1. Remove plug (3) to drain.
2. Install plug.
3. Remove filter (4) and replace with new filter.
4. Add DEO at fill (2) to keep level at highest line on dipstick.
5. Start engine.
6. Run engine until operating temperature is reached.
7. Turn off machine.
8. Check level.
9. Add DEO at fill as needed to keep level at highest line on dipstick.

Oil, Fluid Pump

Check before startup and every 10 hours. Change at 50 hours and every 750 hours thereafter.



j80om031w19.eps

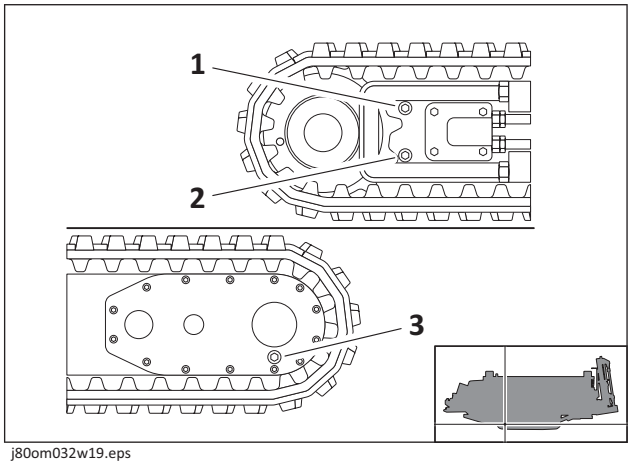
Check

1. Check level at sight glass (1).
2. Add PF at fill (2) as needed to keep level at halfway point on sight glass.

Change

1. Remove plug (3) to drain.
2. Ensure plug is free of dirt and debris.
3. Install plug.
4. Add PF at fill to keep level at halfway point on sight glass.

Oil, Ground Drive Gearbox



j80om032w19.eps

IMPORTANT:

- Use helper to assist in positioning gearbox plugs for checking and adding oil.
- Do not fill more than halfway.

Check every 50 hours. Change every 1000 hours.

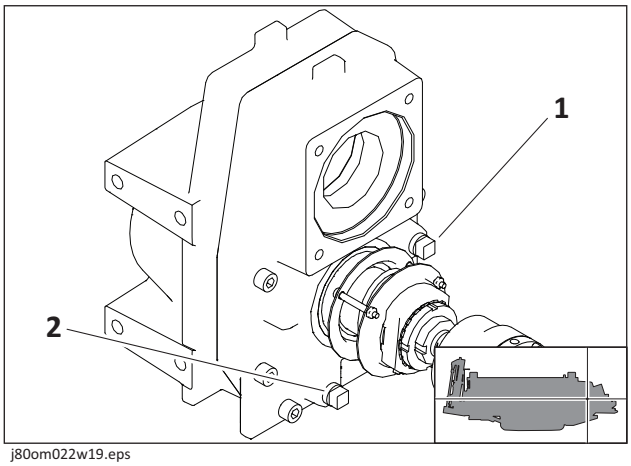
Check

1. Remove check plug (2).
2. Add MPL at fill (1) as needed to keep level visible.
3. Repeat for each gearbox.

Change

1. Rotate gearbox until drain plug is in drain position (3).
2. Remove plug to drain.
3. Install plug.
4. Remove fill plug (1).
5. Add MPL at fill to keep level visible in check plug (2).
6. Install fill plug.
7. Repeat for each gearbox.

Oil, Rotation Gearbox



j80om022w19.eps

Check every 50 hours. Change every 250 hours.

Check

1. Check level at fill plug (1).
2. Add MPL at fill as needed to keep level at indicated point on check plug.

Change

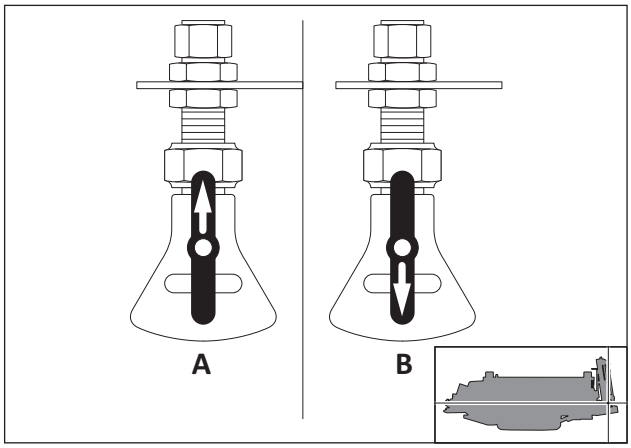
1. Remove plug (2) to drain.
2. Install plug.

NOTICE: Apply Loctite® 567 to plug before installation.

3. Add MPL at fill to keep level at indicated point on check plug.

Pipe Auto-Lubricator

Check before startup and every 10 hours. Clean as needed.



j80om033w19.eps

Check

Ensure that nozzle is free of obstructions and operates properly.

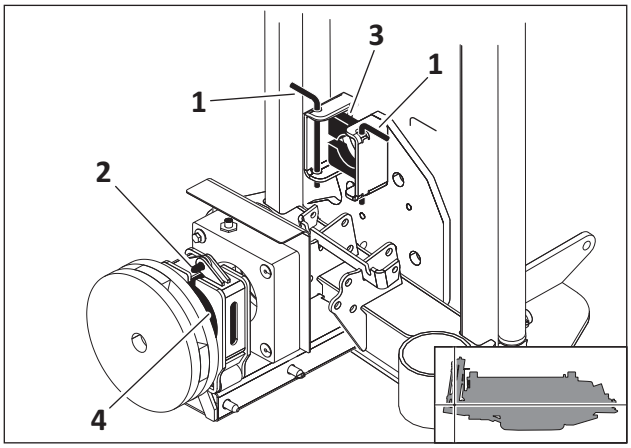
Clean

1. Rotate handle upward to the clean position (A).
2. Operate pump until obstruction is flushed.

> ***NOTICE:*** If neoprene washer is dislodged while cleaning, entire nozzle must be replaced.

3. Rotate handle down to the spray position (B).
4. Clean nozzle guard. If necessary, pull handle/nozzle insert out of housing to clean with fine wire or solvent.

Pipe Guide Inserts



j80om023w19.eps

IMPORTANT: Inserts can be rotated for longer wear.

Check before startup and every 10 hours. Change as needed.

Check

Check for wear.

Change

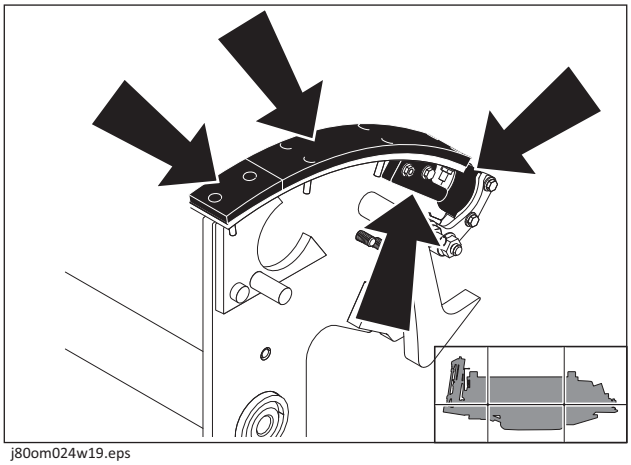
To replace front pipe guide inserts:

1. Remove lynch pins (1).
2. Remove guide inserts (3).
3. Reassemble.

To replace rear pipe guide inserts:

1. Remove pin (2).
2. Open pipe guide.
3. Remove lower guide inserts (4).
4. Reassemble.

Pipe Loader Inserts


j80om024w19.eps

IMPORTANT:

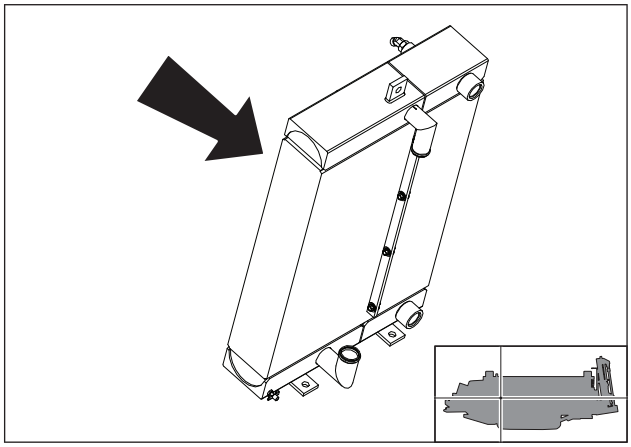
- Inserts can be flipped over for longer wear.
- Ensure bolts are tightened evenly to enable inserts to slide freely and wear evenly.

Check where shown for wear before startup. Change as needed.

Radiator

NOTICE: Radiator may need to be cleaned more frequently in dusty or grassy conditions.

Check every 50 hours. Clean as needed.


j80om034w19.eps

Check

Check radiator (shown) for dirt, grass, and other debris.

Clean

1. Clean fins with compressed air or spray wash.

NOTICE: Cleaning with high pressure air or water can damage fins.

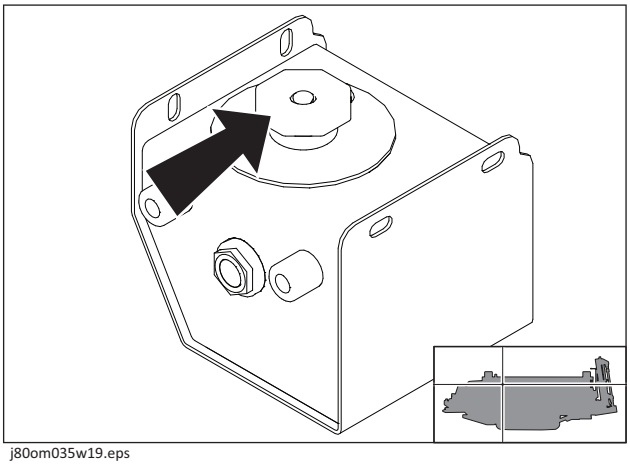
2. Open rear hood and spray through radiator toward engine.
3. If grease and oil are present on radiator, spray with solvent and allow to soak overnight.

Radiator Cap

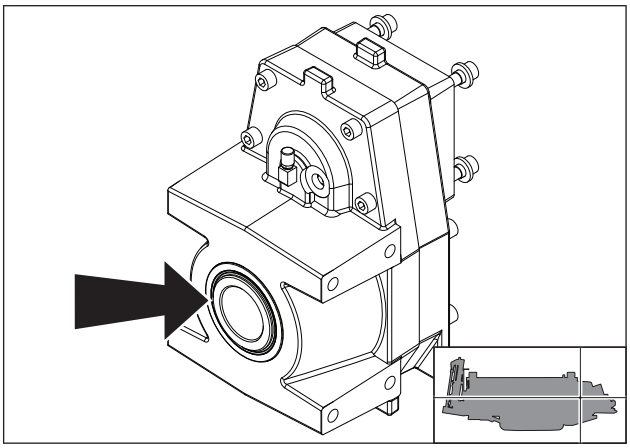
⚠ CAUTION Hot parts. Contact can cause burns. Only touch when cool or wear gloves.

To help avoid injury: Wait for machine to cool before inspecting radiator cap.

Inspect radiator cap (shown) every 500 hours. Ensure rubber seal is not damaged. Replace as needed.


j80om035w19.eps

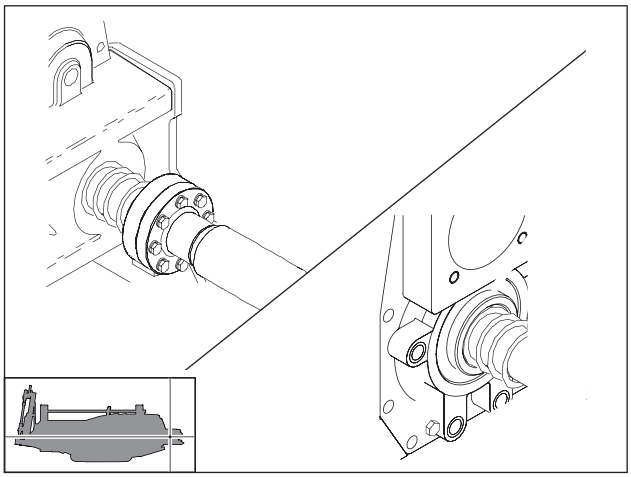
Rotation Gearbox


j80om036w19.eps

Lube rotation gearbox splines with EPG every 1000 hours.

1. Disconnect battery.
2. Clean rotation gearbox area.
3. Disconnect hose and remove water swivel.
4. Remove SaverLok® collar.
5. Remove sliding shaft from front side of gearbox.
6. Clean and dry all components.
7. Coat internal splines in gearbox with EPG.
8. Coat sliding output shaft splines with EPG.
9. Reassemble.
10. Connect battery.

Rotation Gearbox Output Shaft

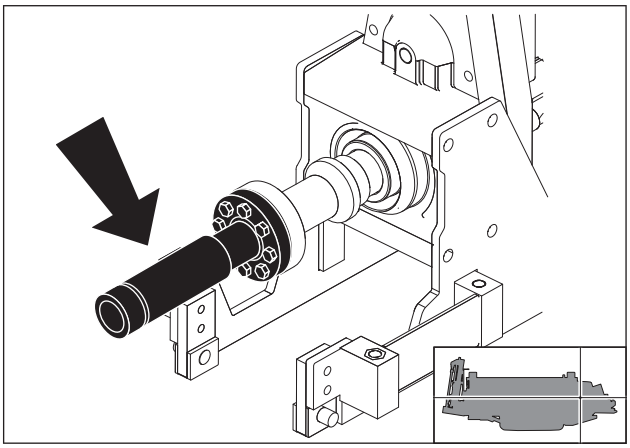

j38om001w20.eps

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

1. Clean and dry shaft.
2. Apply EPS to shaft. Move shaft in and out manually as needed to ensure all surfaces are covered.

Saver Sub

Check every 50 hours. Change as needed.


j80om037w19.eps

Check

Check saver sub (shown) for wear.

Change

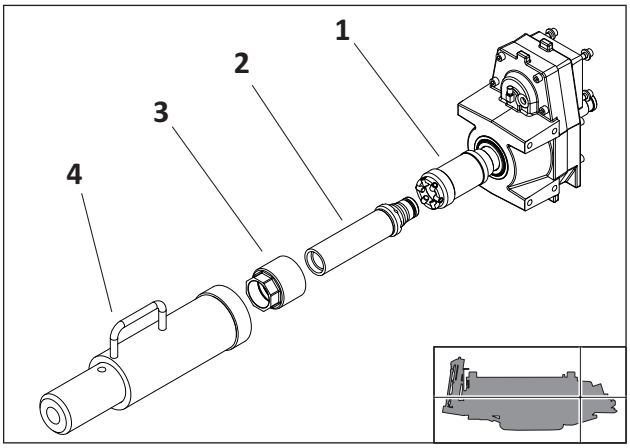
1. Remove eight bolts attaching saver sub to spindle. Do not remove indexing dowels from spindle.
2. Remove and replace o-ring as needed.
3. Reinstall.

NOTICE:

- Apply Loctite® 242 to bolts before installation.
- Tighten bolts in a cross pattern to 47ft•lb (64N•m).

SaverLok® System

Check every 50 hours. Change as needed.



j80om038w19.eps

Check

1. Remove tool (4) from storage location.
2. Slide tool over body (2).
3. Engage collar (3).
4. Start engine.
5. Clamp front wrench on tool or drill pipe joint if pipe is present.

NOTICE: Clamping wrench on nose of SaverLok will damage threads.

6. Clamp rear wrench on tool.
7. Tighten SaverLok assembly until outer rotation pressure gauge reads 3800-4500psi (262-297bar) in low speed setting.

Change

To remove:

1. Remove tool from storage location.
2. Slide tool over body.
3. Engage collar.
4. Start engine.
5. Clamp front wrench on tool or drill pipe joint if pipe is present.

   NOTICE: Clamping wrench on nose of SaverLok will damage threads.

6. Clamp rear wrench on SaverLok assembly.

   NOTICE: Machine may not build enough torque to break out collar unless both wrenches are clamped and engine is at high throttle.

7. Rotate spindle counterclockwise to unthread collar.
8. Shut off machine.
9. Remove collar. Set aside.
10. Remove body from connection (1).
11. Shut off machine.
12. Remove tool from system and store.

To install:

1. Inspect connection for damage.
2. Apply TJC to threads and all surfaces in contact with body and collar.
3. Insert body into connection.
4. Thread body into connection until o-ring is fully engaged using one of the following methods:

   4.1 Slide collar over body and engage threads by hand.

   4.2 Tap nose with rubber mallet until o-ring is fully engaged.
5. Position body by hand for proper engagement of pins and grooves.
6. Slide collar over body and hand-tighten (typically three to four turns).
7. Slide tool over collar until it is fully engaged.
8. Start engine.

9. Position carriage so small end of tool can be clamped in rear wrenches. Ensure tool handle is accessible.


DANGER Moving or thrown tools. Impact will cause death or serious injury. Never use pipe wrenches on drill string. Follow procedure in operator's manual.

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

10. Clamp front wrench on tool or drill pipe joint if pipe is present.

NOTICE: Clamping wrench on nose of SaverLok® will damage threads.

11. Set rotation speed to low.
12. Clamp wrench on tool and tighten assembly until rotation pressure gauge reads 3800-4300psi (262-297bar).

IMPORTANT: Machine may not build enough torque to tighten collar unless engine is at high throttle.

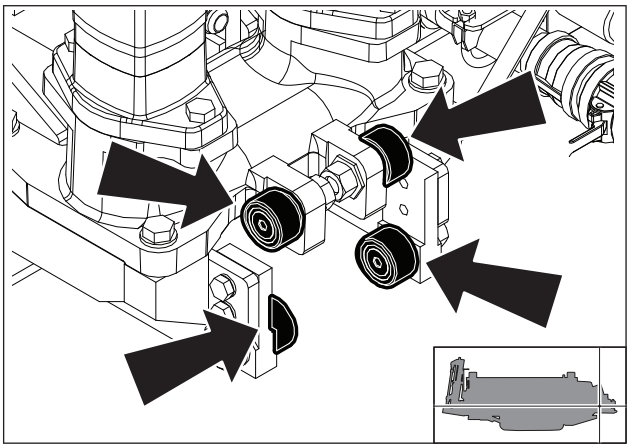
13. Immediately loosen collar and repeat process five times to break in the contact surfaces.
14. Tighten assembly until rotation pressure gauge reads between 3800-4300psi (262-297bar).

NOTICE: Clamping wrench on large diameter of collar or nose of SaverLok will damage threads.

15. Unclamp tool.
16. Position carriage to allow access to tool.
17. Shut off machine.
18. Remove tool and store.

Thrust Rollers

Check rollers (shown) at each end of carriage every 50 hours. Ensure they turn freely. Change or clean as needed.



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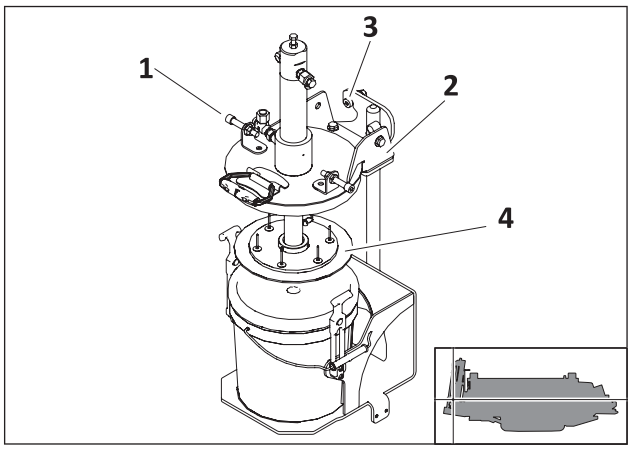
Tool Joint Compound.

NOTICE: Use only genuine Ditch Witch® TJC to maintain warranty.

Check before startup and every 10 hours. Change as needed.

Check

Check TJC level.



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Change

1. Remove TJC pail (1).
2. Lift pump and lid assembly (2) up guide pole and secure on shoulder bolt (3).
3. Remove follower plate (4) from existing pail.
4. Install follower plate into new pail.
5. Press firmly onto follower plate until TJC comes up in center opening.
6. Remove pump and lid assembly from shoulder bolt and lower into pail, guiding pump into center hole of follower plate.
7. Secure TJC pail to pump.
8. Remove cap from discharge tee on pump.
9. Operate pump until discharged TJC is free of air pockets.
10. Replace cap.

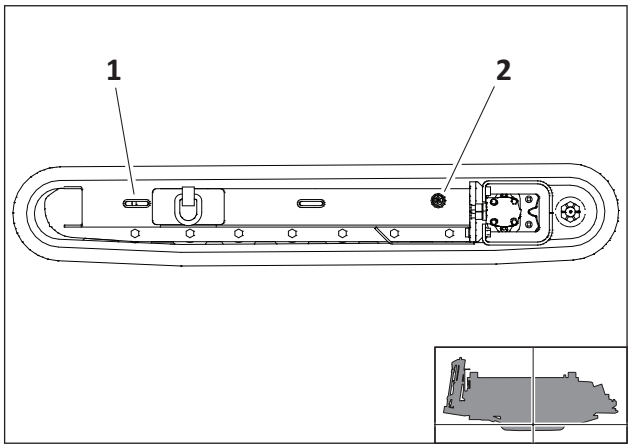
Track Tension

WARNING Contents under pressure. Impact can cause death or serious injury. Relieve pressure before opening.

To help avoid injury:

- Service track grease cylinder only while standing away from zerk.
- Cover connection with heavy cloth when relieving pressure in cylinder.

Check before startup and every 10 hours. Adjust as needed.



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Check

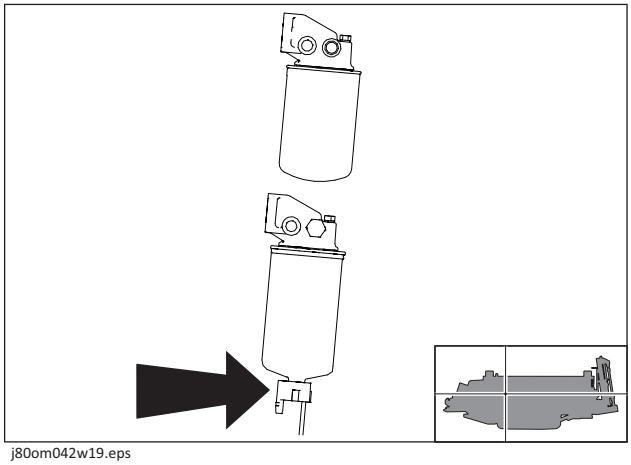
Measure length of compressed spring (1). Distance should be 21.875" (55.56cm).

Adjust

1. Adjust tension.
   1.1 To tighten, pump MPG into fitting (2) until compressed spring measures 21.875" (55.56cm).
   1.2 To loosen, use socket wrench to remove zerk and plug and drain all grease. Follow tightening procedure above.
2. Drive straight forward one machine length and check tension.

Water Separator

Check water separator (shown) located on fuel filter before startup and every 10 hours. Drain water as needed until fuel runs from drain.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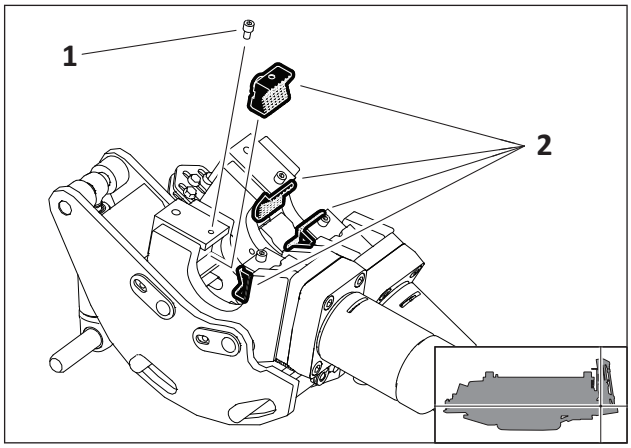
Wrench Jaw Inserts

Check inserts (shown) before each use. Change as needed.



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Check

Check for wear before each use.

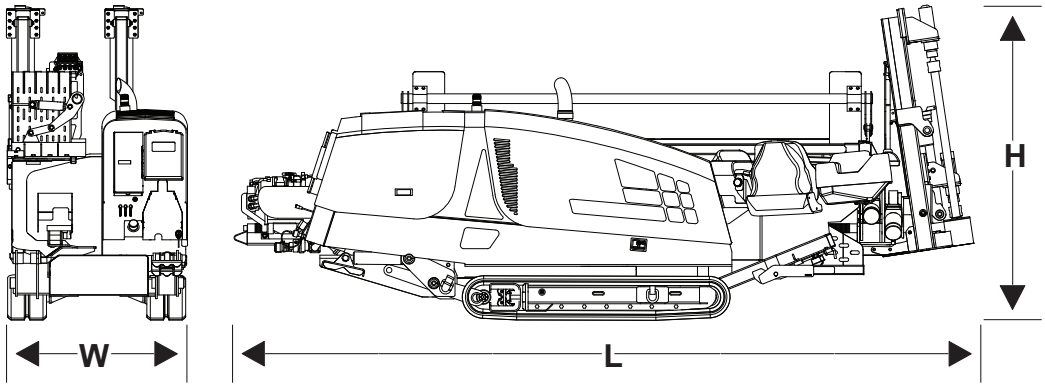
Change

1. With wrenches open, remove screw (1).
2. Remove Inserts (2).
3. Install new inserts.

Specifications

Chapter Contents

JT20



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Dimensions		US	Metric
H	Overall machine height		
	Driving*	90in	2.29m
	Transport*	75in	1.91m
L	Overall machine length		
	Driving*	207in	5.26m
	Transport*	204in	5.18m
W	Overall machine width*	51.5in	1.31m
Entry angle*		10-14°	10-14°
Angle of approach		18°	18°
Angle of departure		18°	18°

Operation	US	Metric
Maximum spindle speed*	210rpm	210rpm
Maximum spindle torque*	2200ft•lb	2980N•m
Operating mass*	11,890lb	5393kg
Carriage thrust travel speed*	100fpm	43m/min
Carriage pullback travel speed*	140fpm	43m/min
Thrust force*	17,000lb	75.6kN
Pullback force*	20,000lb	89kN

Operation	**US**	**Metric**
Bore diameter	4in	102mm
Backreamer diameter	soil dependent	
Ground bearing pressure*	7.9psi	0.56kg/cm^2
Ground clearance*	5.8in	147mm
Ground travel speed, max forward*	3.2mph	5.2km/h
Ground travel speed, max reverse*	3.2mph	5.2km/h

JT20 Power Pipe® HD	**US**	**Metric**
Length, nominal*	120in	3.05m
Joint diameter*	2.63in	66.7mm
Tubing diameter*	2.06in	52mm
Minimum bend radius*	107ft	32m
Weight, lined	67lb	30.4kg

Ditch Witch® Forged HD	**US**	**Metric**
Length, nominal*	120in	3.05m
Joint diameter*	2.50in	63mm
Tubing diameter*	2.1in	53mm
Minimum bend radius*	109ft	33.2m
Weight*	64lb	29kg

JT20 Forged HDX	**US**	**Metric**
Length, nominal*	120in	3.05m
Joint diameter*	2.65in	6.73cm
Tubing diameter*	2.38in	6.01cm
Minimum bend radius*	123ft	37.49m
Weight*	73lb	33.57kg

Engine	**US**	**Metric**
Engine: Deutz® TD2.9L4 EU Stage V		
Fuel	Diesel	

Engine		**US**	**Metric**
	Cooling medium	Liquid	
	Injection	Direct	
	Aspiration	Turbocharged	
	Cylinders	4	
Displacement		$177in^3$	2.9L
Bore		3.62in	92mm
Stroke		4.33in	110mm
Manufacturer's gross power rating (per SAE J1995)		74.3hp	55.4kW
Rated speed		2600rpm	2600rpm

Drilling Fluid System	**US**	**Metric**
Maximum drilling fluid pressure*	1000psi	69bar
Maximum drilling fluid flow*	35gpm	133L/min

Fluid Capacities	**US**	**Metric**
Hydraulic reservoir	19gal	72L
Fuel tank	30gal	114L
Engine oil, including filter	8.5qt	8L
Cooling system	4.75qt	4.50L

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

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

Noise Level
This machine can generate sound levels exceeding 80dBA. Always wear appropriate hearing protection when operating machine. Find sound power and pressure information at www.ditchwitch.com, or contact customersupport@ditchwitch.com.

*Per SAE J2022

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

Declaration of Conformity

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

The Charles Machine Works, Inc.
PO Box 661959 West Fir Avenue
Perry, Oklahoma, USA 73077-0066
Phone: 580 572 3784
FAX: 580 572 3525

Declares that the product:

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

Conforms to the requirements of:

2006/42/EC Machinery Directive
2004/108/EC Electromagnetic Compatibility Directive
2000/14/EC Noise Emission Directive
Measured sound power level (Annex V): **XXXdBA**
Guaranteed sound power level (Annex V): **XXXdBA**

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

The manufacturer's European representative is:

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

Support

Registration

If your equipment was purchased through a Ditch Witch® dealer, it is already registered. If you purchased from any other source, please email productsupportwarrantyadmin@ditchwitch.com or fill out the registration card located in the back of the parts manual. Registration enables you to receive updates on this equipment as well as information on new products of interest.

Procedure

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

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

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

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

Resources

Publications

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

Ditch Witch® Training

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

Warranty

Ditch Witch® Equipment and Replacement Parts Limited Warranty Policy

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

Exclusions from Product Warranty

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

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

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

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

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

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

For information regarding this limited warranty, contact the DWPS department, P.O. Box 66, Perry, OK 73077-0066, or contact your local dealer.

First version: 1/91; Latest version: 7/19